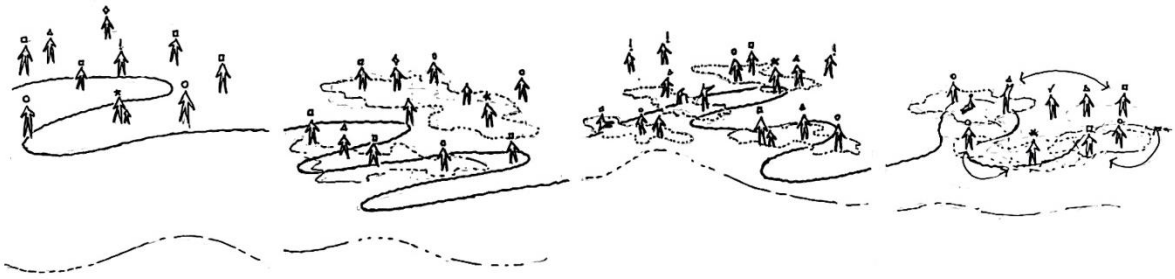

Co-creating the Dynamic Adaptive Policy Pathways (DAPP)

A case study of Vejle

Master Thesis

Submitted by
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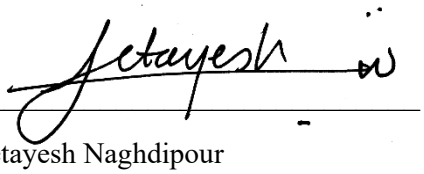
Abstract:

Climate change has increased the intensity and frequency of extreme events, adversely affecting human settlements. Climate Change Adaptation (CCA) is crucial to address these rising risks. However, barriers like uncertainty can hinder effective action. Approaches like the Dynamic Adaptive Policy Pathways (DAPP) offer flexible, long-term planning steps to avoid lock-in situations. Additionally, participatory processes and integrating diverse knowledge sources are essential for effective CCA, requiring approaches that foster collaboration among various actors. This research investigates the roles of co-creation in the Multi-Criteria Analysis (MCA) step of the DAPP approach. On this basis, the MCA step of the DAPP is developed based on the dimensions of co-creation, stages, stakeholders, and tools. Applying the developed DAPP process to the case of Vejle in managing the risk of rising sea levels shows that co-creation in dynamic planning not only might improve stakeholder relations and networks but also can enrich the DAPP process with new ideas and experiences, leading to more robust and adaptive policy pathways. However, it is essential to discuss the applicability of the developed DAPP process to other contexts and hazards.



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Executive Summary

The increase in frequency and intensity of extreme events, ranging from heat waves and droughts to flooding, has led to significant harm to humans, their settlements, and infrastructure as a result of climate change (OECD, 2022). Hence, it is important to adapt to the impacts of climate change in the climate (UN, n.d). Today, decision-makers face not only external factors of deep uncertainty, such as climate change, population growth, and new technologies and their consequences but also changes in societal preferences and perspectives over time, encompassing the interests of stakeholders and their evaluation of plans (Haasnoot et al., 2013). Addressing this issue, a new planning paradigm that highlights the need to design dynamic adaptive plans to address deep uncertainties has emerged (Haasnoot et al., 2013). Danish Coastal Authority adapted the approach to the context of Denmark. According to this guide, a wide range of participation is limited to some steps, especially in the step of multi-criteria analysis (MCA), which causes the bias affecting the outcome of the process. This study is formed around developing the guide to dynamic planning in Denmark made by the Danish Coastal Authority by promoting the participation of a wide range of stakeholders in all steps and mitigating the bias and disciplinary visions in dynamic planning. The research provided constructive criticism of the current guideline for employing the DAPP approach in Denmark and aimed to develop the current guide. The co-creation concept, rooted in the innovation theory, was selected, pointing to a collaborative process of making new knowledge, which in this case translated as generating new visions and solutions with a collaborative effort and based on a shared understanding of the uncertain future. On this basis, this study aims to address the roles of co-creation in the MCA process of the DAPP approach.

Three sub-research questions have been formulated to address the mentioned research question. On this basis, the first sub-research question investigates different municipalities that experienced the process of the DAPP through the guide. In order to do so, the municipalities of Aabenraa, Randers, and Skive are selected. This investigation was carried out based on Document analysis and semi-structured interviews. The results show that their practice of the DAPP approach was mainly limited to interdisciplinary approaches in two risk areas of Randers Fjord and Aabenraa. In the case of Skive, however, the municipality tried to hold a participatory process of dynamic planning for the risk of flooding through co-creation, it was not feasible for all stages as it could become complicated. Therefore, it was limited to bringing new visions and ideas as actions in the second step of the DAPP.

For addressing the second research question aiming at developing the MCA step of the DAPP approach through co-creation. A systematic literature review is implemented to address the question, exploring the ways in which the DAPP process, based on the *guide to dynamic planning* (Kystdirektoratet, 2020b), can be developed. On this basis, the three dimensions of co-creation, stages, stakeholders, and tools, were adapted to the conditions of dynamic planning. However, the study focuses on co-creating only the elements of the MCA step of the DAPP; in defining the pathways as an element for the MCA step, the co-creation of the previous steps is also investigated. As the dynamic planning process is founded on the definition of uncertainty and the likelihood of the risks in the long term, it was also necessary to explore steps 0 and 1 in the dynamic planning process, where the acceptable risks and uncertainties in the system and climate are defined. In identifying and analyzing the stakeholders in the process, the stakeholder characterization framework is used, characterizing them based on their belonging, role, relation to the hazard, and their relation to the actions. Eventually, the related tools and methods required for co-creating the options, criteria, and weightings of the MCA are implemented.

The third sub-research question aims to apply the new guideline developed by the previous question and investigate it with the conditions of the Vejle case. To address the question, document analysis, and interviews provide information regarding the context and the conditions of co-creation. Results from the first and second questions provided the foundation for addressing this question. Due to the complexity of the case of Vejle, the study only focuses on the risk of flooding from the fjord and also limited the area of the study to the East district risk area of Vejle. This area is primarily affected by the risk of flooding from the fjord. In the case of Vejle, co-creating the MCA of the DAPP forms around the steps provided in the previous result. In addition, the stakeholders are selected based on the framework provided by the second analysis. In this case, co-creating the MCA process in the DAPP can develop the process of defining the elements of the MCA process by establishing new relations and networks, stimulating the learning about the uncertainties due to changes in climate, increasing awareness regarding the stakeholders' responsibilities against rising sea levels, bringing and gathering new knowledge, and eventually co-designing new visions and initiatives.

The outcome of this investigation provided a guideline aiming to design the MCA's elements in the DAPP approach through the co-creation process. It can develop the products of the process by using different sources of innovation and can mitigate the bias and subjectivity of the MCA process. Regarding the main research question, co-creating the dynamic planning assists in establishing new relations and networks through the stakeholder characterization framework. Integrating the variety of participants from the first steps of the dynamic planning, where the acceptable risks and uncertainties are described, not only provides a shared understanding of the context but also can enable them to formulate the problem together. It also provides an opportunity to harness local knowledge, ensuring the integration of all perspectives and ideas from the local knowledge. The developed process of defining the elements of the MCA can also stimulate learning among participants and increase their awareness of changes in climate, especially with their uncertainties and their responsibilities.

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I. Introduction

This chapter consists of two sections. The first section provides background information related to the project topic, and the second section, problem analysis, introduces the research question and its relevance and purpose.

1. Introduction

Climate change has caused several adverse impacts due to the changes in frequency and intensity of extreme events, leading to losses and damages to nature and human populations (IPCC, 2022). These impacts are often categorized as primary and secondary impacts and range from changes in rainfall resulting in more floods or droughts and more frequent heat waves to rising sea levels and storm surges (UN-Habitat, 2014). Furthermore, the risks threatening urban areas have increased due to the number of people expected to live in urban settlements with increasing exposure to the impacts of the changing climate (IPCC, 2022). Thus, it is necessary to take measures to assist in reducing their impacts on ecosystems and people's well-being (USEPA, 2023).

Due to climate change's impacts, global and regional mean sea levels are expected to undergo changes (IPCC, 2022a). These changes are categorized into two categories: slow-onset events, defined as events that evolve slowly, taking place in the long term, and sudden or rapid onset events that might be a single event that happens in a matter of days (UNFCCC, 2011). Two significant aspects of sea level are, firstly, the climate-induced Global Mean Sea Level (GMSL)(due to the thermal expansion of ocean water and ocean mass growth) and secondly, the extreme sea level events such as storm surges and tides, that both require critical investigating of the responses to sea level change (IPCC, 2022a). These impacts happen on temporal and spatial scales and threaten coastal communities (IPCC, 2022a). In addition, the interdependence of various factors that cause floods, such as storm surge/tide, sea level rise (SLR), and river flow, can result in the occurrence of compound events (Moftakhari et al., 2017). Their impacts are already experienced around the globe, encompassing damage to infrastructures, coastal erosion, freshwater salination, and habitat loss (McMichael et al, 2020; IPCC, 2018). Low-lying cities and settlements by the sea face adverse impacts of climate change and its interactions with non-climatic drivers, such as the coastal change that increases the frequency and intensity of coastal hazards (IPCC, 2022b). Furthermore, some of the world's most densely populated areas are found in coastal zones, which are also home to many of the largest cities and fastest-growing urban regions worldwide (McMichael et al., 2020). Hence, due to their exposure to various flood drivers, coastal cities require considerations in local planning and adaptation (Moftakhari et al., 2017).

Post-2050, the uncertainty concerning sea-level rise induced by climate change significantly increases, attributed to uncertainties in emission scenarios, resulting in climate variations and the Antarctic Ice Sheet's response to a warmer global environment (IPCC, 2022a). Projections show that GMSL will rise between 0.43 m (0.29-0.59 m range) under RCP 2.6 and 0.84 m (0.61-1.10 m range) under RCP 8.5 to the end of the century. In addition, the increase in sea level will continue beyond 2100 (Ibid). The range must be considered for planning and decision-making concerning coastal responses and depends on the risk tolerance of stakeholders, including those deciding and those who are affected by a decision (Ibid).

In Denmark, the sea level is predicted to rise more rapidly by the end of the century (2071-2100) and is expected to increase between 0.3 and 0.6 m. Also, the intensity and frequency of storm surges is predicted to increase by the end of the century (Klimatilpasning, 2021).

There are several measures implemented by coastal communities in order to adapt to flooding from the sea, which can also be supportive for flood risk reduction (IPCC, 2022a). The design and implementation of an appropriate combination of measures is not only a technical mission but also a fundamentally political and value-laden societal decision involving trade-offs among various values, objectives, and interests (Ibid). Considering the transformations of socio-ecological systems aiming at achieving adaptation, several institutional, organizational, economic, socio-cultural, and knowledge-based barriers have emerged due to the systemic and cross-cutting nature of Climate Change Adaptation (CCA) (Galan et al., 2022). These barriers are: temporal barriers and short-termism, knowledge barriers and uncertainty, governance and institutional barriers, planning and policy barriers, social engagement and legitimacy barriers, and resource barriers (Galan et al., 2022).

Among all the mentioned barriers to climate change adaptation, societies face governance challenges and difficult choices in implementing and selecting the responses to SLR due to uncertainties. A wide range of uncertainty concerning the future changes in sea level, primarily related to the challenges with planning for post 2050, and its substantial expected impacts and socio-economic conditions make planning and making decisions difficult (IPCC, 2022a).

1.1. Uncertainty

As stated in the previous section, uncertainty to future changes in climate and its impacts poses challenges to planning for adapting to climate change, and it is imperative to address this issue. This section introduces the concept of uncertainty, including deep uncertainty, and highlights the importance of incorporating it into the planning process.

Uncertainty is described as limited knowledge concerning the future, past, or current events (Walker et al., 2013). In the context of decision-making, it is characterised as the gap between the knowledge that is available and the required knowledge for decision makers to generate the best policy choice (Marchau et al., 2019).

Uncertainties due to the changing climate include inherent uncertainty originating from insufficiency of models, the need to establish boundaries, inaccuracy of measurements, and other issues that systemically create gaps in understanding as a function of constructing knowledge (Butler et al., 2015; Roelich and Giesekam, 2018). Especially, uncertainty in climate projections creates challenges for adaptation planning, which can result in maladaptive or ineffective strategies (Woodruff, 2016). Thus, it is crucial to employ approaches that enable assessing and addressing this concept in adaptation planning (Ibid). In the context of climate change, the uncertainty lies in four dimensions: (1) the magnitude of the change that points to the wide range in future scenarios, (2) the speed of the changes, (3) implications for a specific area that illustrates the uncertainty in the range of impacts in various regions, and (4) the policies that point to both mitigation and adaptation to the consequences of climate change (Marchau et al., 2019).

In addition, according to Hallegatte et al. (2012), deep uncertainty refers to a condition when one or more of these situations is present: (1) where various possible future worlds exist without understanding their

relative probabilities, (2) the presence of various divergent perspectives encompassing values implemented to determine the criteria of success, and (3) where decisions cannot be considered independently and must adapt over time.

Changes in climate provide an example of very deep uncertainty regarding the multiple competing perspectives and values, lack of explicit probability in them, and high interrelation in a series of decisions over time (Hallegatte et al., 2012). Today, decision-makers face not only external factors of deep uncertainty, such as climate change, population growth, and new technologies and their consequences, but also changes in societal preferences and perspectives over time, encompassing the interests of stakeholders and their evaluation of plans (Haasnoot et al., 2013; Offermans, 2010; Van der Brugge et al., 2005).

Hence, a new planning paradigm that highlights the need for designing dynamic adaptive plans to address deep uncertainties has emerged (Haasnoot et al., 2013). These plans encompass a strategic vision concerning the future that includes short-term actions while establishing a framework guiding future actions (Haasnoot et al., 2013; Ranger et al., 2010).

1.2. Adaptive dynamic planning

Making decisions for the future depends on anticipating the changes, and it becomes difficult to achieve long-term objectives (Marchau et al., 2019). Considering the uncertainties in different fields, such as changes in climate, socio-economic, and political aspects, dynamic planning provides long-term strategic planning with flexibility, keeping options open and avoiding lock-in (Haasnoot et al., 2019; Kuijken, 2012).

This particular approach was created to support the execution of long-term plans and strategies in the face of uncertainties by addressing adaptability at the beginning of the process (Walker et al., 2013). Hence, the changes participate as part of a larger recognized process where planners attempt to keep the system centered on the original goals through monitoring and corrective actions (Ibid).

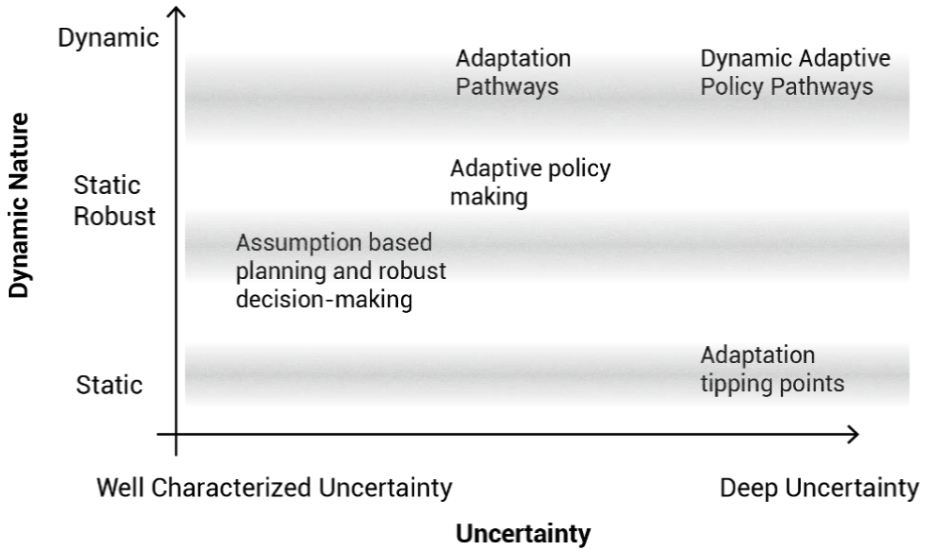


Figure 1.1: Approaches for developing adaptive planning based on the range of uncertainty (Adapted from Walker et al., 2013).

Figure 1.1 shows how various adaptive policies are developed according to the uncertainty level. In the figure, static condition represents timing is not considered clearly; static robust means that adaptation has primarily an anticipatory character, while dynamic illustrates the anticipatory, simultaneous, and reactive character of adaptation (Walker et al., 2013).

Changes in climate is introduced commonly as a source of deep uncertainty (Marchau et al, 2019). According to the concept of deep uncertainty, Dynamic Adaptive Policy Pathways (DAPP) is an approach encompasses the pathway notions of Adaptive Policymaking, where both approaches assist in the recognition of various options and vulnerabilities of a plan over time (Walker et al., 2013). Hence, they provide suitable approaches for situations that are prone to undergoing significant frequent changes (Ibid). It explores various pathways and considers actions' path-dependencies and includes long-term options and short-term actions (Lawrence and Haasnoot, 2016).

In the context of a high range of uncertainties in complex coupled physical-technical-human systems, the DAPP approach provides the ability of long-term decision-making dependant on the path, thereby limiting the risks of maladaptive actions and assisting the identification of the best sequence of actions flexible to various scenarios (Haasnoot et al., 2019).

1.3. Dynamic adaptive planning in the Danish context

In order to formulate Climate Action Plans (CAP) that are aligned with the aims of the Paris Agreement, Danish municipalities received guidance and collaborated through DK2020 to prepare climate action plans (Lind and Hansen, 2023). Hence, almost all municipalities provided the plans by the end of 2023 (Ibid). In addition, the municipalities prone to potential flood risks had to provide risk management plans to reduce the risks related to flooding events (Kystdirektoratet, 2020b).

The document *Adaptation Approaches in Danish Municipalities' Climate Action Plans* (Lind and Hansen, 2023), which aimed to review the municipality's work on climate adaptation in the DK2020 project, mentioned several points that showed the need for more dynamic approaches to CCA plans. Firstly, it emphasized on the significance of considering and integrating uncertainty and the range of outcomes in climate models for decision-making. Secondly, it pointed to implementing flexible approaches for adaptation planning that encompass the possibility of alternative strategies. Thirdly, the authors also highlight the need for more systematic approach that can include new knowledge and bridge the gap between science, experience, and policy development in climate adaptation strategies. Eventually, the document highlights the importance of a closer collaboration between researchers, knowledge institutions, decision-makers, and stakeholders to achieve this goal (Ibid).

Although the CCA plans provided a long list of measures to handle issues related to flooding, it was challenging to observe the connections and dependencies between actions. Therefore, in order to address the temporal perspectives due to the uncertainties and the interdependencies and relations between different CCA actions and municipal development plans, the Danish Coastal Authority provided a guide to dynamic planning adjusted to the Danish context based on Haasnoot et al. (2013). Furthermore, this guide assists in creating a shared understanding and language related to CCA and risk management at the municipal scale (Kystdirektoratet, 2020b).

According to figure 1.2, the process commences with defining the expectations, objectives, and acceptable risks (step 0). In this step, in addition to defining the resources for the process, the working group of the whole process will be established. The next step (step 1) aims to generate a shared understanding of the area based on the Source-Pathway-Receptor (SPR) analysis, where the source of the flooding, the existing measures, and all event receptors are investigated. In this step, the shared understanding also consists of investigating the uncertainties in relation to the current and future conditions of climate and system. In the next step (step 2), this shared frame generates a catalog of all potential CCA measures that consider the municipality's other visions and development plans. Step 3 aims at understanding the individual measures by elaborating more in-depth descriptions of them and identifying their potential limitations. On this basis, in the next step (step 4), the dynamic measure maps form considering the interaction among different initiatives that were selected before. In the multi-criteria analysis step (step 5), selected pathways are evaluated based on the criteria and weightings dedicated to each criterion. The selection of criteria and weightings depends on each municipality and is based on local preferences and interests. The next step (step 6) aims to develop a detailed climate action plan containing all elements and details of each measure to be completed or implemented in the future. Eventually, the whole process follows up concerning any change in the system, such as changes in climate, municipal legislation, or urban development (Kystdirektoratet, 2020b).

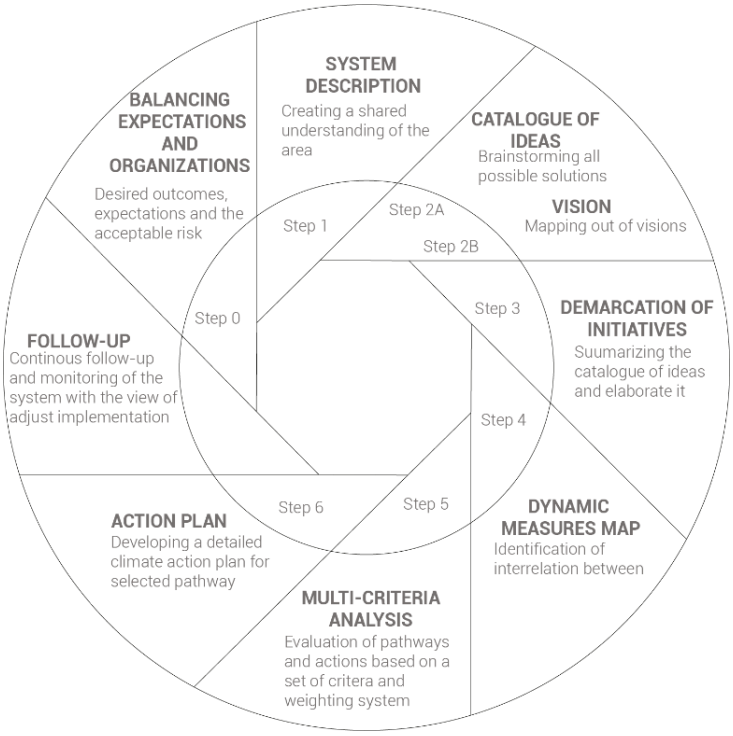


Figure 1.2: DAPP process adjusted by Danish Coastal Authority (Kystdirektoratet, 2020b).

Furthermore, the Coastal Authority introduced and facilitated the DAPP approach through a pilot project in Vejle and Assens, implementing the approach for flood risk management (Kystdirektoratet, 2020a). The two pilot areas were different in size, the complexity of the affected area, and the stage of making risk management plans. Before the process, the Danish Coastal Authority held a workshop with two partners, Kent County Council from the UK and HZ University of Applied Sciences from the Netherlands, in order to review and discuss the DAPP approach. Afterward, the method was customized based on the DCA's

experience and meetings with a consultancy company, Deltares, with the aim to adjust the method to the Danish context. The process of testing the DAPP approach in two municipalities, Vejle and Assens, was undertaken in eight meetings in each municipality (Kystdirektoratet, 2020a). The evaluation of the process showed that the DAPP approach is a suitable supportive procedure with DCA's facilitation, enabled municipalities to structure their discussions and better understand their challenges, and gave them structured specialist guidance. Furthermore, municipalities can not carry out the procedure alone, requiring a facilitator possessing specialist expertise in adaptation and risk reduction (Kystdirektoratet, 2020a).

2. Problem Analysis

The experience in both pilot areas showed that the participation was limited to a group of a project manager from the municipality's environment and nature department, representative from the Marina, an urban planner, and Coastal Authority as a facilitator. Furthermore, in the case of Vejle, an engineer from the watercourse and an architect participated in the process (Kystdirektoratet, 2020b). The experience in both pilot areas regarding the MCA step showed that the process in both cases was too simplified, and only the mentioned experts participated (Kystdirektoratet, 2020a). This can lead to highly subjective outcomes depending immensely on the participant's bias and focus on the time when the MCA was carried out (Ibid). Assessing the case of Assens, DCA specially mentioned the significance of a need for a broad group of participants in the MCA step that enables making decisions including more viewpoints and considerations (Kystdirektoratet, 2020a).

According to this challenge experienced in both cases primarily regarding the MCA process, an approach to dynamic planning that supports the inclusion of various ideas and perspectives is needed where the participation of actors representing various point of views can enhance the outcome of the dynamic planning process decreasing the bias in the MCA process.

According to this, Lawrence and Haasnoot. (2016) argues that new approaches to adaptive planning are needed not only to make them available for decision-makers but also supplementary actions required to catalyze the implementation of them. Supplementary actions such as structured processes for institutionalizing adaptive planning that address the interests, values, and preferences of current and future generation representatives. These actions are suggested as (1) Actors from various levels of governance in the public sector and individuals from the private sector, (2) Buy-in from the top, (3) An agent who coordinates, (4) regular exchange between stakeholders and scientists, and (5) Uncertainty communication (Lawrence and Haasnoot, 2016). In this context, Adger (2003) also points to the significance of effective local collective action in enabling societies to adapt to changes in climate. The author also mentions that, it is important to consider the information networks and flows among groups and individuals.

Several researches highlight the significance of community support and stakeholder engagement in adaptive planning processes. For instance, a research by Kool et al. (2020) underlines the central role of stakeholder and community engagement in planning for managed retreat based on adaptive planning. The authors point to the role of knowledge of local experts and inputs of the community in minimizing the chance of overlooking some critical dimensions, setting the community's understanding, enhancing 'buy-in' to strategy, and facilitating implementation. Furthermore, Bosomworth et al. (2017) highlight the need for adaptive planning to understand clearly the engagement of contested and various goals and means.

Therefore, the authors highlight the need for a transparent engagement process ensuring equal diversity of ideas and knowledge in adaptive planning (Bosomworth et al., 2017; Van Aalst et al. 2008).

In addition to the participatory approaches to dynamic planning, Rodima-Taylor et al. (2011) also argue that effective responses to changes in climate need innovation not only in technological aspects but also in institutional and relational aspects. Furthermore, the authors state that in this context, in order to achieve effective responses, collective and collaborative aspects of innovation must be included in the notion of adaptation. In addition, they highlight the need for an interdisciplinary integration of climate change study and the ability to collaborate in exploring climate adaptation through the lens of multiple disciplines and different geographies. Hence, as climate changes, a broader partnership among all stakeholders and co-production of knowledge is required (Ibid).

In addition to the supplementary actions mentioned by Lawrence and Haasnoot (2016) and needs for more interdisciplinary integration to have effective CCA, Johnson et al. (2012) point to the ability of the scenario development process in improving the system of participants' understanding and social networks and generate learning, knowledge co-production, innovation, and, eventually, changes in practice and action.
Among all concepts related to participation, co-creation provides a structure enabling an effective participation approach. Co-creation provides a sustainable bottom-up approach enabling integration and meeting the communities' needs, generating innovative public services, assisting the process of decision-making, and encouraging transparent, democratic, and non-ambiguous decisions (Grcheva and Vehbi, 2021; Bond, 2011).

It not only provides the ability to bring innovative new outcomes from collaboration between multiple groups of actors (Pappers et al., 2020) but also provides a context for locally-based research to comprehend the vulnerability and views of social science in responding to changes in climate by integrating different perspectives and requirements (Yarnal, 2010). Therefore, according to the need for more participatory approaches to achieving effective adaptive planning in the context of an uncertain future and in accordance with the problem in two pilot projects, in this research, co-creation is implemented in developing the process of dynamic planning In Denmark. This concept can provide a systematic approach addressing the inclusion of new knowledge by generating closer collaboration between different actors.

On this basis, this report aims to examine the following research question:
What are the roles of the co-creation in the Multi-Criteria Analysis (MCA) step of the Dynamic Adaptive Policy Pathway (DAPP) approach?
The research aims to add a layer to the dynamic planning process enabling collaborative efforts by generating networks through the co-creation process in designing the process of MCA.

II. Methods

This chapter is divided into two sections: the first section provides the theoretical and conceptual basis for the study investigating the research question, and the second section is dedicated to the methodologies that were implemented to guide each sub-research question to the answers.

3. Theoretical and conceptual framework

This section identifies and explains the pertinent theories and concepts for the conceptual framework. Firstly, the theories of stakeholder and innovation are studied, providing a basis for co-creation. In addition to the concept of co-creation, multi-criteria analysis (MCA) and flood risk management are also investigated in section 3.

3.1. Stakeholder theory

Stakeholder theory (ST) is founded on business ethics and organizational management (Mahajan et al., 2023; Schaltegger et al., 2019). It highlights that supporting shareholders together with stakeholders is necessary for organizations to exist and thrive (Mahajan et al., 2023). Stakeholders are defined as "those groups or individuals with whom the organization interacts or has interdependencies" and" any individual or group who affects or is affected by the actions, decisions, policies, practices or goals of the organization." (Gibson, 2000, 245; Carrol 1993, 60).

ST is defined as a theory that (1) motivates organizations to identify and consider their internal and external stakeholders, (2) encourages understanding and managing the needs and demands of stakeholders in the decision-making process, (3) defines a comprehensive and accountable framework that surpasses the emphasis on shareholders in the process of making decisions, and (4) consequently, allows organizations achieving strategic goals, optimizing their value creation, and ensuring their long-term success (Mahajan et al., 2023). There are three approaches to stakeholder theory. The descriptive approach seeks whether the interests of stakeholders are considered, while the instrumental focuses on stakeholder's impact regarding corporate effectiveness. The normative approach concerns considering interests stakeholders even when no apparent benefit exists (Gibson, 2000; Donaldson and Preston, 1995).

The characteristics that make stakeholders prominent in negotiations are power, legitimacy, and urgency (Beck and Storopoli, 2021; Mitchell et al., 1997). For managers, these attributes are significant in prioritizing and classifying stakeholders, leading to better decisions on time spending and resources (Beck and Storopoli, 2021). *Power* is defined as the way that they establish or force their will. *Legitimacy* refers to the shared and wide social and organizational perception that is desired, appropriate, and desirable. *Urgency* is defined as claiming something based on ownership, expectations, and sentiment, and it has an inherent dynamic (Ibid).

Application of the stakeholder theory in an urban setting can enhance urban management by fostering better relationships among the various urban stakeholder networks and supporting the municipality in achieving its objectives (Beck and Storopoli, 2021). This means that public managers can make better strategic decisions by considering the perspectives of urban stakeholders (Beck and Storopoli, 2021; Bryson, 2004). Furthermore, Fainstein (2000) analyzed the planning theory's communication model regarding the

responsibilities of urban planners towards urban stakeholders. According to this model, urban planners are accountable for democratizing urban management and promoting accord without the dominance of any elitist group. They should also act as intermediaries between society and government.

ST enables planners to conceive urban areas as containing issues and relationships (Andersen and Nielsen, 2009). The transition from a single government planning activity to innovative urban development is a complex strategic governance matter (Belkaid et al., 2013). This transition introduces the concept of stakeholders in urban governance and advocates for the use of stakeholder theory as a conceptual approach to the city's development (Ibid). By adopting this approach, the city can be viewed as a complex organization, allowing for a rethinking of the city through the networks of relationships between the actors and structures involved (Ibid).

3.2. Innovation theory

Innovation is defined as the ‘’application of knowledge to produce new knowledge’’ (Johannessen et al., 1999; P.2). It is often based on the creation and distribution of new knowledge or on introducing existing knowledge in a new way to organizations (Lambooy, 2005).

The process of innovation includes three stages of invention: the first emergence of an idea; innovation, which represents the first commercial application of the invention; and diffusion, which points to the spreading of the process through the market (Greenacre et al., 2012). Jensen (2021) also argues that these processes can be characterized as both incremental, where the aim is to do better what we already do, and radical innovation, which aims to do what we did not do before. Lambooy (2005) highlights two aspects of innovation: access to basic knowledge and the application of knowledge. The author also argues that in the context of innovation, it is necessary to know how knowledge is introduced, transferred, and distributed and what kind of institutional and social systems are required to foster the generation of knowledge (Ibid).

Innovation is derived from an iterative procedure of communication and interaction among individuals, organizations (e.g., universities or businesses), systems, and institutions implementing signals to determine the directions and orientations in which to develop (Lambooy, 2005). It is the outcome of both individual endeavors and the interaction with environments, and its impacts can revolutionize organizations or transform them marginally (Ibid).

Lambooy (2005) argues that innovation opportunities can be assessed from different views:

- Firms and organizations: it defines in which organization or enterprises the process and diffusion can take place.
- Systems: that are defined as sectors, networks, social systems, regions
- Institutions: illustrates various cultures, resistance to transformation, and educational values
- Individuals: represents the abilities, entrepreneurship, attitudes

According to the purpose of this study, investigating the stakeholder and innovation theory provides understanding prior to investigating the co-creation.

3.3. Co-creation

The co-creation concept is based on the notion of 'open innovation' and the production of joint knowledge (Gioia, 2015). It originates from the business domain and highlights the meaning of value creation through the development of systems, services, or products in collaboration with customers, employees, managers, and other stakeholders (Galan et al., 2022).

Processes of co-creation can be defined as a collaborative effort between various stakeholders or actors who, upon establishing a common framework, participate in the collective generation of knowledge (Mauser et al., 2013). In this procedure, various engaged stakeholders are part of the problem-solving process, and they participate as co-designers (DeLosRios-White et al., 2020). Also, Vandael et al. (2020) argue that all parties offer information and not only collaborate in defining the problem but also in solving it by collaborating collectively. The process has various advantages, including enhancing the understanding of the priorities and values of participants, making greater social accountability, and enhancing the links between practice and research (Kench et al., 2017).

Co-creation is based on the idea that each individual brings distinct perspectives, experiences, and interests (Rădulescu et al., 2020). This allows for a diverse range of viewpoints to be shared, leading to a deeper understanding between all parties involved (Ibid). It also assists in generating an outcome with continuous improvement of results through innovative step-changes leading to novel pathways of problem-solving (Torfing et al., 2019). In the context of design, it presented with key points of empowering, possibility of engage and influence of who are affected by design, and providing the opportunity to gather actors' expertise and knowledge (Koning et al., 2016).

The concept was employed mostly in marketing, management, product development, and services (Gioia, 2015). However, in the public sector, it has received attention from planners and policymakers who employed the concept to discover innovative pathways dealing with rising complex environmental and societal challenges (Rădulescu et al., 2020). It aligned with the growing trend of integration of stakeholders in planning in the last decades, according to the notion that it might enhance the understanding of current complex challenges in planning, leading to a 'win-win-win' solution for them (Ibid). In the urban development context, the significance of co-creation resides in its position between economic and social actors through and across interacting and exchanging networks (DeLosRios-White et al., 2020). It allows the entire procedure to be transparent and inclusive, from planning to implementation and assessing its impact (Ibid). Furthermore, this approach accelerates the demand for capacity building in public administration, leading to effective, shared governance (Dushkova and Kuhicke, 2023; Van der have et al, 2022, DeLosRios-White et al, 2020). Co-creation and participatory approaches use different techniques, but both involve engaging a variety of stakeholders in order to accomplish tasks such as establishing research goals, collecting and analyzing data, interpreting findings, implementing solutions, and monitoring and evaluating the outcomes of development efforts (Dushkova and Kuhicke, 2023). It defines the stakeholder as a part of an ecosystem and comprehends the complex inherent systematic interactions and relationships that exist among them (DeLosRios-White et al., 2020). It also defines the stakeholders responsible for achieving a solution and being part of the overall process of decision-making (Ibid).

Furthermore, co-creation aims to attain various benefits for the community by engaging a wide range of stakeholders not only in the planning phase but also in the design, implementation, monitoring, evaluation,

and maintenance stages of projects (Zingraff et al., 2020). Hence, identifying and addressing stakeholders' interests, values, and knowledge is crucial to ensuring well-functioning co-design processes (Zingraff et al., 2020; Burgers et al., 2017). Also, Bremer and Glavovic (2013) indicate that co-created research possesses the capability to assist in building resilience in the context of complex socio-economic challenges such as coastal hazards by bridging the gap between policy, science, community, and practice.

3.3.1. The conditions of co-creation

Rădulescu et al., (2020) argues that there are some factors enabling or hindering the process of co-creation. The authors contextualize the conditions into two main factors of contextual conditions and stakeholder characteristics and quality of their relationship.

Contextual condition represents the specific factors and situations that influence the commencement and the path of co-creation (Rădulescu et al., 2020). The authors firstly highlight the role of *urgency* as an enabling factor (Ibid). Ehlen et al. (2017) defines the urgency situation as a starting point for co-creation. It can be defined as situations when turbulent environments or events arise, or when an actor or sector fails to independently resolve a problem, a crisis situation is triggered. This situation generates a shared sense of urgency that motivates those involved to collaborate towards finding a solution (Rădulescu et al., 2020). *Power imbalances* may be rooted in the different knowledge systems of users and producers and the ways of priorities and incentives in their working environment (Vincent et al., 2020). It acts as a hindering factor and might affect commitment to the process and the degrees of trust (Rădulescu et al., 2020). Furthermore, it might also impact stakeholder's willingness in engaging in the collaborative process (Ibid). Vooerberg et al. (2014) also argue that in addition to actors' willingness to participate, the knowledge about where and how to influence the process, their feeling to be responsible or sense of ownership is also might influence the outcome of process.

Another contextual condition that has impacts on the process of co-creation is the *history of relations* between stakeholders leading to trust and affecting the quality of co-creation process (Rădulescu et al., 2020). The author also argues that commitment and trust influence the result of the process and are pre-conditions of co-creation (Ibid).

According to Rădulescu et al., (2020), another category of co-creation's condition is related to the stakeholder's characteristics. The factor firstly highlights the significance of *diversity of stakeholder's network* as their group of belonging can vary based on their demographic, capabilities, skills, expertise and motivations and can act as both hindering and enabling factor (Ibid). Furthermore, the *stakeholder's attitude* is also significant to process of participation as enabling and hindering factor. According to Swapan (2017), various social, political, and psychological aspects can impact a person's attitude toward participation. These factors consist of inadequate knowledge, engagement in informal networks, negative perceptions about the outcomes of participation, and primarily, distrust in the planning system (Ibid). Another significant enabling factor in co-creation process is *leadership* (Rădulescu et al., 2020). It gathers the stakeholders together and facilitate dialogue between them. It also has the role of mitigator in terms of conflicts and builder of trust (Ibid). According to Ansell and Gash (2012) pointed to a leader as a steward, mediator, and catalyst in the process. They also argue that co-creation processes need the right leadership to become successful who can navigate the conditions and give equal opportunities to the participants (Ansell and Gash, 2012).

Bradwell and Mar (2008) highlighted the need for a methodology that supports the properties of a co-creation process for achieving success and ensuring that the process achieves its intended goal. Various studies provided different frameworks defining the process of co-creation related to urban development projects. According to DeLosRios-White et al. (2020), the co-creation process encompasses three interlinked dimensions of stages, stakeholders, and subsequent tools and method. In the following sections, the three dimensions of co-creation are defined.

3.3.2. Stages of co-creation

The co-creation stages are like pieces of puzzles, generating the connection between activities required for attaining the objectives of the co-creation process (Hölscher et al., 2020). It is significant to recognize the concrete co-creation stages along with their timeline defining when they are going to take place (Ibid). Co-creation is defined as an open process working under continual transformation in stages that are not constant as they alter over time and need continuing adaptation (Dushkova and Kuhicke, 2023). Vandael et al. (2020) also argue that co-creation is not a linear process of thinking and creating, and it must give flexibility to the stakeholders to refine and reshape the challenge.

3.3.3. Stakeholders in the process

Regeer and Bunders. (2008) defines stakeholders as those parties possessing the power to influence the result of resource management decision, those who are affected by the decision, and the parties who hold relevant knowledge to the decision. Actors also possess unique knowledge, specific needs, and motivations for participating in the development of new products and services (Ståhlbröst et al., 2018). Hence, involving various levels of actors in different stages of developing service/product is required (Ibid). Identifying and addressing stakeholder values, interests, and knowledge is critical in co-creation to ensure a well-functioning co-design process. This step is crucial to dealing with potential conflicts, issues, and constraints that may arise during the co-creation process (Zingraff-Hamed et al., 2020; Burgers et al., 2017).

A successful co-design process is formed based on firm commitment and sharing common vital interests (Zingraff-Hamed et al., 2020; Fohlmeister et al., 2018). Thus, a systematic representation of relevant stakeholders and institutionalization of the participatory process is necessary to achieve a successful integration of scientific and local knowledge (Zingraff-Hamed et al., 2020). Stakeholder mapping enables the systematic identification of participants from all groups, and this structure helps to understand different interests through the co-creation process (Ibid).

Furthermore, understanding stakeholders' power dynamics and interests is crucial to avoiding pitfalls and failures in project processes (Zingraff-Hamed et al., 2020). This can be achieved by characterizing the stakeholders and their specific relationship to the project (Ibid). Citizen participation has a central role in policy discourse that promotes co-creative processes. Also, Co-creation procedures are characterized as the innovation that is derived by citizens as a way of addressing social needs in a novel manner and as a tool to improve democracy (Papper et al., 2020).

Zingraff-Hamed et al., (2020) introduce five categories of variables that are used to characterize each stakeholder in the context of climate change adaptation:

- Belonging: it describes the specific stakeholder group they represent and the institution they belong to. Stakeholder groups designate society's different sections, such as political representatives, governmental authorities, civil society, academia and research, and so on.
- Role of stakeholders: Each stakeholder may possess different roles. For instance, facilitators who are responsible for coordinating different actors for various actions, funders and sponsors, lobbyists, providers of expert knowledge, and so on. Although each stakeholder belongs to one group, they can hold multiple roles, and this varies in contexts.
- Planning (for CCA) stage: The significance of each stakeholder can vary in different project steps. It helps to recognize and better understand the varying motivations of participants. This leads to potential different levels of willingness to participate and act with their relative influence, power, and interest in different stages of co-creation process.
- Relation to the hazards: It describes the difference between the stakeholders who are affected by hazards and the groups who are affecting hazard.
- Relation to the measures: In the context of climate change adaptation, while the selected solutions might affect some stakeholders, it might not benefit some others. This analysis also assists the process in understanding the ability of various stakeholders in affecting the decision on the potential measure. It also expresses that while some stakeholders might not be that effective in decision-making process, they can help the process in implementation or intervention phases.

These five characteristics of stakeholders provide a foundation for a framework of stakeholder identification and analysis in this study.

3.3.4. Tools and methods

As mentioned in the previous section, stakeholder engagement possesses immense role in generating a successful co-creation process (DeLosRios-White et al., 2020).). Hence, tools and methods that support the engagement are also important in co-creation process (Ibid). Ali and Liem (2015) also argues that, for an effective co-creation process, stakeholders must be equipped with appropriate tools (Ali, 2015). The objective of co-creation process, the specific stage, and type of actors that are involved in the process influence selecting the tools (Hölscher et al., 2020). After selecting the tools, it is also significant to determine the materials, skills and other relevant conditions required for implementing the tools (Ibid).

In this study, the stages, stakeholder framework, and tools and methods appropriate for the process of co-creating the MCA step in the dynamic planning process are investigated under the second analysis process.

3.3.5. Co-creation design principles

There are several factors points to a good co-creation process. Hölscher et al. (2020) argue that there are three principles that facilitate the development, assessment, and evaluation of good co-creation process. The authors represent three principles related to the process and three related to the outcome of the process.

The authors highlight three procedural principles as: (1) Inclusivity that brings diverse groups of actors enabling the presence of multiple types of knowledge in an equal place. (2) Openness that ensures the

process openly shares, adopt, and integrate knowledge, (3) Legitimacy, that ensures the integration so legitimate and credible knowledge and it is trusted by actors.

Furthermore, three principles related to outcomes as: (1) Actionable knowledge for planning and policy guarantees that the knowledge that is co-created is promptly applicable and converted into policy and planning, (2) Usable knowledge and empowerment guarantee that the knowledge outputs that are co-created are beneficial and adopted by numerous actors, and (3) Considering synergies ensures that the co-created knowledge links to various objectives, strategies, and agendas within the urban context.

3.4. Multi-Criteria Analysis

Multi-Criteria Analysis (MCA) provides a framework that enables planners to systematically compare the values of different potential initiatives according to a set of criteria (Ellen et al., 2016). The approach is established in mathematics and operational research and was initially developed to assist decision-makers (Oritz et al., 2018; Mendoza and Martins, 2006). Recently, MCA has become a popular tool for facilitating decision-making processes involving multiple stakeholders (Oritz et al., 2018).

MCA offers tools for managing complex decision-making conditions involving a multitude of objectives, which may conflict with one another and be evaluated differently by stakeholder groups or decision-makers (Oritz et al., 2018; Belton and Stewart, 2002). It can be helpful in cases where there are competing stakeholders and objectives with various priorities (Ellen et al., 2016; Hajkowicz and Higgins, 2008; Romero and Rehman, 2003). It is a valuable method for addressing social issues related to conflicts because it can be integrated with participatory approaches, making it a practical solution for dealing with various problems (Oritz et al., 2018). According to Dean (2020), the merits of MCA can be summarized in three main properties:

- Comprehensiveness: considering the multiple criteria and objectives in the MCA process can supply better comprehension of the inherent problem.
- Flexibility: The method provides the possibility of investigating various types of problems and dealing with a broad range of data and information.
- Transparency: The process and outcomes, including criteria, weights, and objectives, with tables, diagrams, and graphs, bring a more transparent approach to appraisal and evaluation (Dean, 2020).

Furthermore, as MCA provides a structure and shared language for discussion, it can assist cross-sector collaboration and also support balancing competing objectives (Ellen et al., 2016; Belton and Stewart, 2002).

In addition to the advantages of the MCA process, the mentioned strategies in multi-actor, multi-criteria practices might face significant implications and challenges (Dean, 2022).

- The practical feasibility of the process
- Reliability and usefulness of the results from participatory practice: Selecting and involving decision-making participants creates a barrier to the reliability and validity of the process (Especially in the context of complex policy disagreements). Hence, multi-actor, multi-criteria practices often involve a few groups of problem stakeholders (Dean, 2022). Furthermore, in such limited opportunity for participant selection due to the practicality of the

process, there is a risk of missing stakeholder participants and also reinforcing the existing social and political imbalance. Eventually, there is often the risk of bias toward the most organized and most powerful parties that could lead to the risk of even a step backward in considering democracy and equity dimensions in the process. (Dean, 2022; Dean, 2018).

- The resources (e.g., time, financial aspects, and level of expertise) needed to run the procedure. Different strategies also have major differences regarding the required resources to manage the process (Dean, 2022; Dean, 2018).

In the complex and dynamic context of identifying and assessing the climate change adaptation measures characterized by uncertainties and long-term project cycles, MCA is a valuable tool for comparing different options across various sets of criteria (Trærup and Bakkegaard., 2015). A significant advantage of MCA in prioritizing the adaptation measures is that it provides the opportunity for stakeholders' preferences to be included in the process and highlights the need for appropriate representation of stakeholders in the process (Ibid).

3.4.1. Key elements of MCA

A multi-criteria framework considers key framing assumptions, including the characterization of 'options', 'criteria', and 'weightings' as explicit inputs. This approach emphasizes the subjective and socially dependent nature of these assumptions (Stirling, 2004). Dean (2022), represents the critical elements of MCA:

- Option: An alternative plan of action is suggested to address an identified problem and attain a comprehensive outcome.
- Objective: a specific purpose in order to assess any option
- Criterion: A specific, measurable index of an option's performance enables measuring (quantitatively or qualitatively) the process to assess to what extent the option meets the related objective.
- Performance score: It indicates a number that determines the performance of an option against a criterion.
- Criterion weight: This coefficient shows the level of importance of an objective and criterion related to the other objectives and criteria, where the objectives and criteria with more significance are identified as having higher weights (Dean, 2022). In addition, it helps to differentiate balance between long-term and short-term objectives (Dean, 2020; Van Pelt, 1993).

3.4.2. Stages of MCA

Dodgson et al. (2009) present primary stages for MCA:

- Establishing the context by defining the purpose of doing MCA and identifying the key players and decision-makers.
- Defining options
- Defining the objectives and criteria reflecting the consequences of each option and associated values.
- Scoring the options against each criterion (describing the performance of each option).

- Defining the weights for each of the criteria describing the relative significance of each decision.
- Combining the scores and weights for each option to draw the total value.
- Examining the results
- Managing a sensitivity analysis of the outcomes in case of changes in weights and scores.

Similar to other appraisal techniques, the MCA method can be structured based on a non-participatory or participatory manner. During the non-participatory method, a single analyst or a research team of analysts analyzes the data using a technocratic approach (Dean, 2022). The research team collects, processes, and interprets data while maintaining a general and independent view of the issue, then presents the analysis results to a few decision-makers (Ibid). In contrast, participatory MCA seeks to employ a more collaborative decision-making process (Ibid). It aims to involve not only the analysts and decision-makers but also problem stakeholders and, in some cases, public participation. It can also include academics and experts to incorporate a more scientific perspective (Ibid).

According to the basic steps of MCA, the stages are the same in both approaches, and participants can play a role in identifying the key elements of the MCA framework (Dean, 2022). According to Dean. (2022), methodological adaptation for participatory MCA is taking place in three principal domains.

- Identifying and choosing the potential participants for group decision-making
- Involvement of the participants in multi-actor multi-criteria's analysis and management process
- Collection, processing, and the inclusion of the preferences of various decision-making participant groups in the multi-criteria framework.

3.4.3. Participatory MCA

According to Stirling (2004), there are three primary considerations that explain the reasoning behind combining analysis and participation. Firstly, the normative consideration highlighting the democratic logic for participation points to social acceptance of equity in access, empowerment of the process, and equal opportunities in outcome (Stirling, 2004; Rawls,1971). Secondly, the substantive reasons that underline the profits of participation in raising the spread of information and accordingly improving the decision's quality (Stirling, 2004; Coenen et al., 1998). Furthermore, according to this rationale of combining participation and analysis, more diverse and context-specific knowledge, values, and interests can be gathered, fostering social and learning to better policy results. (Stirling, 2004; Stirling, 2003). Eventually, instrumental rationale underlines the role of engagement to sustain or reinstitute trust and credibility (Stirling, 2004). One of the critical dimensions of MCA is deciding how the different groups of participants' perspectives are combined and included in the MCA framework, leading to a better understanding and supporting the decisions concerning the problem. The condition might face controversial challenges when perspectives from multiple viewpoints, interests, and priorities are opposed (Dean, 2022).

The concepts of co-creation and multi-criteria Analysis provide the theoretical backbone for answering the second sub-research question aiming at developing the MCA step in the DAPP approach through co-creation.

3.5. Flood risk management

This section investigates the concept of flood risk management based on the focus of the third sub-research question on managing the risk of flooding. According to the IPCC risk assessment framework and in the context of impacts of climate change, Risk refers to ‘’dynamic interactions between climate-related hazards with the exposure and vulnerability of the affected human or ecological system to the hazards.’’ (Reisinger, 2020, 5). According to UNISDR (2017), disaster risk management refers to:

> The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies, and improved coping capacities to lessen the adverse impacts of hazards and the possibility of disaster. It aims to avoid, lessen or transfer the adverse effects of hazards through activities and measures for prevention, mitigation and preparedness (UNISDR, 2017, p. 85).

Schanze (2006) defines Flood risk management as a thorough and ongoing societal analysis, assessment, and mitigation of flood risk (Schanze, 2006). Throughout this ongoing management process, various stages of management can be determined as the pre-flood, the flood event, and the post-flood (Schanze, 2006).

In Europe, floods are categorized as the most costly and common natural disasters. (European Commission, n.d.). Although the risks are worsening due to climate-induced changes in the frequency and intensity of the hazard, it is possible to limit their impact (Ibid). Hence, in order to manage the risks of flooding events, the European Commission planned for EU Flood Directive 2007/60EC dated 23rd October 2007 (Nones, 2015). The aim is to minimize the adverse impacts of severe floods on human health, the environment, cultural heritage, and economic activity. (European Environment Agency, n.d.). According to the Flood Directive, countries must assess the areas that are prone to flood, map the flood proportions and at-risk communities, and consider proper measures to reduce the risk of flood (European Commission, n.d.).

The directive includes 6-year planning periods (European Commission, n.d.). In Denmark, the first plan period was conducted from 2010 to 2015, and 10 risk areas affected by sea or streams were selected. The second plan period was carried out from 2016-2021, where four more risk areas were added to Denmark’s risk areas. The third and current plan period is conducted in 2022-2027. Furthermore, in each plan period, three plan steps define the process of managing the risk in the selected areas. Plan Step 1 aims at assessing or reassessing the risk of flooding, Plan Step 2 aims at preparing the maps of flood risk, and the third plan step tries to prepare the risk management plan for the designated area (Kystdirektoratet, n.d.).

During the first planning period, the Danish Coastal Authority (DCA) developed a method adapted to Danish conditions called XtremRisk ‘cell-based risk assessment’ in order to assess the risk of flooding in the first group of at-risk designated areas (Sorensen et al., 2017). The approach defines a chain ranging from the hydrological events (Source) through the inundation (Pathway) and the impacts on at-risk elements (Receptors), called Source-Pathway-Receptor (SPR) (Scheanze, 2006). According to the guide for dynamic planning in Denmark (2020), the approach is also implemented to describe the area based on the first step of dynamic planning (Kystdirektoratet, 2020b).

While DCA is responsible for mapping and assessing the risk of flooding, it is the municipality’s responsibility to prepare Risk Management Plans (RMP) based on the flood directive step 3 (Sorensen et al., 2017). The RMPs must consider reducing the adverse effects of flood risk before, during, and after the

hazard. (Kystdirektoratet, n.d.). Two critical elements of RMPs are formulating the risk reduction goals (setting the goals) and planning for the actions (setting measures) in order to achieve the goals (Kystdirektoratet, 2020c).

The first key tool, setting goals, is significant for setting directions for how the risk must be reduced. DCA recommends implementing the risk cycle time phases to define the objectives. This cycle defines managing the risk before, during the event, and after the flood (Kystdirektoratet, 2020c). Furthermore, FRM can be formed based on four general objectives (Ibid):

- **Preventing new risks before the flood**, aiming at preventing the increase of vulnerability of an exposed area. It can be related to the development of flood-prone areas where the risk of flooding must be considered.
- **Reducing existing risks before a flood**, aiming at reducing both the risk of flooding and decreasing the vulnerability of the exposed area.
- **Reducing adverse consequences during a flood** points to the active phase of FRM, which includes measures such as emergency services, mobile barriers, or evacuation plans. It highlights the significance of active preparedness that relies on emergency plans.
- **Reducing adverse consequences after a flood**, involves coordinated communication concerning roles, practical help and construction guidance for businesses and citizens. In addition, providing support groups allows affected citizens to share their experiences.

After defining the objectives, the measures must be taken into account to achieve those goals. They are generally divided into three categories: preventive measures, Protective measures, and emergency preparedness measures. These measures will contribute to the fulfillment of the objectives mentioned above (Kystdirektoratet, 2020c):

- **Preventive measures** point to a broad category of actions, from planning to communication. They are also described as soft measures that do not completely prevent flooding but try to manage the situation of acceptable ways of water intrusion into the area. Or building restrictions to not allow building in flood-prone areas related to planning. It also includes citizen awareness regarding the hazard.
- **Protective measures** aim at keeping the water out by constructing protecting measures such as dikes and flood walls.
- **Emergency preparedness measures** include the active response to a flood.

The RMPs have an impact on a broad range of stakeholders and interface with other municipal plans and tasks. Hence, various actors, such as citizens, authorities, and other stakeholders, must play a role in the realization of prioritized actions in RMPs. DCA guide for generating RMPs also emphasized that preparing RMPs is a multidisciplinary initiative that needs collaboration among various working groups with several disciplines. Furthermore, wide stakeholder involvement can provide broad support for the plan, raise awareness, and make more robust plans. It can be helpful when it comes to implementing the actions where the stakeholders gain ownership of the plan (Kystdirektoratet, 2020c).

3.6. Conceptual framework

Investigating the co-creation process based on its three dimensions, stages, stakeholders, and tools, allows for studying and implementing it along with the DAPP process. The conceptual framework in this research is formed based on two main concepts of multi-criteria analysis of the DAPP approach and the co-creation process. Based on the research question, the aim is to investigate the roles of the co-creation in the MCA process in the DAPP. This objective is followed by exploring the impacts and defining the roles of co-creation in developing each element of the MCA. As mentioned in section 3.4.1, the MCA possesses three dimensions: options, criteria, and weightings. According to the MCA in the DAPP approach, pathways are the same as the process options. However, the aim of this study is formed around the development of the MCA step of the DAPP; it is also essential to address the previous steps in the DAPP in this study. As the dynamic planning process is founded on uncertainties in the climate and system, it is also essential to consider its previous steps to adapt the co-creation process to defining the pathways. As mentioned in section 1.3, defining the acceptable risk and describing the system along with its uncertainties take place in the first steps (steps 0 and 1). Thus, as the mentioned steps influence the following steps and provide the pathways (which are composed of actions made in previous steps of the DAPP), exploring the co-creation of these steps is also considered in this study.

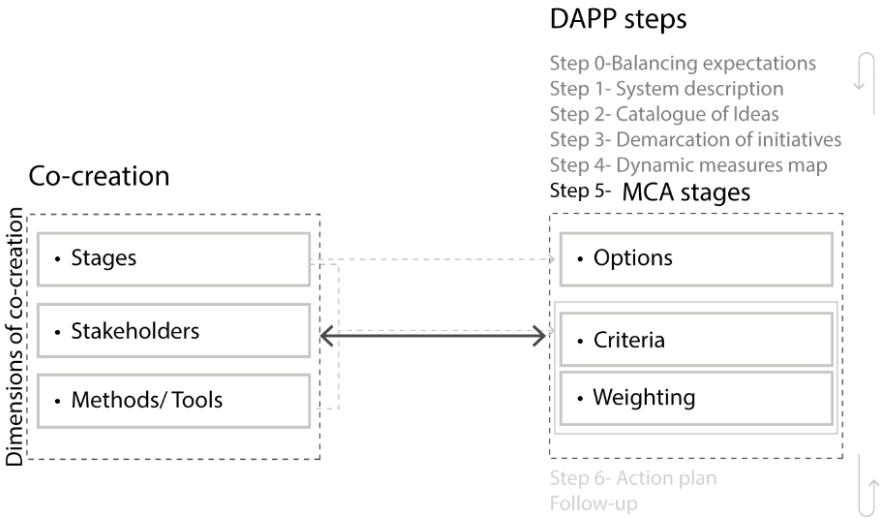


Figure 3.1: framework of Co-creating MCA elements of the DAPP for flood risk management (Made by the author).

According to Figure 3.1, co-creation forms the structure of the conceptual framework. This structure enables co-creating different elements of the MCA in the DAPP, options, criteria, and weightings. It means that in order to study the roles of co-creation in developing the MCA step, it is essential to consider the mentioned dimensions of co-creation.

4. Research Design

The following figure, presents the structure of the research illustrating the pathways to answer the research question.

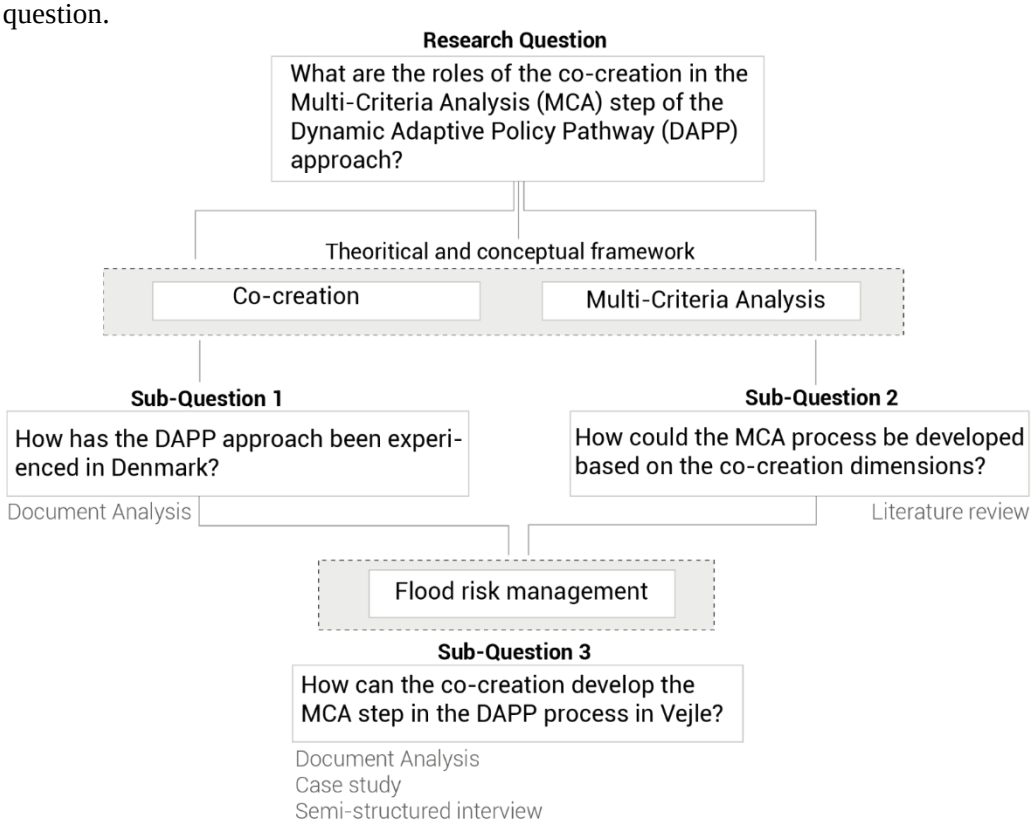


Figure 4.1: Research design (Made by the author).

This research aims to answer the research question:
What are the roles of the co-creation in the Multi-Criteria Analysis (MCA) step of the Dynamic Adaptive Policy Pathway (DAPP) approach?
It will be done through three sub-research questions. The first sub-research question is: *How has the DAPP approach been experienced in Denmark?* It aims first to explore which municipalities implemented the DAPP approach in addition to pilot cases of Vejle and Assens, and then investigate the process through the lens of actors *who participated in the process* and study *to what extent their process was participatory*. As the research aims to study the co-creating elements of MCA in Denmark, designing this question provides a deeper understanding of the approaches experienced in the country and the experiences and limitations that each municipality faced while developing the MCA process in the DAPP approach. Analyzing the municipalities' documents regarding the implementation of the DAPP process and interviews with experts in municipalities or companies who facilitated those processes provided the required knowledge to respond to this sub-research question.

The second sub-research question is: *How could the MCA process be developed based on the co-creation dimensions?* It aims to define co-creation dimensions in relation to MCA elements in the DAPP approach. According to section 3.3, the dimensions are stages, stakeholders, and tools. Firstly, a systematic review of projects that implemented a co-creation approach in planning for climate change adaptation takes place. It

assists in selecting more appropriate stages to co-create the elements of MCA. In addition, defining the stakeholders, a framework of stakeholder characterization by Zingraff-Hamed et al. (2020), is implemented and adapted according to the context of dynamic planning. Eventually, various tools and methods are studied to investigate which types of tools are compatible with co-creating the elements of MCA.

The answers to previous sub-research questions provide a basis for responding to the third sub-research question: *How can the co-creation develop the MCA step in the DAPP process in Vejle?* In this context, the experiences of other municipalities implementing the DAPP approach and the defined pathways of co-creating the elements of MCA assist in developing the MCA process in Vejle, which was experienced as a pilot area. In this process, the municipal documents are studied, and interviews provide complementary data that provides information regarding the case area's conditions.

5. Methodology

According to the research design discussed in the previous section, the following section will explain the methods, providing the methodological considerations for this study and guiding the analysis. In this study, *literature review*, *document analysis*, and *semi-structured interviews* are implemented. Eventually, a *case study* is used to apply the findings.

5.1. Literature review

Farthing (2016) describes a literature review's purpose as a means to review the state of knowledge related to a question. The author argues that the research question provides a framework to review the literature (Ibid). In this study, the literature review is conducted as the primary data collection method. As Bryman (2012) mentioned, a literature review usually acts as a research starting point. In this study, reviewing the literature not only allows the overviewing of the state-of-the-art but also serves to review the theories and concepts related to the study's research questions. In order to discover relevant literature for the current condition, two main stages of reviewing the literature are carried out. Firstly, the theories and concepts provide the foundation for answering the research question. Secondly, the relevant literature for the second analysis is found based on the second sub-research question. Google Scholar and Scopus are primarily used to conduct a comprehensive literature review for both rounds.

In contrast to the first round, the aim of reviewing the literature for the aims of the project's second analysis was focused on discovering studies that implemented the co-creation process into the planning context. In this phase, the aim was to discover the literature most related to the aims of the section. Hence, to the objectives of this step, the term "co-creation" was followed in combination with "infrastructure design," "water management," "urban planning," and "climate change adaptation." Also, regarding the finding of the other dimensions of the research in the second analysis, the 'stakeholder' was also followed as a combination of 'stakeholder selection,' 'multi-stakeholder MCA,' 'participatory MCA, "Participatory DAPP,' and 'multidisciplinary approaches'.

5.2. Document analysis

As a qualitative research method, document analysis provides a systematic process in order to review or evaluate the documents (Bowen, 2009). Fitzgerald (2012) argues that analyzing official documents generated at an organizational level can elucidate the context of the organization(s) being studied.

According to Bowen (2009), document analysis can provide: (1) data about the background and context help understanding of historical roots and conditions, (2) additional questions for the other methods such as interviews, (3) supplementary data in addition to other methods, (4) a method to follow the changes and developments, and (5) verification to the outcomes and findings of a research. According to the specific uses of document analysis by Bowen (2009), it is used in the context of this research to obtain data regarding the conditions and backgrounds, to provide additional questions for interviews, and as a complementary method to other methodologies.

In the context of this study, the method is implemented in order to support the study's first and the third analysis. It employed to analysis of the Aabenraa, Randers and Skive's dynamic planning by the first analysis. The aim of analysing the first set of documents is to obtain insight regarding the process of their dynamic planning documents. It also provides documentary evidence for third analysis by studying the Vejle's urban development plans. Vejle's Climate Action Plan Risk management plan, Vejle's Storm Surge Strategy, Vejle's Resilience Strategy. The following table illustrates the documents and derived and analysed data.

Table 5.1: Analysed documents (Made by the author).

Document selected	**Data analysed**
Guide to dynamic planning (Kystdirektoratet, 2020b)	It provides insight into the designed process by Danish Coastal Authority. It shows how is the process and who will be participated in steps.
Study of the method 'Dynamic planning for risk management and climate adaptation' in a Danish municipal context (Kystdirektoratet, 2020a)	It provides insight regarding experiences about the two pilot projects of Vjle and Assens. It supports the process of analysing the problem and in the provided information regarding how the process experienced, who were the participants in these two pilot project areas. It also assists understanding the Vejle municipality's experience with flood management as the third analysis.
Long-term and flexible climate adaptation planning I Randers (Teknologirådet, 2020)	Use for investigating the process of dynamic planning experienced in Randers. It also provides insights regarding the participants and their role in the process.
Aabenraa and the fjord (Aabenraa Kommune, 2021)	Use for investigating the process of dynamic planning experienced in Aabenraa. It provides the information regarding the process and the participants.
Vejle's Resilience Strategy (Vejle Kommune, 2016)	the document is reviewed to obtain insights regarding the municipality's visions made based on their partnership with 100 Resilience Network (100RC)[1]. As it provides foundation for the other municipal plans such as Storm Surge Strategy (2020), it assists understanding the context and conditions in the risk area of Vejle.
Risk management Plan (Vejle Kommune, 2021)	It provides insights into about the risks in the case area and actions based on the flood risk management framework.
Storm Surge Strategy (Vejle Kommune, 2020a)	The document assist understanding the phases and the measures planned for the areas affected by storm surges in Vejle.
Climate Action Plan (Vejle Kommune 2020c)	How municipality planned to adapt to the impacts of changes in climate.

5.3. Semi-structured interview

In conjunction with the analysing the documents, the method provided relevant information to the research. Semi-structured interviews categorized as in-depth interviews by which the interviewees must answer to preset question with an open-ended character (Jamshed, 2014). The method primarily aimed at collecting information and data from key informants who possess experiences, attitudes, or beliefs regarding the research topic (De Jonckeere and Vaughn, 2019).

In the context of this research, this method is implemented in two parts of the analysis. Firstly, for the first analysis, in the case of Skive, as more data in addition to the documents and literature is required regarding participatory processes two interviews are conducted. Firstly, a semi-structured interview with Rick Pieter Kool, PhD student in NIRAS and DTU and secondly, with Mette Bentzer Lundov, a project manager from NIRAS, who was engaged facilitating the dynamic planning process in Skive. Furthermore, to gather data from local experts another semi-structure interview is planned with Ulla Pia Geertsen, Climate Coordinator in Vejle Municipality. She was selected as she was one of the experts responsible for the dynamic planning pilot project and in charge of all climate adaptation projects in Vejle. Jamshed (2014) also argues that semi-structure interviews are founded on semi-structure interview guide that represent schematic questions which is required to be explored by the interviewer. Therefore, in this study interview guides are made based on the two phases of the interviews.

5.4. Case study

According to Baxter and Jack (2008), case study method provides researchers with the tools to explore a wide-ranging view within a context. In the context of this study, the third sub-research question is formed around the case of Vejle. According to strategies provided by Flyvbjerg (2006) to select the cases, in this study the information-oriented selection was adopted as it has taken place based on certain factors.

In particular, Vejle is selected as a case as the DAPP process was tested there as a pilot project (Kystdirektorate, 2020a) and it has already experienced the process of dynamic planning. Furthermore, it is designated according to the Flood Act as a risk area based on two planning periods of 2015-2021 and 2016-2027. Hence, it can be assumed that the city has a advanced visions managing the risk of flooding. In addition, as the project is a part of the DK2020lab in region southern Denmark, the case of Vejle as it is also located on this region is selected to put the outcomes of the first and second analysis into its context.

III. Results

This chapter consists of three sections aiming to unfold three sub-research questions. The first section, *experiences with the DAPP approach in Denmark,* aims to study how different municipalities managed the DAPP process within their context. The second section, *Co-creating the MCA elements of the DAPP approach***,** develops the MCA elements through the co-creation process. Eventually, the third section, *co-creating the MCA elements of the DAPP approach in Vejle***,** aims to apply the developed MCA process in Vejle's case.

6. Experiences with the DAPP approach in Denmark

This section addresses the sub-research question, *how has the DAPP approach been experienced in Denmark?* It aims to investigate the municipalities that used the DAPP approach and realize how the process is handled. According to section 1.3, the limitation and disciplinary approaches in the DAPP process experienced in the pilot project caused biased views toward the criteria and weightings in the MCA process affecting the outcomes of the process. Hence, this analysis aims to investigate who participated in the process, what methods and tools were implemented, and to what extent the dynamic planning process was participatory.

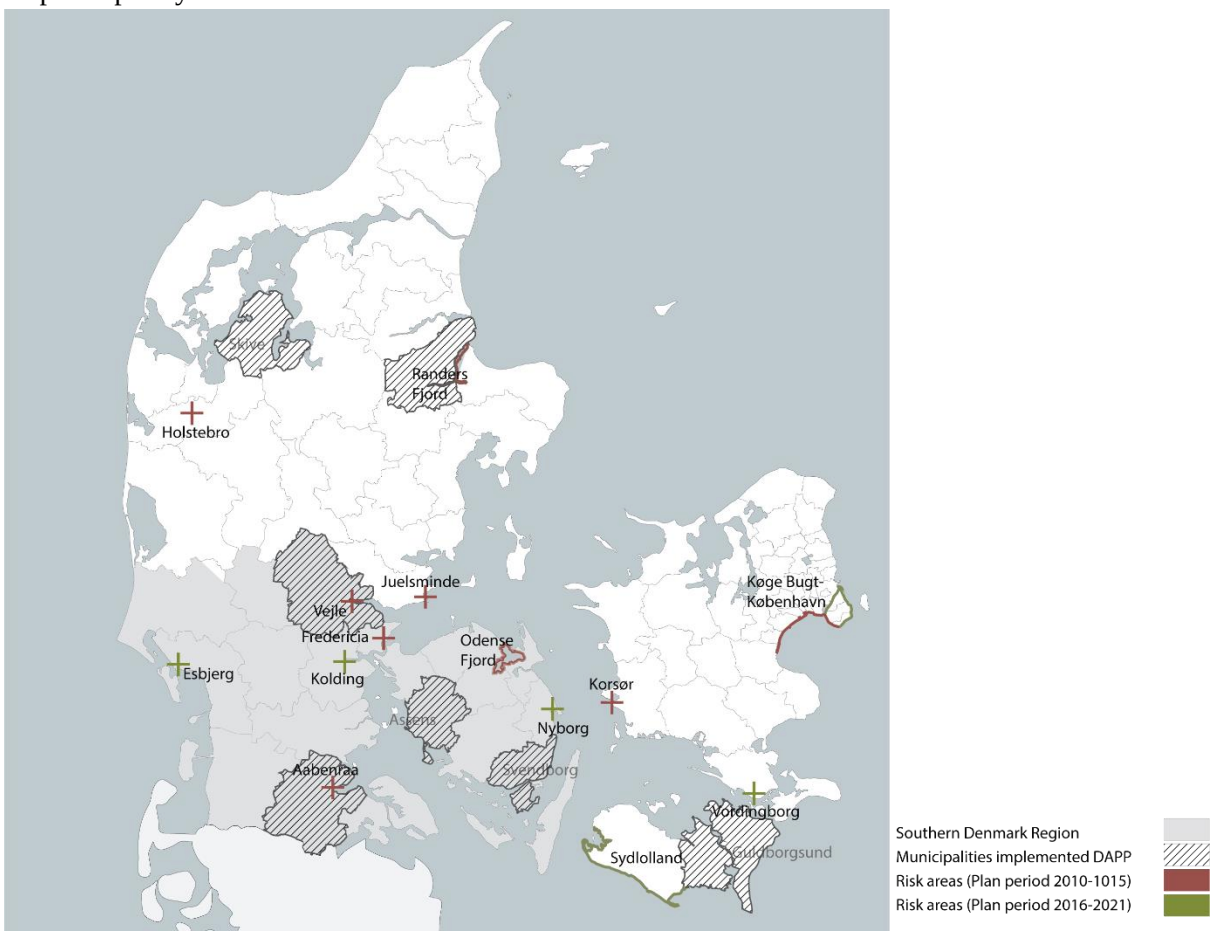


Figure 6.1: Denmark's risk areas designated by DCA and municipalities implemented DAPP approach (Map is made by the author- the data derived from Kystdirektoratet, (n.d.) and interviews regarding the municipalities implemented the DAPP).

Figure 6.1 illustrates municipalities designated as areas prone to flooding (based on the first and second planning periods) and municipalities that implemented the DAPP approach to manage the risk of floods.

The cases of Randers and Aabenraa were selected because they both experienced the DAPP approach. In addition, they were selected as areas prone to flood risk in the first planning period and remained as flood risk areas in the subsequent planning period. Hence, their experiences concerning flood risk management might be advanced compared to other municipalities. In addition to these cases, the case of Skive municipality is also investigated because they experienced the co-production and stakeholder engagement process along with implementing the DAPP approach to adapting to changes in sea level. Insights from these cases will provide knowledge regarding the limitations and advantages of implementing transdisciplinary approaches in the DAPP approach in Denmark. The three cases and their context are described in the following paragraphs, and eventually, their experiences are investigated in Table 6.1.

6.1. Randers

Randers Fjord area was selected as a risk area in the first planning period (2011-2016) and was maintained as an area at risk of flood in the second planning period (2017-2022) (Kystdirektoratet, n.d.). The risk area encompasses parts of Randers and Norddjurs municipalities (Randers Kommune, 2021). The sources of the risk are from the streams and the fjord, and the particular vulnerabilities are related to several polluting companies, central plants, emergency centers, and treatment plants (Kystdirektoratet, n.d.). Randers municipality wanted to work with long-term dynamic planning that provides flexible solutions, risk-adapted planning, and combinations of solutions. Technology Council (Teknologirådet) implemented the guide to the dynamic planning process introduced by DCA, adapted to the Danish context (Teknologirådet, 2020). While the risk area of Randers Fjord contains two municipalities, Randers and Norddjurs, the project only focused on Randers municipality's side of Randers Fjord (Ibid). This area includes low-lying fields between fjord and coastal slopes encompassing agricultural areas, villages of different sizes, and seasonal settlements (Ibid). As mentioned in the risk area's description, it is affected by both streams and fjords, while in the dynamic plan, due to the complexities in Randers, only the flooding from the fjord is considered a source of flooding (Teknologirådet, 2020). The project's vision was to focus on strategies for handling flood risk while focusing on increasing the recreational values along the fjord and ensuring access to the water. Climate adaptation measures must consider constructing new businesses or residential areas in villages and developing businesses in Randers and rural areas. Also, other relevant visions from municipal plans, local plans, and development plans were considered in the process: Increasing natural value, providing recreational opportunities and outdoor life, increasing tourism, and maintaining businesses (Ibid).

6.2. Skive

Skive is an old market town located next to Limfjorden and stream Skive Å. (Skive Kummune, n.d.). The lowest part of the town is at risk of flooding from various sources, primarily the Fjord and stream (Skive Å), rainfall, and shallow groundwater (Skive Kommune, n.d.). The project area includes several types of functions, from urban and industrial areas to protected NATURA 2000 areas (Ibid). The challenge in the project area was uncertainties regarding future changes in climate and urban development (Kool et al., 2022). Hence, NIRAS, together with LYTT architects, generated a strategic climate and urban development

plan based on the DAPP approach (NIRAS, 2023). They implemented the guide to dynamic planning, adapted by DCA to the Danish context, employing the DAPP approach (Lundov, 20204). Throughout the DAPP development process, several participatory processes were conducted to explore potential future development visions and consider how they can be integrated into adaptation planning (Kool et al., 2022). Along the process, they constantly involve citizens, students, politicians, professionals, and landowners (LYTT architects, n.d.). According to an Interview with Lundov (2024), the purpose of conducting a co-production and participatory process was to collect a diverse range of views and perspectives and increase people's awareness about the ongoing changes in climate.

6.3. Aabenraa

Similar to the case of Randers Fjord, Aabenraa was also designated in the first planning period in 2011 and maintained as a risk area in the second planning period (Kystdirektoratet, n.d.). The primary risk sources are from the sea and streams. The risk area consists of the inner city, industries (the harbor), and housing areas (Ibid). Several high-vulnerability functions are located in the area: hospital, critical infrastructure, cultural heritage areas, and polluting companies (Ibid). The overall purpose of the project *Aabenraa and the Fjord- scenarios for the future* is to provide a long-term development for urban waterfront areas that enable a better connection between the fjord and the city, providing spaces for businesses, housing, and museum, besides new recreational areas considering also protecting the city from flooding (Aabenraa Kommune, 2021). They needed help with the different attitudes of some existing businesses in developing recreational and housing areas. Furthermore, they wanted to develop a plan that included citizens', businesses', and investors' needs (Ibid). Teknologirådet, Niras, Hasløv & Kjærsgaard, and DTU contributed to the project (Ibid).

The following table presents the municipalities of Randers, Skive, and Aabenraa in terms of how the process of the DAPP was undertaken. It provides data concerning which actors participated, which methods were implemented, and their experience of using the DAPP approach.

Table 6.1: DAPP process experienced in Denmark's municipalities (Made by the author).

	Process description	**Participants, methods**
Randers	The document mentioned that while it would be ideal if the criteria and weightings were set based on a wide range of stakeholders, in this case, the criteria were selected within the mentioned group of participants due to the limitations in time and available resources. Scores and weightings were also determined based on only expert judgment (Teknologirådet, 2020).	• Professionals from both Randers and Norddjurs municipalities and the Danish Coastal Authority (DCA) participated in the process. They had expertise in planning, river biology, geography, coastal engineering, and architecture (Teknologirådet, 2020). • Norddjurs municipality has been involved only to ensure coordination and a comprehensive perspective on the challenge of changes in sea level related to Randers Fjord (Teknologirådet,2020).
Skive	• After the knowledge transfer workshop between the municipality and NIRAS, NIRAS planned several measures for the area. After selecting the pathway, the	• **Big Blue Forum** was a committee responsible for testing the ideas and findings of the project. The enclosed workshops aimed at engaging politicians, local stakeholders, and business owners (Kool et al., 2022).

	MCA process was implemented to evaluate the adaptation measures (Kool et al., 2022). • Through the DAPP process, various participatory processes have been held scrutinizing the future development visions for the town and planning for adaptation (Ibid). Feedback and outcomes from the co-production process were evaluated and applied to make the scenarios, which served as a foundation for MCA criteria (Ibid).	• **Open community involvement** at the library aimed to engage various adult groups, who were provided with information regarding climatic drivers and visions (as poster installations). They had the opportunity to provide feedback with a mailbox as posters were exhibited for days at the library (Ibid). • **Green Innovation Week**, where Universities, young adults, and teenagers were invited along with politicians to an open workshop. They were supplied with development ideas concerning the project area through drawings and visualizations of future changes (Ibid). • The stakeholder selection was open to everyone and included involvement for everyone who was interested (Lundov, 2024).
Aabenraa	Teknologirådet made four narratives based on future changes in sea level. Then NIRAS, together with Hasløv & Kjærsgaard architects, provided an opportunity catalog for flood protection and future development of the area. Then, DTU provided the quantitative calculation of costs and damages under each scenario. After the quantitative assessment of the actions, a qualitative process was carried out by experts from the municipality, the architecture office, and NIRAS (Aabenraa Kommune, 2021).	Professionals form NIRAS, Teknologirådet, Hasløv & Kjærsgaard architects, and the municipality participated.

The investigation of three cases in Denmark shows that in addition to the pilot projects of Vejle and Assens, the process in the case of Randers and Aabenraa both experienced with a limited range of participation of experts. In the case of Randers, however, the document also mentioned the need for a broad range of stakeholder participation in the process; it was not done due to the limitations of time and resources. However, the case of Randers Fjord encompasses a large area, including two municipalities, a large urban area of Randers, and several rural areas, which means a diverse range of interests and perspectives; the participants in the process were limited only to the experts from the municipality departments, teknologirådet, and DCA. Participation in the case of Aabenraa was also limited to the experts from the mentioned companies and professionals from the municipality.

According to the case of Skive, Kool et al. (2020) emphasized the positive impact of implementing the DAPP process, enhancing stakeholders' familiarity with the changes in climate and uncertainties in the system. In addition, the authors also mentioned that the process needed the participants to collaborate beyond their scope and expertise, creating knowledge and generating a mutual understanding of the challenges (Ibid). In this case, Kool (2024) also highlights the significance of visualizations about changes and illustrations as tools in attaining a shared understanding concerning future transformation between participants. This approach provides the right data illustrating the range of changes in the future and also showing trade-offs and benefits of the proposed actions (Ibid). Investigating the co-production process experienced along with the DAPP approach in Skive illustrated that although the various stakeholders

participated in the process through different types of workshops, their role was limited to providing the local information about their desires and expectations concerning the future. Lundov (2024) states that the citizens were not directly engaged in gathering knowledge and generating the actions, pathways, and criteria in MCA. She also mentioned that although before the process, the municipality aimed to have a more collaborative process in all stages of the DAPP, due to the time limitations, it was limited to harnessing the local knowledge about participants' desires and needs (Ibid).

Investigating these cases shows that all these areas are not only faced with the risk of floods from one source, but also they are affected by multiple other sources (complex areas). It also showed that they encompass different functions and, in some cases, (Randers Fjord) encompasses several types of infrastructure, urban and rural areas, and even protected natural areas (in the case of Skive) need collaborations beyond the municipalities and expertise and require integrating a wide range of interests and needs of all groups who are affecting and affected by the flooding. Furthermore, according to pilot projects and the case of Randers, where the area is too vast, and there are several sources of the flood (complex area), it is significant to divide it into smaller areas to make managing the flood risk easier. According to the case of Skive, it is also significant to mention that, in addition to engaging the various stakeholders, it is crucial to consider the resources for the process as a source of limitation to the co-creating process.

7. Co-creating the MCA elements of the DAPP approach

This research section is designed to respond to the second sub-research question: *How could the MCA process be developed based on the co-creation dimensions?* The section follows the structure of the conceptual framework, where the co-creation process is investigated within three dimensions: stages, stakeholders, and tools. In the following sections, the dimension of co-creation is defined according to the needs of this study (co-creating the DAPP). Then, the dimension will be developed in relation to the steps of the DAPP.

7.1. Stages

This section aims to investigate firstly the appropriate stages of co-creation according to the characteristics of the DAPP process (7.1.1). Furthermore, the selected stages are described (7.1.2). Eventually, it aims to develop the process of designing the MCA elements through selected co-creation stages (7.1.3)

7.1.1. Investigating the stages of co-creation

However, various studies provide different sequenced stages to achieve the objectives of the co-creation process; this study aims to investigate co-creation processes implemented in the context of urban transformation and climate change adaptation. On this basis, the research projects that provide related stages to this study's objectives are investigated. Hence, this study investigated three research projects: the Life cycle of Co-creation Processes (DeLosRios-White et al., 2020), Co-creating infrastructure in the Overdiepse Polder project (Rădulescu et al., 2020), and RECONECT seven-step pathways (Dushkova and Kuhlicke, 2023).

The first research presents the development of a Life Cycle of Co-Creation Processes (LCCCP) for Nature-Based Solutions (NBS). It is constructed on ongoing development cycles and design thinking methods,

providing stages together with involved stakeholders and related tools and methods (DeLosRios-White et al., 2020).

The second case employed co-creation in an infrastructure project where the managers adopted a qualitative approach to water management in the Overdiepse Polder project in the Netherlands (Rădulescu et al., 2020). The project was a part of the Dutch national plan, 'Room for the River,' to manage the risk of floods, and it focused on the horizontal expansion of rivers rather than vertical protections (Ibid). Hence, the transformations were perceived as a threat to the farmers and businesses along the river (Ibid). The project is unique in focusing on implementing a new idea of making space for the river and transforming the citizen initiative into a co-creation process where local stakeholders and government representatives can collaborate (Ibid).

The third case was part of a RECONECT project that aims to improve the European reference framework concerning Nature-Based Solutions (NBS), decreasing the hydro-meteorological risks (RECONECT, n.d.). One of the project's objectives was to encourage innovation in evaluating, selecting, designing, and operating NBS through co-creation (Ibid). The aim of the research by Dushkova and Kuhlicke (2023) was to offer an easy-to-use strategy for the process of co-creation. In addition, another objective of the project was to expand the scale of the projects implementing co-creation from urban to 'land use planning' that can sustainably connect the decreasing of the risk of hydro-meteorological events with the regional development goals (Dushkova and Kuhlicke, 2023).

In the following table, as the stages are not separated from the other dimensions of co-creation, the other dimensions of co-creation are also studied in addition to the stages dimension to obtain a comprehensive understanding of the processes provided by the studies.

Table 7.1: research projects investigated co-creation in the context of climate adaptation (made by the author).

	3 dimensions of co-creation (based on DeLosRios-White et al, 2020)			
	Reference	**Process**	**Stakeholders**	**Methods/Tools**
project/ research	Lifecycle of co-creation (DeLosRios-White et al., 2020)	• The research implemented the concepts of systematic thinking and lifecycle approaches. The basic levels of the process are Co-explore, co-design, Co-Experiment, Co-Implement, and Co-management. • Based on this study, each stage has various sub-stages providing sequenced steps guiding the process.	• The actors of an urban living lab (ULL) were considered participating stakeholders. ULL follows the Quadruple Helix Model (QHM) approach, which divides the actors into four comprehensive categories: academia, Businesses, Public sector, and civil society. • Roles for each actor are also defined within ULL in two main categories: internal roles aimed at setting and managing the ULL and external roles for managing ULL activities.	• To define methods in each step, objectives of stakeholder participation were considered, ranging from informing and educating them to promoting dialogue and delegating or entrusting control. • The research also provided several tools specifically for each stage and sub-stage of the proposed co-creation process.
	Co-creation in infrastructure (Rădulescu et al., 2020)	• The process is defined as four stages: Initiation, Plan development, Co-creative design, and Evaluation. • It provided an iterative process • The step is defined based on three pillars: the objective, the role of the participating stakeholders, and the activity of the related step.	• It considered the participation of stakeholders based on a group of government actors at the national, regional, and local levels, non-governmental organizations at the local level, academics, and the private sector. • The process defined several roles according to different actors. It also defined the participation of each role in each step.	The project implemented a series of Interviews, Meetings, and Workshops in different stages of the project in various ways.
	Seven-Steps-Pathway process (Dushkova and Kuhlicke, 2023)	• The process provided a seven-step pathway/guide for applying a participatory approach in co-creating NBS solutions. • Each step is guided by a question asking for the purpose and the relevant methods/tools. • It also points to an iterative process.	Based on step 2, it divided the stakeholders into five categories: academia, Public authority, private sector organization, civil society, and media. However, it did not point out each of their roles and their relation to the NBS solution.	The research also provided a toolbox assisting the selection of solutions to facilitate the process's operation. The stepwise questions are guided by a set of tools that help achieve the purposes of each step.

As mentioned in section 1.3, the dynamic planning process describes a tool to help planners in long-term adaptation and with an iterative process where the focus is not just on predicting the future but aims at preparing and adapting through a monitor and adapt paradigm (Marchau, 2019). Hence, the co-creating process appropriate for dynamic planning must emphasize an iterative approach that allows for system transformations in response to change. Comparing three research studies, the case of the *Seven-Steps-Pathway process* and the *co-creation in infrastructure* highlighted an iterative process that can support another process that is also iterative.

The Seven-Steps-Pathway case also provides a comprehensive, structured process, where each step has a question that provides the objective and required activity. Furthermore, it represents a sequenced clear process, which makes its development according to the steps in the MCA process easier. Thus, in this research, the seven-step pathway process is selected to define a structured set of sequenced steps guiding the process of co-creating the elements of the MCA in the DAPP approach.

7.1.2. Seven-step pathway of co-creation process

According to the analysis in the previous section, the seven-step pathway process provides comprehensive stages to guide the co-creation process. This study provides the stages required for co-creating the elements of the MCA step in the DAPP in this study. In this section, the seven-step pathway is described. Table 7.2 illustrates the steps in the co-creation process provided by Dushkova and Kuhlicke (2023) and their respective objectives and guiding questions.

Table 7.2: Seven-step pathway of co-creation process (Dushkova and Kuhlicke, 2023).

Step	Purpose	Guiding questions
Define	Identify the planning stage	At which stage of planning are you?
	Determine the purpose of co-creation process	What is the purpose of implementing co-creation?
Identify and analysis	Identify stakeholders and analysis	Which stakeholders are engaged in the process?
	Identify the type of co-creation activity	What types of co-creation activity will be applied?
	Analyse the conditions allowing co-creation	• What capacities is required for co-creation process? • How many stakeholders is planned to be will participate? • How much time will be dedicated to the process? • How experienced are the participants about co-creation?
Decide	Level of co-creation	What level of co-creation is required?
Select	Select the appropriate tools for the process	Which tools are the most appropriate for the co-creation activities?
Design	Invite	How will the stakeholders be invited to the process?
	Share	How the relevant information is distributed and shared with stakeholders?
	agree	How to ensure a shared understanding?
	Ensure the quality of co-creation	What are the criteria defining a good co-creation process?

Realize	Starting/continuing the process	• How to make the actors' network? • How to make the co-creation process practical? • How to use the outcomes and experiences of the process?
Evaluate and adapt	Co-monitor and co-evaluate	How the process experienced and how to improve it?

Step 1: define

In the process of co-creation, objectives have impacts on who can be involved (actors) and in which way the collaboration can be attained(tools) (Hölscher et al., 2020). Hence, it is significant to define what is the *objective* of implementing co-creation. The goals might overlap with each other, and they might transform during the process as it evolves. (Dushkova and Kuhlicke., 2023).

Step 2: Identify and analyse

Defining the *group of participants* and their role, illustrating how they may impact the process, is significant. This study investigates this through a separate sub-section that identifies and analyses actors in the process.

Defining the *type of activitie*s that are desired for the process, Dushkova and Kuhlicke., (2023) suggested implementing (1) templates and visualization techniques that might be helpful involving actors with different education and backgrounds (Matrices, maps and flowchart, timelines, etc.), (2) Workshops and oral communication techniques that can be useful gathering knowledge and uncovering varying views and ideas, or (3) field work techniques that assist collecting the information in the field. considering the *resources* that is needed for the process, Dushkova and Kuhlicke., (2023) also suggests considering the size of the stakeholder group, the time frame, and the required level of expertise for the process that depends on contextual factors.

Step 3: Level of Co-creation

According to the seven-step co-creation process, it is imperative to define the *co-creation level*. This will help determine the specific engagement activities associated with each level of co-creation (Dushkova and Kuhlicke., 2023).

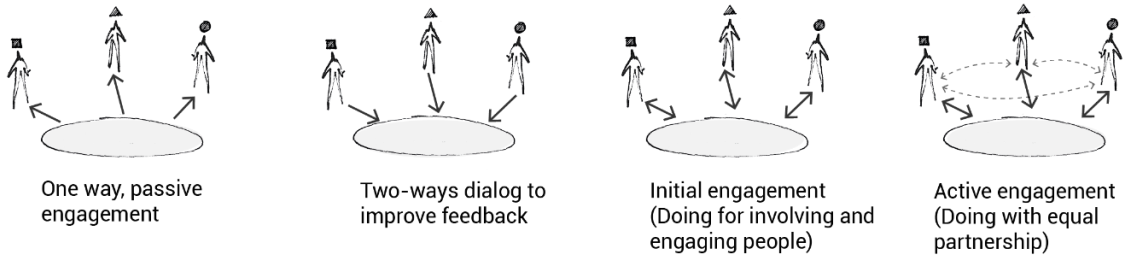


Figure 7.1: Level of co-creation (made by the author, adapted from Dushkova and Kuhlicke, 2023).

In the figure above, each step shows a level of co-creation. The levels of co-creation based on seven-step pathways are (Dushkova and Kuhlicke., 2023):

- Informing stakeholders defines a level of co-creation where the co-creator aims to inform about the process.
- Consulting is the next level, where the aim is to provide a two-way dialogue in order to obtain consultation.
- Collaborating takes place when the people in the co-creation engage through establishing a partnership.
- Empowering represent an active form of participation where the main actors are the stakeholder and are equally project partner.

Step 4: select appropriate tool

In this step, the *tools* facilitating the process of co-creation that are appropriate to the process according to the contextual conditions must be selected. The selection is based on the first three steps defining the scopes and scales of the process (Dushkova and Kuhlicke., 2023). Tools and methods as a dimension of the co-creation process are investigated in section 7.3.

Step 5: Design

As mentioned in table 7.2, the design stage comprises three objectives. The ways of stakeholder *invitation*, *sharing the information*, ensuring the common understanding and quality of the process. Dushkova and Kuhlicke., (2023) introduce three approaches to inviting stakeholders to the process of co-creation. Firstly, the direct approach (through invitations), indirect (advertisements in public, social media, etc), and motivation approach (through extrinsic or intrinsic motivations). The agree sub-stage refers to designing the consensus regarding the type of co-creation process with tools such as agreements and contracts (Dushkova and Kuhlicke., 2023). *Ensuring the quality of the co-creation process*, six co-creation design principles introduced by Hölscher et al. (2020) in section 3.3.5 provide a set of standards related to the procedure and the outcome to guarantee the quality of the process.

Step 6: realize

It highlights the ways in which the process's key aspects are considered, from mapping the stakeholders and the tools required and assembling the networks of groups and their role in the process to practically implementing it (Dushkova and Kuhlicke., 2023).

Step 7: Evaluate and adapt

Co-creation processes are open processes in nature, pointing to their evolution as learning develops over time. Hence, they need continuous reflexivity (Hölscher et al., 2020). In this step, the outcomes of the process will be evaluated based on the objectives that were determined at the first step. It illustrates whether the modifications into the process, or investigating new pathways to improve the outcome are required (Dushkova and Kuhlicke., 2023).

7.1.3. The stages of co-creating the MCA elements

Before applying the co-creation process based on the investigated stages, it is significant to study the conditions of co-creation according to section 3.3.1. The second category of factors is related to stakeholders, and they will be investigated in the next section. Here, the research will focus mainly on the category of contextual conditions of co-creation.

Table 7.3: Co-creation conditions (made by the author).

Contextual conditions	Sense of urgency	Currently, climate change is affecting human settlements. Furthermore, according to the objectives of this research, illustrating the uncertainties in future changes can act as an enabling factor in the experience of co-creating dynamic planning.
	Imbalance of power, resources and authority	in order to ensure that power imbalances are addressed and effective co-co-creation is achieved, it is necessary to design an inclusive and equitable participation of all stakeholders from the beginning of the process (Vincent et al., 2020). In the context of this research, stakeholder participation from the first stages might provide a shared understanding concerning the uncertainties in the system and area, decreasing the imbalances in their knowledge, especially regarding the wide range of projected future changes.
	History of relations	The history of the relations and the degree of trust among the stakeholders participating in the process are essential. Willingness is affected by various factors such as actors' skills, level of education, and awareness, which also contribute to providing the context for co-creating the dynamic planning process.

According to the table, as defining the elements of the MCA along with the other steps of the DAPP approach requires knowledge about the uncertainties and the process itself, it is important to notice the imbalances in participants' different levels of knowledge and the history of the relations. After considering the conditions of co-creation that can influence the process, the following section investigates the stages of co-creating the elements of MCA.

This section of the research aims to define stages of co-creating the elements of the MCA process in the DAPP approach based on the seven-step-pathway method. As mentioned in section 1.3, to run the MCA process in the DAPP approach, three elements of pathways, criteria, and weightings must be defined before the assessment and the decision-making process (Kystdirektoratet, 2020b). In order to investigate pathways (options in MCA), the steps leading to pathways, as well as steps 0 to 4 of the DAPP approach (based on the guide to dynamic planning), must also be considered. As mentioned in section 3.6, the reason is that the definition of pathways is characterized by uncertainties in the long term, rooted in the process's beginning steps. Pathways are selected and defined based on steps 0 to 4 of the process and will be assessed against the criteria and the weightings dedicated to each criterion. Hence, the seven-step method is implemented to co-create each of these elements, providing sequenced steps of co-creation. According to section 3.6, this research aims not to define the complete co-creation of all DAPP steps (steps 0 to 4). Thus, as defining the pathways is related profoundly to the last steps, only the first step of co-creation (defining the objectives) is investigated in steps 0 to 4 of the DAPP process.

Defining the objective of co-creating step 0 of the DAPP: According to the *guide to dynamic planning* (kystdirektoratet, 2020b), most parts of step 0 of the DAPP approach are dedicated to defining the objective, establishing the working groups, and considering the resources that align it with the first stages of the co-creation process aiming at setting the context as preparatory steps. However, as the acceptable risk defined in this step is one of the primary notions important in dynamic planning, participation of different stakeholders from the second phase is needed. Hence, developing new visions and problem framing and identifying and analysis of stakeholders and their relations can be achieved through co-creating the first step 0 of DAPP. Also, as one of the purposes of this step is to discuss the resources required for the project, supporting collaboration might lead to better formation of resources.

Defining the objective of co-creating step 1 of the DAPP: Step 1 of dynamic planning is dedicated to describing the system and the area (Kystdirektoratet, 2020b). Providing knowledge regarding local context, making connections among participants from the beginning steps of the process, and gathering data are the objectives of co-creating the system description process in the DAPP. It gives participants the same understanding concerning the area and systems in the process. Describing systems also might affect discovering needs for new connections and, therefore, highlight the purpose of identifying and analyzing the stakeholder and their relations. It is also an essential stage of co-creating the DAPP process due to its role in defining uncertainty. Understanding the range of uncertainties in the system and area greatly impacts the participants' understanding of the dynamic planning process. Hence, it is significant to highlight the engagement of various actors in this step. Thus, it encourages the learning objective of co-creating this stage.

Defining the objective of co-creating step 2 of the DAPP: Step 2 of dynamic planning has two main steps that point to different perspectives regarding the process and range of participants. Firstly, the general brainstorming step (step 2A) represents an open process that points to thinking broadly and including all ideas concerning the problem because these catalogs of ideas provide a foundation for the measures selected in the following steps (Kystdirektoratet, 2020b). Hence, the purpose of co-creating the brainstorming step is to develop new visions, empower citizens into a collaborative effort, and discover concrete solutions. The next step (step B) aims to map the visions to ensure the connection between all municipal plans and new visions (Kystdirektoratet, 2020b). Exploring the connection requires investigating several layers of plans as proposed in the guide to dynamic planning by Kystdirektoratet (2020b), such as municipal and local plans, risk management plans, nature, and outdoor strategy, etc. Hence, the purpose of co-creating this step is to explore the local context regarding the responsibilities and knowledge regarding the other plans and layers.

Defining the objective of co-creating step 3 of the DAPP: According to Kystdirektoratet (2020b), Step 3 aims to demarcate the visions and possibly detail them according to their mapped visions. This step allows better comprehension of the limitations and potentials of each measure (Ibid). Hence, the participation of both groups that affect the area and those who will be affected by each measure might lead to better elaboration of the plan. Therefore, the objective of co-creating this step is limited to generating concrete plans and empowering various actors who are affected by the measure to participate in the collaborative effort of making and elaborating the measures.

Defining the objective of co-creating step 4 of the DAPP: Eventually, step 4 of the guide follows the selected single measures made in the last step to generate a composition of measures happening in sequence, fulfilling the aims of the area's purpose of reducing risks (Kystdirektoratet, 2020b). Generating pathways is the first element of co-creating MCA. In this step, the objective is to make concrete solutions.
Although all these steps mentioned above seek solutions, the range and the objective of co-creating them differ. Investigating each step of the DAPP by all the stages of co-creation requires elaborating on all the mentioned stages along with the stakeholders and methods suitable for co-creating specific steps. As mentioned before, due to the limitations of this project and as illustrated in the diagram, the focus on defining the pathway (options) in the MCA process is limited to only investigating the first step of the co-creation (defining the objectives of co-creation) process seeking the objective of doing this innovation process.

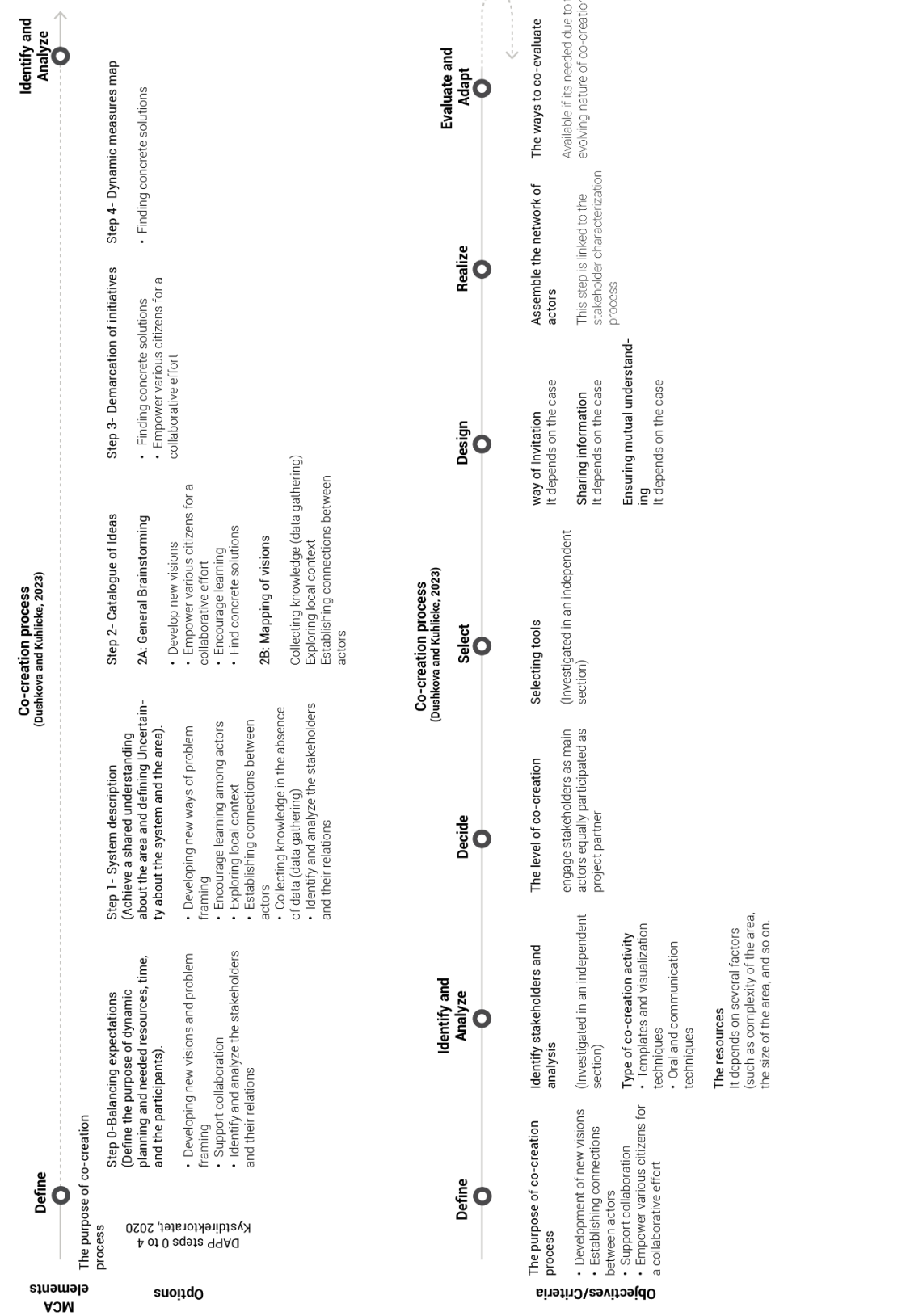


Figure 7.2: The stages of co-creating the MCA elements (Made by the author).

In this research, as presented in Figure 7.2, the complete process of co-creation based on a seven-step pathway (Dushkova and Kuhlicke, 2023) is investigated, defining the criteria and weightings of MCA of the DAPP process. In the following paragraphs, the co-creation of the criteria and weightings of the MCA of the DAPP based on the seven-step pathways is described.

According to step 1 that aims at defining the objectives, a co-creation process assists in developing the criteria and weighting elements of MCA in the DAPP process. It takes place through creating connections between actors, supporting collaborations, raising awareness, empowering various citizens to participate in a collaborative effort, and eventually discovering concrete solutions (in this case, criteria and weights).

According to the step 2 of co-creation aims at identifying and analyzing, stakeholder identification and mapping as dimensions of the co-creation process are studied in the next section. When it comes to identifying the type of co-creation, activity in determining criteria and weightings, templates and visualizations, and oral communication techniques were selected as the process encompasses a diverse range of considerations and participants with different attitudes and backgrounds. Determining the resources needed for the process depends on several variables that differ according to the context. Variables such as the size and complexity of the area, the complexity of the problem (hazard), etc.

According to step 3 that aims to decide the levels of co-creation, as recommended by Kystdirektoratet (2020b), the project group, including a wide range of participants, must determine the criteria and their weights. A high level of co-creation process is selected to define the criteria. It aims at active and equal engagement of stakeholders as project partners where all perspectives are integrated in selecting the criteria and weights.

Selecting tools (step 4 of the co-creation process) is also a site-dependent step that depends on several variables, ranging from the size of the participant groups to dedicated resources. However, as a dimension of co-creation, it is also investigated in another section.
Same to the tools, the design step (step 5 of co-creation) pathway also represents a site-specific process, which might vary in different cases and areas.
The realization step (step 6 of co-creation), which aims to assemble the network of actors and realize the process of co-creation, is partly related to the process of stakeholder characterization, which will be investigated in the following step.
According to section 1.3, as the area and system evolve in each case and as the aim of dynamic planning is to plan for the long-term corresponding to the uncertainties of the system and area's transformations, the evaluation and monitoring step (step 7 of co-creation) is significant in co-creating a criterion for MCA in dynamic planning. It provides the opportunity to change as the co-creation process's objectives evolve over time.
After explaining the context in which co-creation occurs and the stages of co-creating MCA, the following section will investigate stakeholders as another dimension of co-creation.

7.2. Stakeholders

Several studies emphasized mapping the stakeholder characteristics involved in the process and the quality of their relationships are significant in co-creation (Rădulescu et al., 2020; Ehlen et al., 2017; Voorberg et al., 2015). Moirano et al. (2020) highlight that bringing a diverse group of stakeholders into the co-creation process is also significant. The authors argue that the importance of diversity originated from the notion of innovation, which is the outcome of transdisciplinary interaction (Ibid). Furthermore, Catmull and Wallace (2014) highlight the necessity of getting the right team to act as the activator of obtaining the right idea in the co-creation process. Also, as mentioned in section 1.4, the scenario development process must develop processes that can improve the system of participants' understanding and generate learning and co-producing knowledge, innovation, and changes in practice and action, highlighting the significance of characterizing the stakeholders in the process of co-creating the pathways in developing scenarios. (Johnson et al., 2012; Rozas et al., 2015; Butler et al., 2019).

As mentioned by several authors, the dimension of stakeholder mapping and characterization immensely impacts the quality of the project's outcome. Investigating the stakeholder identification and analysis step, which is one of the steps in all three research projects studied in section 7.1.1, illustrated that none of the processes bring a comprehensive way of selecting and classifying stakeholders relating to their groups, roles in the process, or their relation to their responsibilities. Furthermore, according to the project's objectives, which aim to co-create the dynamic planning process, it is also essential to investigate and indicate the relation of stakeholders to the hazards in terms of how they are affected or affect it. The stakeholder characterization framework provided by Zingraff-Hamed et al. (2020) presented in section 3.3.3 is selected to provide a foundation for a stakeholder characterization framework for co-creating the elements of MCA in the DAPP process.

7.2.1. Conditions of co-creation

According to section 3.3.1, before defining the stakeholder characterization framework adapted by this study, the stakeholder characteristics factor as a condition prior to the co-creation process in relation to the process of dynamic planning is investigated.

Table 7.4: Co-creation conditions (characteristics of stakeholders) (Made by the author).

Stakeholders' Characteristics	Diversity of stakeholders	In the context of dynamic planning aiming to plan for the long term along with the range of stakeholders who are affected by a hazard or are affecting it, considering the diversity of stakeholders is significant. As mentioned in section 3.3.1, *diversity* is defined as demographic differences (as planning for the long term, considering different generations), diversity in expertise and perspectives, or diversity in motivations and skills of the stakeholders.
	Attitude of stakeholders	In the process of planning for climate change, where the public authorities are responsible for planning, its attitude and openness toward stakeholder participation play a crucial role in the process of co-creating. Considering this factor, one may also notice a probable negative attitude of some groups of stakeholders unwilling to participate in the process.
	Leadership	In the process of dynamic planning, the presence of a facilitator who is familiar with the process and who has

	professional expertise in risk management is essential (Kystdirektoratet, 2020b). Similar to this context, running a co-creation process also requires a facilitative type of leadership that can build trust and provide developed shared understanding between actors. Therefore, prior to co-creating the dynamic planning steps, paying attention to the role of the leadership, which is crucial for both processes, is important.

7.2.2. Stakeholder characteristics

As mentioned in sections 1.3 and 6.1, the broader participation of various stakeholders was needed and recommended based on both the pilot projects and Randers' experience doing the MCA process. Furthermore, as an important dimension of the co-creation process, as mentioned by several studies, in this section, the project aims at defining the main core of participants in the process. Although the degree of participation depends on several aspects such as the stage, the objective, and site-specific dimensions such as size and complexity of the area, in this section of the research, the aim is to provide a framework where the stakeholders were characterized, defined, and classified based on different criteria. This research implements a framework of stakeholder characterization from Zingraff-Hamed et al. (2020). As mentioned in section 3.3.3, each stakeholder is characterized based on five variables: Belonging, role of stakeholder, planning stage, Relationship to the hazard, and relation to the measure.

7.2.2.1. Belonging

According to DeLosRios-White et al., (2020), as changes in climate pose dynamic and complex challenges to urban areas, engaging relevant stakeholders to respond to these challenges can reduce the conflicts, generate trust, and facilitate social learning around these challenges is necessary. In this challenging context, various stakeholders provide different levels of knowledge, roles, and interests in the procedure.

Furthermore, according to Papper et al. (2020), citizen participation is central to policy discourse promoting co-creative processes. Also, Co-creation procedures are characterized as the innovation that is derived by citizens as a way of addressing social needs in a novel manner and as a tool to improve democracy. In addition, due to the objectives of this project, a model that emphasizes the role of citizens in the co-creation process, the Quadruple Helix Model (QHM), is implemented in this research. Based on the model, involving members of society and individual citizens is expected to realign research paths with public preferences and result in more favorable and sustainable solutions (Schutz et al., 2019).

In the next step, the QHM model and the role of its sector in the process of co-creation is investigated. The QHM model is a novel social dynamics model that relies on networking, fostering collaboration between institutions, and integrating diverse social sectors (Paskaleva et al., 2021; Klasnic, 2016). It provides an open, systemic, user-centric model for knowledge production involving the academy, government, industry, and citizens (Paskaleva et al., 2021). Different from the Triple-Helix model, where the citizens were the passive participants, in QHM, citizens are positioned in the center of the innovative process (European Union, 2019). It assists public participation in innovation by facilitating dynamic, multi-layered, and bi-directional interaction among academia, government, industry, and society (Schutz et al., 2019).

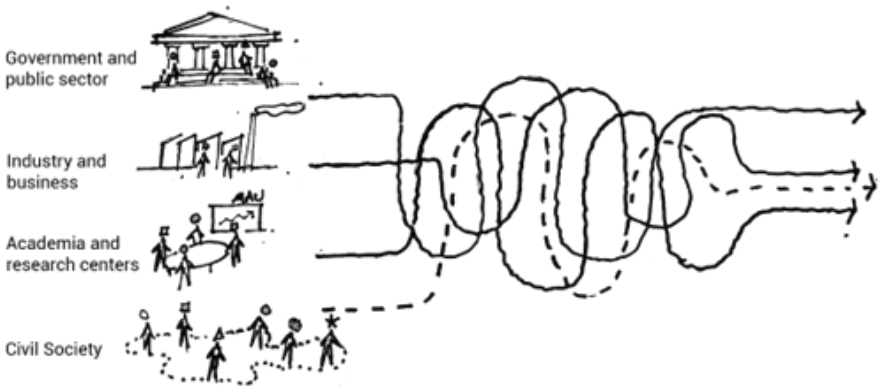


Figure 7.3: Quadruple Helix Model (QHM) (Made by the author, adapted from Carayannis and Rakhmatullin., 2014).

As illustrated in the figure above, the four factors of the QHM model formed around the civil society's participation in the process of innovation.

Civil society

Carayannis and Rakhmatullin (2014) define civil society and users as the drivers and possessors of the process of innovation. It represents a group of users or citizens who bring knowledge regarding their experiences, desires, and needs. Due to their direct relation to the changes in the urban context, they can bring first-hand information concerning existing difficulties and become innovation users (DeLos Rios-White, 2020). Academia, government, and business have defined collaboration with society through transdisciplinarity, open science, deliberate democracy, and user-centered innovation. These three subsystems and society constitute the quadruple helix (Schutz et al., 2019).

Schutz et al. (2019) mention two challenges regarding society's incorporation into innovation processes: firstly, regarding the ways in which their perspectives can be introduced and about the benefits of their views to the process, and secondly, regarding the reasoning behind their participation in the process.

Gonzalez-Martinez et al. (2021) argue that there are four viewpoints regarding the concept of civil society:

- **Society from the demand viewpoint** that defines it as end users and consumers. It also highlights their significant role in each phase of innovation. This perspective puts civil society at the center of the QHM model and points to their influence in making knowledge with demand function.
- **From the cultural and media viewpoint**, society represents the keywords of creative industries, media, lifestyles, and the creative class.
- **Society from the NGO viewpoint** defines the fourth helix of the model encompassing citizens, NGOs, compare to the growth-oriented viewpoint that point to the consumers and users.
- **From an intermediary organization's viewpoint**, it represents society as an intermediary and network between organizations.

Industry and business

A strong actor, also known as the economic sector or commercial market that leading the organizational and technological innovations. They usually play the role of producer and distributor of products and services (DeLos Rios-White, 2020).

Academia and research centers

They represent historically a fundamental factor in the knowledge production process, and due to knowledge's recent role in the development process, they have become contributors to innovation (DeLos Rios-White, 2020).

Government and public sector

The innovation from this sector usually delivers as strategies, policies, and initiatives. Their role is to support industry and academia in order to implementation of information for development (DeLos Rios-White, 2020). The following table aims to illustrate the reasons behind each QHM actor's participation, describing the knowledge and type of innovation they can bring to the process.

Table 7.5: Stakeholder groups and the reasons and type of innovation provided by their engagement in co-creating MCA in DAPP (Made by the author, adapted from Dushkova and Kuhlicke, 2023).

Stakeholder belonging	**Reasons for engagement**		**Type of innovation**
	options	**Criteria/ Weights**	
Academia	• Developing technical guidelines and codes • Defining the uncertainties • Assessing the ideas	Bring new visions	Technical innovation
Public authority	• Comparing the actions with existing municipal plans • Responsible in making risk management plans • Responsible and owner for the area • Providing information, permits and institutional assistance	Comparing the selected values with municipal visions	Evaluate whether the new ideas are beneficial for society.
Private sector and Business	• Generating and disseminating the solutions • Provide professional expertise • Assist translating the uncertainties in the system and area into actions.	Assist generating new perspectives within an interdisciplinary approach	Organizational and technological innovations
Civil society	• Awareness regarding uncertainties about future climate, increasing awareness	By providing the process with their diverse needs and interests, they support the criteria that are more compatible with the area's future	Providing information about their needs, expectations, and experiences

	about acceptable risk that is affecting the area, awareness about the long-term solutions and the tipping points, providing a space for sharing the experiences (Social learning) • it provides public needs and desires as end-users for the area • providing support for data collection • A collaborative approach for cooperation, dissemination, and exploitation	development and with managing the risk of flooding.	As they are affected by the actions, hence they can bring first-hand information

Table 7.5 summarizes the reasoning in participation of each actor in the process of co-creating the elements of MCA. In relation to the stages, Dushkova and Kuhlicke (2023) argue that in order to consolidate the process's narrative, it is significant to get the same actors in all stages.

7.2.2.2. Roles

In the process of co-creation, it is significant to engage a diverse network of stakeholders (Rădulescu et al., 2020). This diversity derives from different demographic factors such as age, family composition, or gender, as well as their skills, motivations, capabilities, interests, expertise, and access to resources (Ibid). Hence, it is significant to classify this range of diversities into different roles. In this research, the actors' roles are adapted from the study of Rădulescu et al. (2020). The approach to defining the role originated from the study of Nystrom et al. (2014), detecting the roles of actors in living labs characterized by openness and user engagement. The following table presents the roles and their involvement in the co-creation process steps.

Table 7.6: Roles in co-creation process (Made by the author, adapted from Rădulescu et al., 2020).

Role	**Description**	**Co-creation steps**			
		Steps 1,2,3,4,5		**step 6**	**Step 7**
Weber	Who decides about involving actors. He/she is responsible generating networks and who act as an active leader with the vision and social skills to link different groups (Rădulescu et al., 2020).	*	*		
Patron/promotor	It is responsible to support the innovation process.	*			
Advocate	Who supports an initiative and distributes information externally (Rădulescu et al., 2020).	*	*		
Co-creator	The service, product, or process is co-designed by the user and others (Nystrom et al., 2014).	*	*	*	*
Builders	Constitute and encourage the emergence of collaboration and assist stakeholders in observing their objectives (Rădulescu et al., 2020).		*		

Facilitator	He/she equalizes the power differences and the transformation of stakeholders into groups (Rădulescu et al., 2020). He/she also assists participants to move toward the goals.	*	*	*
Orchestrator	He/she can also decide about involving other actors such as external evaluators (Rădulescu et al., 2020). He/she also responsible to guide the networks and activities to achieve goals. The role also responsible to establish trust in the network (Nystrom et al., 2014).	*	*	*
Coordinator	Assists and coordinates a group of stakeholders to collect information regarding their ideas and needs and redirect it to other stakeholders (Rădulescu et al., 2020).		*	
Messenger	Forwarding and distributing information (Rădulescu et al., 2020).		*	
Integrators	He/she combines heterogeneous ideas, knowledge, or outputs of different groups into a functional structure (Nystrom et al., 2014).		*	
Contributor	Works closely with all members of the network to create and innovate new products, services, processes, or technologies(Nystrom et al., 2014).	*	*	

According to the *guide to dynamic planning* (Kystdirektoratet, 2020b), the facilitator has a crucial role in the process of dynamic planning. In addition, as conditions of co-creation, the leadership of the process plays a vital role in facilitating, making connections, and setting the structure for the co-creation process. Therefore, a facilitator/leader person or group who is familiar with both processes plays a significant role in co-creating the process of dynamic planning.

7.2.2.3. Planning stage

In this case, as the focus is on the process of dynamic planning, and its aims at designing the adaptive measures for the long-term, the focus in this study is on the design stage of the planning.

7.2.2.4. Relation to the hazard

It differentiates between those affected by the hazard and stakeholders affecting the hazard (Zingraff-Hamed et al., 2020). For instance, in the case of flooding, stakeholders can potentially be divided into those affected and those who can mitigate hazards (Ibid). This classification might differ in case of different hazards.

7.2.2.5. Relation to the actions, measures

In some cases, although some stakeholders might benefit from a solution (affected), the others might not benefit from the same action (Zingraff-Hamed et al., 2020). This analysis enables determining the different stakeholders' abilities affecting the potential solution. It also shows the range of stakeholders' influence on some actions specifically related to one stage of an action, such as high abilities in the implementing phase (Ibid).

The stakeholders are characterized in the following table as co-creating the elements of the MCA step in the DAPP approach. As mentioned at the beginning of this section, the structure of the framework is adapted

from Zingraff et al. (2020). It was adapted to the needs of this study by defining the groups of stakeholders based on the QHM model and the roles based on the roles of actors in living labs by Nystrom et al. (2014).

Table 7.7: Stakeholder characterization structure for the process of MCA in the DAPP (Made by the author).

Belonging	**Role**	**Relation to hazard (low-medium-high)**	**Relation to measures (low-medium-high)**
Academia	Weber	Affecting the hazrad	Affecting the measure
	Advocate	Affected by the hazard	Affected by the measure
Public authority	Co-creator		
Business and private sector	Builder		
	Orchestrator		
Civil society	Facilitator		
	Messenger		
	Integrator		
	Contributor		
	Coordinator		

This study implemented research by Zingraff et al. (2020) that provided a framework to identify and characterize the stakeholders in the co-creation process. It characterizes actors based on their belonging to the group, their role in the process, their relation to the hazard, and their relation to the measures. Defining the stakeholders' belonging, the QHM model is implemented. Their role is defined based on the roles of participants in Urban Living Labs. Eventually, they are characterized based on who is affecting the actions and those affected by the actions.

7.3. Tools and methods

As mentioned in section 3.3.3, stakeholder engagement has an immense role in generating a successful co-creation process. Tools and methods supporting engagement are also important for realizing a successful co-creation process. According to section 3.3.4, the objective of the co-creation process, specific stage, and type of actors, influence selecting the tools for co-creation. Site-specific factors can vary from the skills and expertise of participants to the resources dedicated to the process, the facilitation level, etc. (Dushkova and Kuhlicke., 2023). Several studies and projects, such as U4IoT, MindTools, Service Design Tools, and the UNaLab project, present various methods and tools facilitating the co-creation process (DeLosRios-White et al., 2020).

In order to investigate the tools suitable for each step of co-creating the MCA elements, the UNaLAB toolkit website, the toolboxes studied by Dushkova and Kuhlicke (2023), and research by DeLosRios-White et al. (2020) are studied, proving tools and methods based on the study's needs. These references are investigated and proposed based on the objective of co-creating each element of MCA.

Table 7.8 illustrates the proposed tools for co-creating options in the MCA process. As argued in the previous sections; to define the pathways (options in the MCA process), it is also significant to consider steps 0 to 4 of the DAPP process. Hence, the methods facilitating the co-creation of pathways, ranging from tools for harnessing knowledge and describing the context, including probable future changes, to designing actions and finding pathways, are considered.

Table 7.8: Tools for co-creating the options in MCA process (Made by the author).

Main objective	• Collecting knowledge (data gathering) • Exploring local context • Establishing connections • Identify and analyse stakeholders and their relations • Developing new visions • Find concrete solutions • Empowering various citizens for a collaborative effort
Why participatory tools are required	The participatory tools are required to facilitate: • The data collection about the local context • Engaging various stakeholders • Creating innovative solutions and unleashing creativity • Designing actions and pathways
Involved actors	The variety of actors who can provide local knowledge, representing different perspectives, bringing different types of innovation.
Tools	• Hazard, exposure, vulnerability data collection: Citizen science methods/ Participant observation/ focus groups/ participatory mapping • Need finding: Geographic mapping/ power, interest matrix/ visual Mindmap/ commons mapping/ participatory mapping • For stakeholder engagement: Actor's map, stakeholder mapping/ stakeholder CV tool /User persona/ people and connection map/ service blueprint / expert interview/ stakeholder visualization/ team canvas/ People shadowing/building partnership map • Ideate and generate innovations: Brainstorming/ Mindmaps/ Wall of ideas/ idea rating/ The actors' map/5 whys/ Idea dashboard/ Awareness sheet/ Strategic canvas/ Creative workshop/ Brain writing/ 6 thinking hats/ Lego serious play • Tools for designing strategies: SWOT workshop/ Roadmapping/ communication map/ vision development/ Data discussion sheet

The definitions of each tool and method along with their condition of implementation is presented in the Appendix A.

Furthermore, as mentioned in section 1.3, according to the experiences in pilot projects and the case of Randers section 6.1, the MCA is a subjective process influenced by participants' bias. Based on this study, the aim of applying the co-creation approach to the dynamic planning process, especially in defining the elements of MCA, was to decrease the bias by increasing the engagement of all stakeholders in the process. Following the past steps of dynamic planning leading to the selection of pathways, the aim here is to present tools that enable discovering the insights, interests, and priorities of stakeholders in ideation and selection of the criteria and weights of the MCA process.

In order to collecting the participants ideas concerning the criteria, the same structure is implemented. The following table shows the tools for co-creating criteria and weights in the MCA process.

Table 7.9: Tools for co-creating the criteria and weights in MCA process (Made by the author).

Main objective	• Empower various citizens to a collaborative effort • Developing new visions

Why participatory tools are required	The tools are needed for collecting the various perspectives and preferences of the participants
Involved actors	Same as the last process, based on the objectives of co-creating the process of setting the criteria that is to engage variety of participants, it might be beneficial to engage wide range of actors.
Tools	• Ideate Brainstorm/ wall of ideas • to select Scaling plan/ transformative impact/ I like, I wish, what if/ scoring and rating

As mentioned, tools and methods influence the outcome of the co-creation process by impacting participants' engagement in it. According to the experiences in pilot areas and the cases studied in this research in chapter 6, one limitation they faced was the constraints of resources and time. Several references providing toolkits for co-creating processes are investigated based on this research. As these toolkits also consider the conditions of the context, including time and the size of the groups, they can provide means that might fit the case's requirements. Hence, in addition to engaging the right team that has been studied in the previous section, the suitable tool that is selected based on the contextual and procedural conditions might affect not only the needed resources for running the co-creation process but also the outcome of the project.

8. Co-creating the MCA elements of the DAPP approach in Vejle

This section aims to unfold the sub-research question: *How can co-creation develop the MCA step in the DAPP process in Vejle?* The section is divided into two main sub-sections: the first sub-section tries to investigate the risk area in Vejle, and the second sub-section is designed to follow the framework explored and set in chapter 7 to develop the MCA process in the DAPP approach in Vejle.

8.1. The case of Vejle

This section tries to provide an understanding of the risk area by analyzing the municipal documents. The following parts will analyze the risk management plan, Storm Surge Strategy, Vejle Resilience Strategy, and the DAPP process in the case of Vejle.

The case of Vejle is selected based on three criteria. As illustrated in Figure 6.1, it is designated as an at-risk area for floods for the first planning period and maintained as a risk area in the second planning period (kystdirektoratet, n.d.). Hence, experiences of managing the risks of flood in this area are supposedly more advanced compared to the other cases with the same condition. Vejle has also experienced the DAPP process as a pilot project that provides the background for developing it according to the co-creation. Eventually, the case is also selected as it is positioned in the Region of Southern Denmark, as this research is part of the DK2020 lab for the region of Southern Denmark.

It is located southeast of Jutland; since the first settlements in 1100, water has formed characteristics of this city as it is located close to the fjord and the streams that run through the city (Vejle Kommune, 2022). The city was historically threatened by water, which caused damage to infrastructure and buildings (Vejle Kommune, 2020). In 1872, ‘’Den Perfekte Østenstorm’’ caused massive flooding and damages in the city

(Vejle Kommune, 2022). In more recent times, the city experienced storm surges in 1993, 2006, and 2008. Furthermore, changes in climate will lead to wetter conditions in Vejle (Vejle Kommune, 2020). The changes in water level in the fjord, frequent storm surges, and discharging of large volumes of water into watercourses more often, together with the more frequent and intense rains and rising groundwater, make Vejle town vulnerable to a variety of hazards due to climate change (Ibid). Projections of future climate changes show an increase in sea levels in Vejle by 0.80 m (RCP 8.5). In addition to the changes in sea level and frequent storm surges, the level of water in Vejle Å is influenced by the level of water in Vejle Fjord; therefore, increasing sea levels means raising the water level of this stream (Ibid).

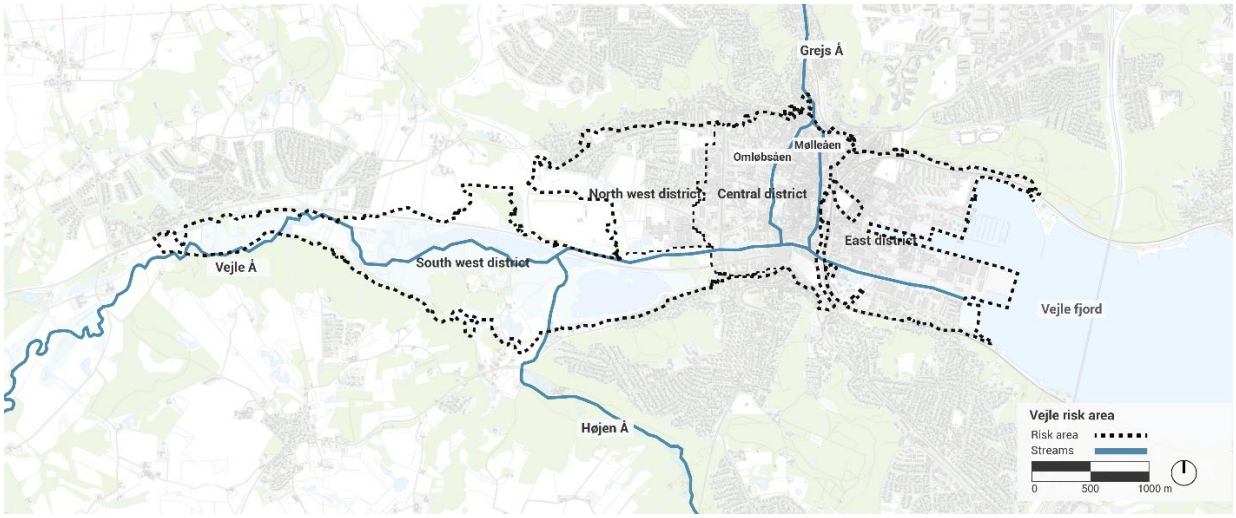


Figure 8.1: Vejle risk area based on the second planning period (2021-2027) (Made by the author, adapted from Vejle Kommune, (2021); Miljøministeriet (n.d.)).

The sources of flood are primarily from the fjord and streams Vejle Å, Grejs Å, and Højen Å (Kystdirektoratet, n.d.). following table illustrates the general information about the of Vejle risk area.

Table 8.1: Vejle risk area (Kystdirektoratet, n.d.).

Risk area	Vejle
Municipalities	Vejle
Main catchment area	1.11 Lillebælt
Source of flood	Sea and streams
Historically highest water level	2.15 m, storm surge 1872
Water level to define the risk area	3.05 m
Affected residents	14,979
Special vulnerabilities	Hospitals, 3 potential polluting companies, 2 heating treatment plants, economic activity

Climate change is expected to cause increases in the water levels in Vejle Fjord in the future (Vejle Kommune, 2021). Rising sea levels in the fjord also lead to higher future storm surges, where changes in climate also lead to more extreme wind speeds in Denmark (Ibid). As mentioned, there are also streams running through the city that may cause a risk of flooding during the high-water flows in the streams. Grejs Å, which originates in Fårup Lake and flows east, divides into Omløbsåen and Mølleåen streams when it

arrives at Abelones Plads, and a large amount of water in this stream causes the flooding of the Abelones Plads. Vejle Å originates form Engelsholm lake and flows east. The stream is directly affected by water levels in the fjord, and a rise in the water level in the fjord will cause a rise in the water level of Vejle Å. However, the entire city has a sewer system from both combined and separated systems; in some cases, the rainwater flows on the ground and causes flooding in the low-lying areas of the city (Ibid). In addition to the mentioned sources of flood in the city, the groundwater is also high in several places in Vejle. Investigating the projections concerning future changes in climate illustrates the rise in the groundwater table (Ibid). According to medium and maximum scenarios, the increase in the groundwater in several areas is from 0-1 meter (KAMP, n.d.).

As mentioned, the case of Vejle is threatened by various hazards from the fjord, the streams affected by both the fjord and precipitation, and the rising groundwater. According to the direction of the study and due to the complexity of the area, in this analysis, this section aimed to focus on risk of rising the sea water levels.

8.2. Flood risk management in Vejle

For the second planning period, the Danish Coastal Authority provided hazard maps, damage maps, and risk maps for four present-day scenarios and three climate-related scenarios. These scenarios were modeled for both fjords and streams (Vejle Å, Højen Å, Grejs Å). Based on the risk management plan process, after modeling the flood hazard maps, which model the water spread in the terrain over time and also illustrate the flood depth in 25m x 25m cells for each event, the flood damage map encompassing the hazard's tangible and intangible damages was prepared. Eventually, the risk maps were created based on the total economic damage for each event (Vejle Kommune, 2021).

Eventually, as it illustrated in figure 8.1, the whole risk area is split into four districts, each with its own hydraulic character (Vejle Kommune, 2021).

- District East is primarily affected by the water level in the fjord. Based on the RMP, the area must be protected against rising water levels in the fjord.
- In the central district, the sources of floods are the water level in the fjord and streams (the increase in the water level in the fjord causes flooding from the watercourses due to the inadequate capacity of the streams to carry water).
- District southwest is also affected by both fjord and water level in Vejle Å.
- District Northwest is exposed to flooding due to increasing water levels in Vejle Å.
-

According to the damage maps and based on all events, district East has the largest damage amounts due to its dense built-up area, which makes it the most vulnerable area to flooding.

8.2.1. The selected area in Vejle

According to Figure 8.1, illustrating the risk area and four risk districts, the study of the co-creation of the MCA step in the DAPP approach in Vejle needs to be limited to one of the risk districts. The reason is, as mentioned in section 8.1, where the risk area is described, the Vejle risk area is exposed to flooding according to various flood sources, from the fjord and streams to precipitation and rising groundwater. Hence, due to the limitations of this project and the focus of the chapter, which is about investigating the

impacts of changing sea levels, at this stage and due to the complexity of the area, this research aims to focus on one of the East district.

East district is mainly flooded by the rising water levels in the fjord. The area is also exposed to the greatest risk because of its dense built-up area (Vejle Kommune, 2021). The second planning period assessments show that the East district is the most vulnerable area under all events, and the largest damage occurs in this area (Ibid). Its 160 ha area makes it the second biggest district among the four risk districts (Ibid). The changes in the fjord's water level influence the river's and groundwater's water levels. Furthermore, in case of storm surges, water is pushed into Vejle Å and causes flooding along the river. In addition, the sewage and pipes leading surface water to the fjord and river are influenced.

The following table presents general objectives for all districts (which means that they must also be applied to the selected district) and district-specific objectives, along with the actions that must take place based on the latest risk management plan (2021-2027) in district East.

Table 8.2: Actions in the flood risk management (2021-2027) (Vejle Kommune, 2021).

Goals	**Action to take**	**Type of action**
Preventing new risks before flood		
Future constructions must be climate-proofed to +2.5 m DVR 90	Future municipal plans and local plans	Preventive
Construction in and outside of risk area must not worsen the flood risk	Prioritizing SUDS in new local plans	Preventive
Realizing the storm surge strategy	Implementing phase 1 of the storm surge strategy (investigated in the next section)	Protective
Reducing the risk of flooding in Ibæk Strandvej	Developing a project for flood protection	Protective
Preventing existing risk before flood		
Prioritizing the critical and cultural assets	Investigating the flood risk to special critical and cultural infrastructure	Preventive
Protecting municipal buildings against flooding	Climate-proofing municipal buildings	Protective
The alert system awareness	Smart water Vejle	Preparedness
Preventing negative consequences during flood		
Updating the climate preparedness plan according to growing knowledge and implemented measures	Update the climate action plan continuously	Preparedness
Ensure accessibility in the city	Assess the condition of the critical roads in during the event	Preparedness
Preventing negative consequences after flood		
Fast recovery and communication and support for businesses and citizens	Planning for rebuilding and communication after flood	Preparedness
Knowledge upgrade		
Generating a better understanding about the hydrological system in the city.	• Investigating the future level of groundwater D • Development project about implementing green spaces to surface runoff	Preventive

	• Developing the hydraulic model for entire city	
Engagement and communication		
Active participation of citizens, businesses, and relevant stakeholders in flood risk management This purpose encompass requesting for selecting the measures, the added value, and collecting the relevant background knowledge.	Citizen meeting s and dialog meetings	Preventive
Rising the citizens, businesses, and stakeholders' awareness regarding the risk of flood and the ways they can contribute in reducing the risk.	Providing Site-specific information for citizens and businesses and the ways they can protect themselves.	Preventive

8.3. Storm surge strategy

Following the risk management plan based on the first planning period (2015), in 2017, the city council developed a storm surge strategy according to Vejle's Resilience strategy from 2016. (Vejle Kommune, 2020a). It is a part of Fjordbyen's project in Vejle's Resilient Strategy, which primarily highlights climate resilience and water management. Storm surge protection is one of the three sub-projects of Fjordbyen's project (Ibid). It considers the fjord and the increasing challenge of rising sea levels as a threat and focuses on how to keep the water out while adding value and contributing to the future development of the city. It also provides a strategic basis for the next risk management plan for the second planning period (Ibid). Exploring the "Storm Surge Strategy" document by Vejle Kommune (2020a) provides essential knowledge about visions of Vejle municipality concerning the East district that is exposed to the risk of flooding from the fjord.

In addition, they also mentioned that all strategies must encompass three main criteria (Vejle Kommune, 2020a).

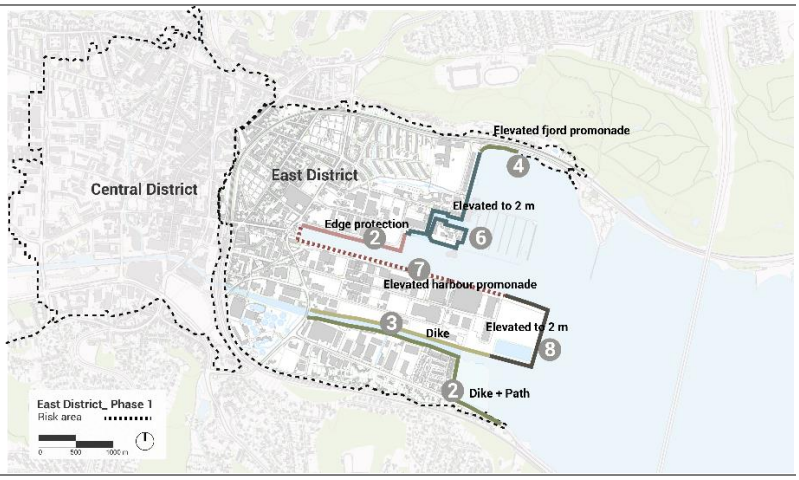
- It is significant that future storm surge actions strengthen the Vejle's identity.
- Building a resilient district where storm surge protection employs also as a benefit for urban and social capital.
- The third criterion points to three principles highlighting three aspects of future actions and solutions in this area: (1) adding recreational value along with improving physical and mental health, (2) collectively managing the risk that means individual protection is not enough, and measures must secure the underlying, and (3) making the connection between city and water as fjord is a fundamental part of city's DNA

This strategy is based on three phases for developing storm surge protection: Phase 1, for 2025, aims to establish a series of edge projects with a height of 2.5 meters; Phase 2, for 2050, aims to develop the port and the city to a height of 2.5/3 meters; and, eventually, phase 3, which is planned for a height of +3 meters in 2070 (Vejle Kommune, 2020a).

Table 8.3: Phases of storm flood strategy (Made by the author, adapted form Vejle Kommune, 2020a).

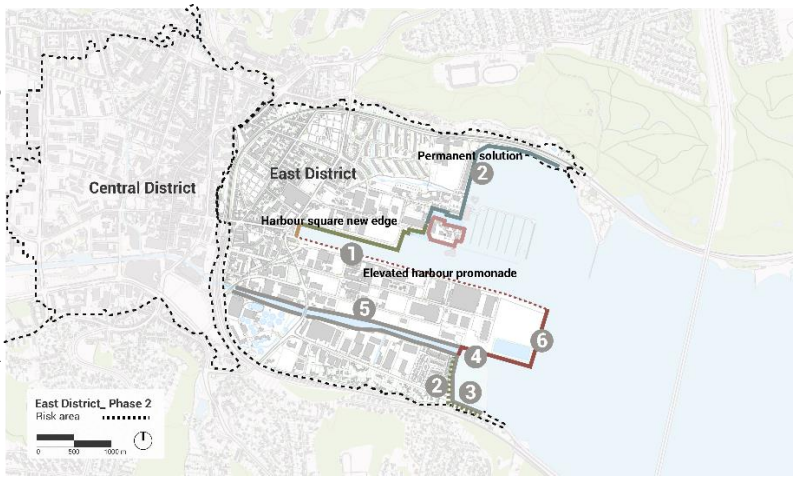
Phase 1 (Security line at 2 meters by 2025)

The aim is to secure the city to the elevation of 2 m (DVR90). It encompasses eight actions:
(1) Emergency solutions, (2) a path with the level of 2 m connecting the city to the fjord, (3) Dike on the south quay protecting the harbour, (4) the fjord promenade protecting the infrastructures and roads while making recreational elements, (5) check valves controlling the entering water to the pipes (6) protection of shipyards, (7) safety edge along the North quay, and (8) Safety protection along the south quay.



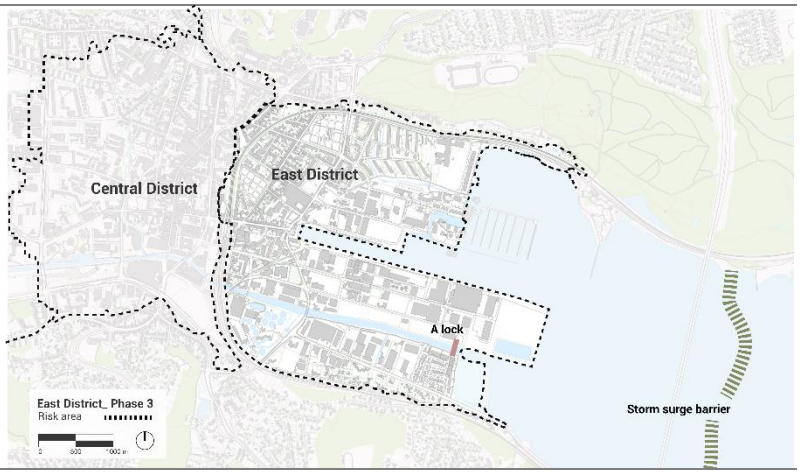
Phase 2 (Security line at 2.5/3 meters by 2050)

The aim is to expand the existing measures by phase 1 while establishing a lock on the Vejle Å. It includes seven actions: (1) New quay edge raised to 2.5/3 m, (2) emergency or permanent solution at 2.5/3 m in front of the Wave building, (3) Path Road extension for 0.5 to 1 m as urban furniture, (4) High water lock and pumping station with a bridge, (5) Storm surge protection along the South quay at the 2.5/3 m level, (6) Nature-based safety protecting harbour with 2.5/3 m height, and (7) A permanent protection of the city at the harbour
The challenge for this phase is related to the environmental concerns about health the fjord.



Phase 3 (Security line above 3 meters by 2070)

It aims to provide a barrier in the fjord that can protect the city above 3 m. The action comprises several challenges, including environmental and legislative issues related to the Coastal Protection Act and NATURA 2000 plans. In addition, cross-municipal collaboration is required to implement this action, and it requires immense investment.



8.4. The DAPP process experience

Vejle was one of the pilot projects that implemented the DAPP approach to managing the risk of flooding in Denmark. Because of the diversity of sources of flooding and the complexity of the area, the DAPP map was made only for two sources of flooding: flooding from Grejs Å and the fjord (Kystdirektoratet, 2020a). According to the focus of this research, flooding from the fjord, the DAPP map for the harbour and Vejle center is investigated in this section.

According to the steps of the DAPP process mentioned in section 1.3, in step 1 where, the aim was to describe the area, Sources of a flood, Pathways that are the route the water takes, and Receptors that explore the affected elements through specific sources and pathways were investigated. Based on steps 2A and 2B, the protection measures, preparedness, and preventive actions were considered to address the risks (Kystdirektoratet, 2020a). Following that, the actions were classified based on four major themes: prevention, raising awareness, protection, and preparedness, and considered based on their implementation time horizon and lifetime (Kystdirektoratet, 2020a).

According to step 4, a DAPP map for two areas (the harbour and Vejle, and Grejs Å) was planned. According to the DAPP map of Vejle city and harbour, which is the focus area of this project, three pathways were selected to be assessed against the criteria for the process of MCA.

- The first pathway describes building a wall/dike protection along the harbour and its extension. In addition, protecting the area against the water level of +3 m, a flood barrier was proposed.
- The second pathway was similar to the first pathway. However instead of expansion of the protection, it highlighted to the raise of terrain in the area in connection with the urban development. Constructing the storm surge barrier was the final action to this pathway.
- The third pathway represented a protection for individual object to the tipping point of 2 m and in case the water level exceeds this amount, retreating the area and giving up the land can contribute managing the risk in this area.

As mentioned in section 1.3, the multi-criteria analysis step was simplified due to the limited participation of actors. And eventually, the action plan was prepared based on the second pathway providing detailed actions for the near-term (2019-2024), mid-term (2024-2050), and long-term (2050-2070) (Kystdirektoratet, 2020a).

8.5. Vejle's Resilience Strategy

In addition to the documents that were investigated, the risk management plan, the storm surge strategy, and the DAPP process, Vejle municipality provided a document, *Vejle's Resilience Strategy* (2016), as a member of 100 Resilient Cities (100RC). Vejle is the only Scandinavian city that is selected by 100 RC and made the driving force to make the plan (Vejle Kommune, 2016). It aims to improve their capacity to build resilience in Vejle through joining forces, implementing existing and new partnerships, and turning the challenges into opportunities jointly (Ibid). The challenges ranges from climate change and flood risk, infrastructure demand, and urbanization to demographic changes and changes in new technologies (Ibid). This plan introduced four pillars, 12 goals, and 100 actions generating the resilience strategy. The first cross-cutting pillar is Co-creation City. It aims to create a resilient city through productive partnerships. It

encompasses three goals: (1) making resilience at the center of the municipality's visions, (2) using co-creation in constructing resilience capacity, and (3) developing an innovative, resilient city. The other pillars are a climate resilient city, A socially resilient city, and a smart city (Ibid).

8.6. Summary of Plans

The plans mentioned were studied in order to provide comprehensive knowledge regarding the context, including the risk of flooding, as well as the perspectives, visions, and plans for the future of the city of Vejle. Exploring these plans illustrates their overlaps and, to some extent, their differences. Vejle's Resilience Strategy (2016) provides a foundation with four pillars and their related goals and actions to make a resilient city against future challenges mostly related to climate change. Following the mentioned goals, the Storm Surge Strategy (2020) provides a series of actions based on three criteria within three phases.

Exploring the *Storm Surge Strategy* and *Resilience Strategy* shows that the first and second pillars of resilience strategy, *Co-creation City* and *Climate Resilient City*, in managing the risk of flooding in Vejle are addressed in the storm flood strategy under two goals of *Shared identity* and *Partnership development*. According to the shared identity goal, community and co-creation among citizens, municipality, and other actors is essential for storm surge protection in Vejle (Vejle Kommune, 2020). Hence, it emphasizes that protecting the city against storm surges, along with its future development, first requires a common understanding regarding the current and future challenges (Ibid). This shared understanding provided a basis for innovative solutions to address both the challenges and the urban development visions (Ibid). Achieving this goal, from 2015 until now, several meetings, workshops, and dialog meetings with stakeholders with the aim of gathering ideas and knowledge and generating shared understanding have taken place in the context of Vejle (Ibid). In addition, the Partnership development goal also highlights the significance of developing public-private partnerships around new innovative actions in protecting Vejle against the storm surges in connection to the Vejle resilient strategies (Ibid).

However, the plans highlighted the need and desire for an active involvement of citizens through co-creation in confronting the future challenges in Vejle; a structured process providing steps and a framework for co-creating different stages of planning for the risk of floods is required. In addition, while several documents pointed to the significance of active involvement in managing the risk of flood, the experienced DAPP process in Vejle was limited to the interdisciplinary integrations that led to a simplified process of MCA based on step 5 of the DAPP.

Therefore, co-creating the DAPP process that provides opportunities to address deep uncertainties regarding future climate changes can enable the city of Vejle to address both the visions in the Vejle Resilience Strategy and Storm Surge Strategy criteria, aiming to foster the connection between the city and the fjord and jointly plan for an unknown future. It can also enable the consideration of all actions required for managing flood risks, ranging from prevention and protection to emergency and preparedness.

8.7. Co-creating the MCA elements in the DAPP approach in District East

As mentioned in section 3.3.1, prior to commencing the design of the co-creation process, investigating the co-creation conditions based on two factors of contextual and quality of stakeholder relations is significant. The previous sub-sections provided not only a context describing the risk condition but also illustrated the

conditions in which the co-creation process will be investigated. Exploring the municipal efforts managing the risk of flood in Vejle showed the attitude of the Municipality and public officials in having other stakeholders in the processes according to the objectives and visions mentioned in both Vejle's resilience strategy and storm surge strategy. The following table summarizes the co-creation conditions based on the municipal plans that are studied in the context of the Vejle East district.

Table 8.4: Conditions of co-creation in Vejle (East district) (Made by the author).

Contextual conditions		
Sense of urgency	Imbalance of power	History of relations
The experience of several meetings, workshops, and open citizen dialogues increased awareness regarding extent of the risks.	Several efforts from municipality provided opportunities to increase citizen's awareness: • Økolariet as a living exhibition provide invites citizens to learn and play concerning sustainability and climate (Vejle Kommune, 2020b). • Furthermore, application (iReact) that support resilience and communication of citizens living in the flood-prone areas (Vejle Kommune, 2020b)	• Vejle has the long history and culture of involving stakeholders (Vejle Kommune, 2020b) • Form 2015 several participatory activities experienced among various stakeholders (Vejle Kommune, 2020a).
Stakeholder Characteristics and quality of their relationships		
Diversity of stakeholders	Attitude of stakeholders	Leadership
Broad Diversity of stakeholders in the area	• Pointing to active involvement of citizens in developing the future fjord city. • Participation of citizens in previous meetings and workshops	Vejle municipality experienced several participatory activities in different forms.

According to the conditions of co-creation mentioned in section 3.3.1, the sense of urgency provided by meetings and open dialogues with citizens and information stands in the city can act as an enabling factor for the process. Considering the imbalance of power as their level of knowledge, the municipality's efforts in establishing different platforms of communication and learning in the context can decrease the imbalances. In addition, the history of participatory processes and relations also acts as an enabling factor for co-creation in this case.

It is also highlighted in the Climate Action Plan that key actors in the public sector, civil society, businesses, and those affected by climate change must be involved in developing the planning for climate change (Vejle Kommune, 2020b). Hence, a wide range of stakeholders supporting an integrative, multidisciplinary innovation process to dynamically plan for managing the risk of flooding is considered. This range can act as both an enabling and hindering factor. Therefore, it is important to consider this in the process.

8.7.1. Co-creation process

After determining the conditions of co-creation, the process of selecting the elements of the MCA process is investigated through the seven-step-pathway presented in section 7.1.2.

Step 1: Define the process

According to section 7.1.2, the first step in defining the process is to set the objectives of implementing the co-creation. Based on the purposes mentioned in section 7.1.3, and in addition to the aims of Vejle's resilience strategy concerning employing the co-creation concept to make Vejle resilient to future challenges, the purposes of implementing it in this case are described in the following table.

Table 8.5: Objectives of co-creating dynamic planning in Vejle (Made by the author).

Objective of co-creation		**Relation to each step of the MCA**
stimulate learning and increasing the awareness among diverse actors	However, Vejle municipality provided opportunities to increase awareness and learning through open dialogues and meetings**.** Co-creation of the MCA provides a structured process for achieving a shared understanding about the future, especially regarding its uncertainties among all participants.	Selection of options (pathway). Mostly in step 1 of the DAPP.
Establishing new relationships	• Gathering the stakeholders based on different risk districts and making networks based on the same shared understanding about the uncertain future is another purpose of co-creating dynamic planning. • According to the Storm surge strategy document, some visions regarding the future (phase 3) have immense impacts going across municipal borders and affect natural areas (such as beach protection or nature and wildlife reserve areas based on NATURA 2000(n.d.).). Hence, co-creation can provide the opportunity where, in the context of an uncertain future, other municipalities affected by this vision, nature ministry, and others participate in the process and ensure the effectiveness of the measures.	Related to the entire process
Gathering data	• As the process aims to plan for the long term, and due to the long-term impacts of climate change going beyond 2100, it is also significant to gather knowledge, mostly concerning people's interests and perspectives about the area. • Making new networks and collaborating based on a structured steps also provides the opportunity to harness local knowledge from various actors in different belonging groups. • Gathering experiences from the other or the previous events.	Related to the entire process
Developing new visions	• Investigation of the Storm surge strategy document showed that the municipality has ambiguous visions regarding future cohabitation with water. Hence, providing a context for generating new ideas based on a wide range of	Related to the entire process

	participation might influence the creation of new visions related to the unknown future. • It can also provide opportunities to merge different municipal plans, including all visions and ideas, from Vejle resilient strategy and risk management plan to storm surge strategy, and provide a common and around the dynamic planning.

Step 2: Identify and analyse

According to section 7.1.2, the first part of step 2 is identifying the stakeholders as one of the dimensions of co-creation. The following table is an adapted model of the stakeholder characterization framework based on the risk of rising sea levels from section 7.2 of this study.

Table 8.6: The stakeholder characteristics framework for East district (Made by the author).

Belonging	**Role**	**Relation to hazard (low-medium-high)**	**Relation to measures (low-medium-high)**
Academia	Weber Advocate Co-creator	**Slow onsets** Affecting the flood Affected by the flood	**Prevention** Affecting the measure Affected by the measure
Public authority	Builder Orchestrator Facilitator	**Both slow and sudden onsets** Affecting the flood Affected by the flood	**Protection** Affecting the measure Affected by the measure
Business and private sector	Messenger Integrator		**Preparedness** Affecting the measure Affected by the measure
Civil society	Contributor Coordinator		

According to Table 8.6, the stakeholder characteristics framework for East district, identifying the actors in co-creating the DAPP approach, is designed based on characterizing them according to their group, role, relation to the hazard, and measures. The changes compared to the general framework are in the stakeholder's relation to different aspects of the risk of rising sea levels and their relations to the flood risk management measures. As mentioned in section 1.1, the impacts of climate-induced changes in sea level are categorized into slow onset and sudden onsets. This analysis shows to what extent each stakeholder is exposed to the slow onset changes or both slow and sudden onset events. Although the impacts of slow onsets are not that adverse and they pose low risk compared to storm surge events, it is also significant to consider these impacts as they take place in the long term and might affect the settlements next to the streams and sea and as the aim of dynamic planning is to plan for a long-term considering the uncertainties. Hence, investigating the relationship of stakeholders to changes in sea level considering both aspects of this hazard, including the range of their relation, is essential in characterizing the stakeholders engaged in co-creating the MCA process. Furthermore, according to section 2.1.3, flood risk management, The measures related to managing the risk of flooding are followed based on three actions: prevention, protection, and Preparedness. It provides a map for identifying and analyzing the stakeholders related to the risk and area. In the following sections it guides the process of stakeholder characterization.

Stakeholder groups and their participation objectives related to each step of defining the MCA elements are explained in Table 8.7. In the context of Vejle's East district, these four groups are explained:

Table 8.7: Stakeholder characteristics based on their belonging group (Made by the author).

Sector	**The purpose of engagement**	
Social society	• Residents living in the area (also will be investigated based on their relation to the hazard) • Citizens from entire city • Media	• Increasing their awareness regarding the hazard and uncertainties in future climate • Gathering information regarding their visions • Developing new visions
Public authority	• Vejle municipality, • Other adjacent municipalities affected by changes in the fjord • Vejle Spildevand A/S • Environment Ministry • Danish Coastal Authority	• Providing local knowledge • Bring new experiences and knowledge • Supporting the social society • Bring ideas form previous participatory experiences and other municipal plans
Businesses and industry	• All industries are in the risk area such as Vejle Spildevand A/S and Port of Vejle • Other opportunities even from outside of the city	• Developing new visions • Providing new technical solutions
Academia	• Universities and research centers • Vejle partnerships (for instance with 100 Resilient Cities (100RC) or Kyst+ Network)	• Developing new visions • Bring knowledge regarding the uncertainties • Providing new technical solutions • Bring new experiences (making networks with other urban areas, experiences and practices.

According to the criteria mentioned in the *Storm Surge Strategy,* providing access to water for all is important because the district's unique location provides access to the fjord for all Vejle citizens. Hence, it is also important to consider all Vejle citizens, along with groups of residents (directly affected by flooding) in the district, in the co-creation process.

As the Vejle municipality is responsible for making municipal plans addressing the risk of flood together with their participatory experiences, they play a critical role in several steps of co-creating the DAPP. In addition to the local authorities, collaborations and participation across municipal borders can take place. Investigating the case of Randers, section 6.1, indicated that as the flood risk affected two municipalities, the DAPP approach with the collaboration of experts from adjacent municipalities was experienced. The level of that collaboration was not high, but in this case, it can happen with a more effective role than just an observer. This approach might also assist in sharing the experiences and knowledge between municipalities through co-creation.

Vejle's ambiguous visions for future urban development provide an interesting area for collaboration and investments. For instance, the third phase of the *storm surge strategy* highlighted the need for more ideas to realize nature-based strategies for building the storm surge barrier. In addition, the Vejle Spildevand A/s

and Vejle Port were also considered for co-financing the second phase of *the Storm Surge Strategy* (Vejle Kommune, 2021a).
Academia plays a significant role in providing new knowledge about recent changes in climate and uncertainties and related technical solutions to their impacts. Also, Vejle municipality has experienced several workshops and projects based on various networks managing the risk of flood. These networks provide a significant basis for sharing and providing new knowledge and experiences (for instance, 100 RC or Kyst +).

As this section aims to study the impacts of change in sea level, investigating the relation of stakeholders to hazard is limited to those affected by sea level change. This analysis shows to what extent each stakeholder is exposed to slow-onset changes or both slow and sudden-onset events. In order to characterize the actors in the process of co-creation related to the hazard, the hazard map from the Risk Management Plan (2021-2027), which represents a 100-year storm surge event in 2115 under the RCP 8,5 scenario, is selected that shows the event causing the highest risk. The following figure includes two layers of the risk map, and the land uses based on the Municipal Plan (2021-2033) in the East district.

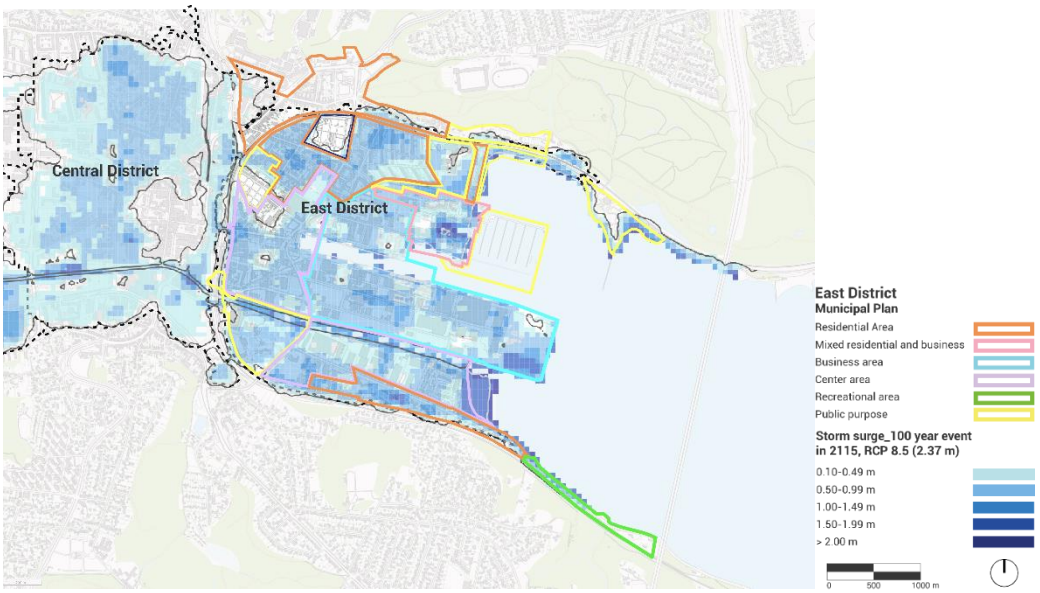


Figure 8.2: The hazard map of the 100-year storm surge event on 2115 based on RCP 8.5 (Made by the author, adapted from Vejle Kommune, 2020a), and plan for the area 2021-2033 in East district (Vejle Kommune web kort, n.d.).

In this research, the municipal plan (2021-2033) and the hazard map of the 100-year storm surge event in 2115 under scenario RCP 8.5 are implemented, describing the affected groups. The hazard map shows to what extent they are affected, and the municipal map assists in investigating different groups affected by the hazard. Each of these areas is composed of several functions, but groups of stakeholders based on their relation to the hazard are classified under the main categories in the municipal plan.

Residential area: It includes areas with different characteristics and degrees of being affected by the event. For instance, the residential area in the northern part of the district is highly affected, while the high-rise constructions next to the fjord are affected moderately due to existing protections. According to this group, due to the differences in their conditions related to the hazard, different groups of participants from residential areas can be considered.

Business area: It is mainly formed by activities related to the port of Vejle. The area is determined for port purposes and businesses such as manufacturing, workshops, service businesses, and wharf facilities (Vejle Kommune, 2021b). According to the hazard map, this area is also immensely affected.

Public purpose: the areas with public purposes include different types of areas. For instance, an area next to the fjord for recreational and winter boat storage or an area with public purposes in the western part with offices, car parks, railway operations, and water treatment (Vejle Spildevand A/S). The northwestern part also includes schools, a church, and a cemetery (Vejle Kommune, 2021b). As the areas with this category are exposed to the risk of rising water levels within various ranges, and according to the diversity of these areas, it is also significant to consider this variety. Based on the experience of co-production in the case of Skive in section 6.2, systematic participation of young people from schools located in this area, which can show the urgency of the condition, can help plan for the long-term.

Mixed residential and business area: According to the Municipal Plan (2021), the use of the area is determined for business purposes, including offices, hotels, exhibitions, and restaurants. It can also be used for public purposes and recreational areas. Furthermore, it can be used for residential purposes. According to the hazard map, this area is highly exposed to the storm surge event.

Center area: These areas also contain a mix of residential and areas with public purposes (Vejle Kommune, 2021b), and they are moderately affected by the hazard compared to, for instance, the northern residential area.

According to table 8.6, which provides a framework to characterize the stakeholders for the objectives of this research, identification of the actors based on their relation to the hazard is divided into being affected by slow onset events and both slow and rapid onset events. However, in this case, due to the existing protections, the rising sea levels alone cannot cause severe damage to the East district. Hence, only the combination of these two, slow and rapid onsets, are considered in this study.

In addition to characterizing the stakeholders based on their relation to the hazard, they can also be identified based on their relation to the actions in managing the flood risk. According to table 8.6, this can be investigated through prevention, protection, and preparedness actions. The following table identifies the stakeholders based on their relation to the risk reduction actions.

Table 8.8: Stakeholder's characteristics based on their relation to the measures (Made by the author).

Action	Affecting the action	Affected by the action
Prevention	Businesses and residents (for preventive actions) Vejle Municipality The port of Vejle Spildevand A/S	Businesses and residents (for preventive actions)
Protection	Municipality (preventive measures to protect critical and cultural assets) The port of Vejle Spildevand A/S	The port of Vejle Spildevand A/S Citizens (generally) and residents
Preparedness	Citizens and businesses in the area Vejle Municipality The municipality	Citizens and businesses in the area

According to Vejle Kommune (2024), it is a private landowner's responsibility to protect their property against flooding from the fjord and streams, while the municipality is responsible for securing critical infrastructure. As a resident, the responsibilities are divided into all three actions of preventing and protecting against flood and actions after flood (Vejle Kommune, 2024). As prevention measures, the municipality advised citizens to protect their property by collaborating with neighbors. They also recommended investing in smart solutions (Ibid). There are actions for residents during and after the flood, ranging from being updated regarding new guides or crisis information to activities such as getting the water away from their property. In addition, the municipality is also responsible for preventing floods by smart planning through standards, guides, and regulations, and making communications and informing citizens and businesses about the hazards along with protecting the city by implementing actions such as locks (Ibid). In addition to these measures, the risk management plan also highlights actions for *knowledge building* where the aim is to understand better the risk areas. Also, the *involvement and information* action that aims to increase awareness and collect relevant background knowledge (Vejle Kommune, 2021a). Furthermore, in the process of co-creating the design and implementation of the solutions, academia, industry, and businesses can play a significant role by providing new technical knowledge and innovations for preventing, protecting, and preparing against flooding events.

The co-creation process by shaping networks and providing a shared understanding in the process of defining the elements of MCA, enables the participation of all who are affecting and those will be affected by the both hazards and actions in a joint process, defining the pathways, criteria and their weightings in the process of co-creation.

Based on Table 8.9, in addition to the actors' characteristics, defining their role in the co-creation process is also required. The designation of the roles is divided into two major groups in co-creating the MCA elements. The first set of roles is related to the preparatory stages for the co-creation (steps 1 to 5 of the co-creation). The second group runs the realization of the process (step 5 of co-creation).

Table 8.9: Actors' roles in co-creating the elements of the MCA in the DAPP approach in the East district of Vejle risk area (Made by the author).

Co-creation steps	**Roles**	**Belonging and roles**
Preparatory steps (steps 1 to 5)	Weber	Actors from the municipality and representatives from site users (based on Figure 8.2) who are aware of the networks can play a role in selecting the participants based on the framework.
	Patron	A person familiar with the DAPP, flood risk reduction, and co-creation can support the innovation process.
	Advocate	A person who distributes the information externally regarding the process. He/she can be from the municipality and is familiar with both the context and other development processes.
	Facilitator	They are familiar with both processes of the DAPP and co-creation. He/she designs and adapts the process.
Realizing steps (step 6)	Facilitator	A person familiar with leading the co-creation and the DAPP process. Here, they act as a leader, conducting the process.
	Builder	The municipality here can also act to demonstrate the emergence of collaboration and action against the growing risks of rising sea levels and affect the conditions of co-creation by building trust among actors.
	Orchestrator	It can also be done by the facilitator, who is familiar with both processes. He/she can guide the groups and networks in achieving their goals.

Co-creator	It points to actors from civil society (residents and citizens), Academia, industry and businesses, and public sectors contributing to the process of producing pathways, criteria, and weightings.
Coordinator	An actor for each group who coordinates the group. It can be a person with knowledge of risk reduction and running a participatory process.
Messenger	This role can be merged with the facilitator. He/she forwards and distributes knowledge between groups of participants.
Integrator	This role can be shared between actors from the Municipality (possessing local knowledge) and the Coastal Authority (risk reduction knowledge), combining heterogeneous ideas and structuring of visions.
Contributor	Actors from academia and public sectors (other municipalities, environmental agencies, etc.) can provide new products and work closely with all actors.

As mentioned in section 7.2.2.2, the roles for preparatory steps are merged with the project group required to set the DAPP approach. It has also been mentioned that an actor (group of actors) can play several roles in the process. The experience of Vejle municipality in running various participatory processes with different purposes, along with their experience of applying the DAPP process and managing the flood risk, gives them an important position in playing various roles in the co-creation process. Hence, they, with all their departments, can play various roles, from Weber to builder, co-creator, or integrator. Actors from civil society primarily act as co-creators in groups with actors from other sectors.

Another preparatory process in step 2 of the co-creation process is to determine the resources before starting the process. According to section 6.3 and the experience of co-creation of the DAPP process in Skive, one of the limitations that facilitators and the municipality faced was the constraints of time because the process was too long. Hence, in this step, it is also significant to, in addition to engaging the right team, determine the options that can enhance the effectiveness of the process.

Step 3: Decide

According to section 7.1.2, which presented the levels of co-creation in defining the pathways of the MCA process, *an Empowering* level aiming to generate cooperation among stakeholders is required for the case East district. This level highlights the active engagement of actors and is appropriate for the case area. The approach is selected due to Vejle's previous experiences in applying participatory approaches and due to its emphasis on municipal visions concerning the active engagement of stakeholders in defining urban development plans. Furthermore, defining the criteria and weightings of the MCA, *Empowering* or *Collaborating* level initial engagement is needed to fulfill the objectives of the co-creation process based on the contextual conditions and needs of the dynamic planning approach. This factor, the level of co-creation, is not only related to the objectives and outcomes of the co-creation but also is linked to the contextual conditions. Implementing the collaborating level can also lower the complexity of defining criteria and weightings.

Step 4: Selecting the tools

Appropriate methods and tools for the process for the case area must be selected based on the table in Appendix A. According to section 6.3, the experience in the case of Skive showed that, however, in the beginning, the aim was to have a wide range of participation in all stages, it was not feasible due to the time constraints. Hence, applying the most suitable tools and methods is significant in mitigating the limitations of the process. Based on the contextual characteristics of the East district, including both the diversity of

stakeholders (large groups of participants) and the previous experiences of citizens in participatory approaches (level of familiarity), methods, and tools that can afford large groups of participants and control the time are required.

Step 5: Design
According to section 7.1.2, inviting participants is one of the actions in this step. Due to the complexity of the area and the variety of actors, the process of inviting the stakeholders from social society, those who are directly affected by the hazard and affecting the actions, businesses, academia, and public authorities, can happen through direct invitations. Indirect tools such as advertisements, social media, and news can be implemented to invite the general participants of the social society sector. These general invitations can be through the Municipality's citizen involvement website (Bylab.vejle.dk), Networks, Økolariet, Green Forum, etc.

As also mentioned in section 7.1.2, *agreements* and contracts about the roles must be considered using tools such as contracts or formal and informal agreements. Furthermore, ensuring the quality of the co-creation process can be done based on the *co-creation principles* presented in section 3.3.5, which provided a frame by which the quality of the procedure and outcomes can be tested.

Step 6: Realize
This step defines the starting and continuing of the process of co-creation, and it will be followed throughout the process.

Step 7: Evaluate and adapt
Due to the ongoing changes in the system and climate, as well as the requirements of dynamic planning, this step plays a vital role in providing an opportunity for adapting to the transformations. Developments in the techniques, changes in generations and their needs, along with uncertainties in changes in climate. These transformations highlight the need for co-evaluating and co-creating again based on the changes. Also, the transformations might affect the actors participating in the process based on the changes and needs for new knowledge and roles.

The following figure illustrates how co-creation can develop the defining elements of the MCA process in the East district of the Vejle risk area in accordance with the described steps.

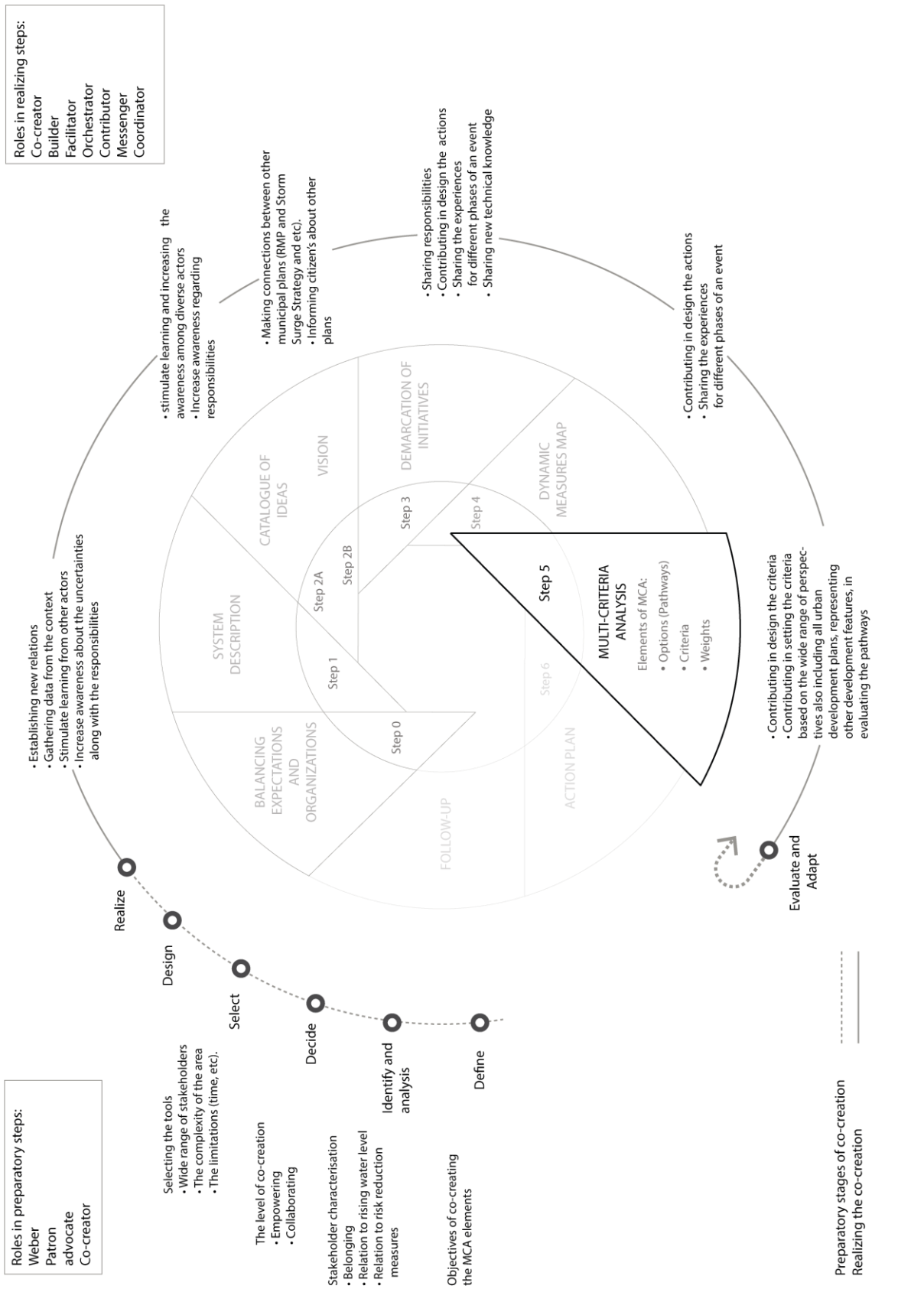


Figure 8.3: The co-creating map for MCA step in the DAPP approach (Made by the author).

According to the figure above, step 0 of the DAPP, which can be understood in two phases, overlaps with the preparatory steps of the co-creation. Both aim is to provide the conditions and plan for the processes. However, some phases of the 0 step of the DAPP, which aims at defining the acceptable risk, can be aligned with the realizing step of co-creation. Based on the map of co-creating the MCA in the East district of Vejle (figure 8.3), co-creating the elements of MCA commences from this step of the DAPP.

According to the figure above, and based on the stakeholders' relation to the hazard and measures, co-creating steps 1 and 2 of the DAPP approach provides not only the required knowledge but also an opportunity to understand stakeholders' responsibilities regarding the risk. It can also increase the stakeholders' knowledge concerning the uncertainties about future changes in climate and their role in taking action, leading to a shared understanding of the process. It can also provide a context for bringing new ideas and knowledge from different stakeholders, such as academia or industries, as mentioned before.

Specifically, concerning the participation of citizens (mostly the residents of the East district), co-creating can provide a place for them to share their experiences regarding prevention, protection, and preparedness in addition to increasing their awareness. Related to the second step, the process's co-creation helps address the measures mentioned in the risk management plan as well as prevention, protection, and preparedness. It provides the opportunity to *build knowledge* by making networks and engaging various actors. It also allows stakeholders to be involved and informed about their responsibilities and impact in managing flood risk.

Co-creating the DAPP can provide an opportunity to combine the visions and aims of Vejle's Resilience Strategy with all other municipal plans, from storm surge strategy, climate adaptation plan, and Risk management Plans to other urban development plans. It enables stakeholders to become aware of the outcomes of all municipal plans while trying to observe their relation with other municipal visions in step 2B. Regarding step 3, where all initiatives are demarcated, due to the awareness of the stakeholders about their duties and relation regarding the hazard and the measures, they can collectively discuss the demarcation of the initiatives, leading to making the pathways in step 4.

After determining the most suitable pathways, the criteria and weightings can be selected based on a shared understanding of all actors who are aware of the system's uncertainties, the variety of perspectives on managing the risks, and other urban development plans.

In conclusion, in the case of the East district of Vejle risk areas, due to the previous experiences of participatory processes along with the municipality's willingness to engage a wide range of participants in the urban development processes, the conditions of co-creation play as enabling factors to the co-creating the MCA in the DAPP approach. Co-creation can develop the process of defining the elements of the MCA process by establishing new relations and networks, stimulating the learning about the uncertainties due to changes in climate, increasing awareness regarding the stakeholders' responsibilities against rising sea levels, bringing and gathering new knowledge, and eventually co-designing new visions and initiatives.

IV. Discussion

The last chapter of this study consists of two main sections: discussion and conclusion. The first section aims to discuss the conditions of co-creating the DAPP, the applicability of the co-created dynamic planning process in other contexts, the limitations of the project, and eventually, possible further research. The second section, the conclusion, will provide the findings and results of the study, answering the project's research question.

9. Discussion

This section aims at discussing the related factors of co-creation condition prior and after the process. It also tries to investigate the general applicability of the process to other contexts such as different hazards or compound effects. The section will be continued with presenting the limitations and further research possibilities.

9.1. Conditions of co-creating the DAPP

In this research, prior to adapting the structure of co-creation to the dynamic planning process, the conditions of co-creation were investigated. The conditions provide hindering and enabling factors to the co-creation and can affect the outcome of it. Investigating these conditions, mainly regarding the citizens' attitudes toward participatory approaches, required a comprehensive analysis, including field research or interviews with citizens. According to the project's outcome, investigating the conditions after the process might also be significant in addition to the conditions prior to the process. As the co-creation process takes place for each planning stage and each takes a long time, it is also essential to investigate the conditions after the process, which provide the conditions for co-creating the subsequent phases of planning. For instance, the DAPP process aims to dynamically design and plan based on unknown future changes in climate, and its co-creation requires investigation of the co-creation condition mentioned in section 3.3.1. Furthermore, due to the urgencies and the need for immediate solutions (short-term actions), some solutions need to be implemented in the near future. Therefore, co-creating the DAPP process can affect the conditions, contextual and related to the stakeholders, after the process and influence the following stages, such as implementation. Following the issue in the context of co-creation projects around Europe illustrates the significance of this matter. For instance, several projects like CO-ADAPT and RECONECT, or EU-Horizon 2020, pointed to co-creating the design and implementation of the actions that show the significance of noticing the other levels of planning.

In addition to the conditions of co-creating the DAPP approach discussed above and the stakeholder characterization framework, there are other factors that can influence the state of stakeholders participating in the process that were not covered by this study. According to Murray-Webster and Simon (2006), it is possible to categorize the stakeholders based on their attitude, power, and interest in the process. In this study, several roles can be considered as characteristics of stakeholders based on the level of these three dimensions, which can be high or low or positive or negative. For instance, one of the other discussions in the context of this project can be regarding the unwillingness of some stakeholders who have the power and also a positive attitude but low interest in the process. Murray-Webster and Simon (2006) conceptualize these stakeholders as *Sleeping Giants*. In different cases, this influential stakeholder characteristic can be

referred to different groups, from some parts of civil society to industries and businesses. Hence, knowing about these features of participants can affect the state of the co-creation. Overall, identifying stakeholders based on their attitudes and interests influences the process of stakeholder analysis by allowing the consideration of more dimensions in characterizing them. On this basis, identifying stakeholders based on foundations beyond their belongings and relation to the actions and hazards can also provide valuable contextual knowledge.

Furthermore, as the dynamic planning is a long process in nature and co-creating also affects the duration of this process, highlighting the stakeholders' motivation in all stages is also considered to be highly important. Responding to the question of maintaining the networks and keeping the stakeholders motivated to participate and influence the process is central to considering this challenge. However, the conditions of co-creation mentioned before might affect their motivation to participate in the process; it can be argued that several other factors might affect their drive to remain active actors during the process. In addition, it can also be argued that, even if the longevity of the process does not influence their participation, in some cases, it can change their attitude or interest. Accordingly, it might affect their contribution and the level of co-creation.

9.2. Co-creating the dynamic planning in other contexts

Changes in several dimensions in this study might affect the structure and other factors that were mentioned and considered in this study. In the context of the discussion, it is also interesting to investigate to what extent these changes influence the applicability of the outcome of this project. One of these dimensions could be applying the process to mitigate the impacts of hazards other than rising seawater levels. Due to climate changes, urban areas face several other adverse impacts. Furthermore, the application of dynamic planning is not limited to planning for flooding from the sea. Hence, in addition to the outcomes of this project, it is also interesting to investigate the applicability of the process made by this study in case of other hazards. This argument can also be applied to other sources of flooding, such as groundwater and intense precipitation events. However, considering the mentioned impacts individually does not influence the process immensely; considering different sources of flooding can provide a need for adjustment to the process.

In addition to investigating the process in the case of other impacts of climate change or individual flood types, its applicability in the case of compound effects is also significant to study. Compound flooding is caused by various flood drivers and points to the concurrent occurrence of multiple flooding sources that can lead to more damage (Wang et al., 2021). Studies show that the changes in climate affect the occurrence of compound effects by influencing the flood drivers (Bermúdez et al., 2021). On this basis, it affects the process as one of the hindering aspects that can stop applying the process with the desired level of co-creation due to the complexity of the condition. Hence, in addition to the complexity of considering different sources of floods, considering these impacts might also need different actors, from experts to the affected stakeholders. On this basis, it can be argued that the *roles* managing the process of stakeholder and *actor identification* can be central in this adaptation to other or composition of other hazards. It can also be argued that considering different hazards can influence defining the criteria in the process of MCA in the DAPP to achieve a consensus about the criteria and weightings. Furthermore, on this basis, the transformations in the roles are also significant. As mentioned in section 7.2.2.2, for both processes of the DAPP and co-creation, the *leader* or *facilitator* is central in the processes. Hence, dealing with various challenges from various

sources might raise the discussion regarding the main instigator of the process. This transformation requires other strategies to define the criteria and weightings.

Projections show that drier summers and periods of drought will be experienced due to the changes in climate, rising temperature, and shifts in the precipitation patterns, which can influence the ecosystem and agricultural state in Denmark (Klimatpasning, 2023). In this context, applying the co-creating of the dynamic planning for heat waves and droughts can influence the project's applicability concerning the stakeholders, the roles, the objective, and the level of co-creation. As the problem, compared to flooding hazards, is new to the context of Denmark, and like other impacts influenced by uncertainties, the need for experts that bring the background technical knowledge is considerable in providing the conditions prior to the process of co-creation. It can be different compared to the conditions that traditionally the stakeholders were exposed to flooding events. In contrast to the other hydrological challenges, it requires changes in the roles, and as a new base for knowledge is needed, it might need a broader set of collaborations beyond the municipal or national borders. In this case, the level of co-creation due to the potential imbalances in the knowledge might differ. For instance, to some extent and in some steps of dynamic planning, the objective of co-creation might be limited to increasing awareness and one-way sharing of knowledge. Zingraff-Hamed et al. (2020) highlight the role of *knowledge providers* to ensure knowledge transfer between the actors in addition to the facilitator. On this basis, the transformation of roles and responsibilities can also be argued.

9.3. Limitations

One of the topics this research should have referred to was understanding the meaning of the co-creator role in the co-creation process. As one of the significant roles in the process, it requires more elaboration when it comes to public innovation, where a wide range of citizens participate in this role is expected. According to Lund (2018), the co-creator role can be divided into co-implementors, co-designers, and co-initiators, each representing an approach to citizen involvement. It ranges from *co-initiator* as the most resource-demanding and active form of the citizen role to *co-designer* as a process initiated by the public authorities but developed by the citizens, and eventually, *co-implementer* that points to the significance of citizens while does not deliver a role for design or initiation to them. Therefore, due to this range mentioned by the authors, it is significant to delve deeper into the level of action specifically for public innovation. According to Boonstra and Boelens (2012), the co-initiator and co-designer roles can also shift the planner's role as experts in making plans to become facilitators of a process connecting various existing networks between actors within the urban context. Hence, shifting toward these points of view for planners responsible for these ranges of participatory processes requires a different set of skills (Lund, 2018), which was not considered in this project in defining the role of the co-creator in the analysis.

9.4. Further research

The project can be continued and developed in two directions. The first orientation is based on expanding the co-creation process to other steps of the DAPP approach. Furthermore, it can be followed by exploring the co-creation process in dynamic planning for other hazards. In this case, the orientation was limited to rising sea water levels, while according to the discussion, it can be extended to considering other sources of risk.

According to the possibilities and limitations of the study mentioned above, firstly, the co-creation of the entire process, which means designing the co-creation of each step in the DAPP approach, can be explored. Based on the framework provided by this research, each step requires a specific stakeholder with different reasoning and levels of participation. The roles might also differ in each step according to the characteristics of each step of the DAPP. Therefore, exploring other steps of the DAPP requires further research. Secondly, including other sources of flooding besides rising sea levels provides opportunities for further research in this area. For instance, based on this study's case, it is also possible to consider other sources of flooding or consider them together to find synergies in the planning for more than one source of risk.

Eventually, as one of the starting points of this study, besides uncertainties in the changes of climate, was rooted in concerns with the concept of human scale in planning for climate change adaptation, one limitation was the need for more focus on the local scale by considering all the different views. However, the reasoning for doing so was the gap between the design and planning; it was not possible to point out that this gap and must be investigated due to the limitations of the project. Applying these notions in other contexts also requires comprehensive social and cultural explorations, providing necessary knowledge regarding the composition of the stakeholder, which means observing the stakeholder as active actors with their specific characteristics. This requires experience, knowledge, and tools for communicating and deriving data regarding the groups of actors in the local context. It can be argued that comprehensive research about the community hosting the process prior to its beginning can give different input for the level, objectives, or roles in co-creating the dynamic planning process.

10. Conclusion

This chapter aims to provide the answer to the study's research question. This research aimed to answer the Research question:
What are the roles of the co-creation in the Multi-Criteria Analysis (MCA) step of the Dynamic Adaptive Policy Pathway (DAPP) approach?

In order to answer the question, three sub-research questions were set, guiding the main question to the answer. Three processes of analysis aimed to answer questions regarding (1) the municipalities that experienced the DAPP approach in Denmark, (2) the ways to develop the Multi-Criteria Analysis step of the DAPP approach through co-creation, and (3) the potentials of developing the MCA process in the DAPP approach through co-creation in the case of Vejle, Denmark.

Firstly, the Danish municipalities' experiences that integrated the DAPP approach in managing the flood risk were explored. Three cases were investigated, and their practice of the DAPP approach was mainly limited to interdisciplinary approaches in two risk areas of Randers Fjord and Aabenraa. However, in the case of Skive, the municipality tried to hold a participatory process of dynamic planning for water-related challenges through co-creation. The outcome showed that although the municipality had an ambiguous objective of participating all citizens, it was not feasible for all stages as it might become complicated. Therefore, it was limited to bringing new visions and ideas as actions in the second step of the DAPP.

The second analysis tried to develop the MCA step in dynamic planning through co-creation. Exploring the ways in which the DAPP process, based on the *guide to dynamic planning* (Kystdirektoratet, 2020b), can be developed to foster the participation of a diverse range of actors in the urban context into the process of innovation and can mitigate the bias in defining the elements of its MCA process. According to the conceptual structure, the three dimensions of co-creation, stages, stakeholders, and tools, were adapted to the conditions of dynamic planning. However, the research focused on co-creating only the MCA step of the DAPP sedue to the project's scope; in defining the pathways as an element for the MCA step, the co-

creation of the previous steps was also investigated. As the dynamic planning process is founded on the definition of uncertainty and the likelihood of the risks in the long term, it was also necessary to explore steps 0 and 1 in the dynamic planning process, where the acceptable risks and uncertainties in the system and climate are defined.

The last analysis, the third sub-research question, aimed at applying the new guideline developed in the previous section and investigating it with the conditions of the Vejle case. In addition, the experiences from the cases of the first analysis also guided the formation of the new guidelines in the East district in the Vejle risk area. The third analysis tried to design the preparatory steps of the new guideline in the case area, from exploring the objectives of co-creating each step of the dynamic planning to stakeholder identification and analysis.

These analyses provided essential data concerning making a guideline that can develop the current MCA process in the guide to dynamic planning in Denmark. The guideline is formed around three dimensions of co-creation: stages, stakeholders, and tools. In order to define the stages, it adopted the seven-step pathway process by Dushkova and Kuhlicke (2023), providing a series of steps for co-creating the elements of the MCA process based on the guide to dynamic planning by the Danish Coastal Authority. The guideline also formed a stakeholder characteristics framework adapted to the purpose of the research. The stakeholder characteristics procedure, which defines the participants based on the Quadraple-Helix model, tries to bring different sources of innovation into the dynamic planning process. Eventually, the guideline provided several tools that can assist the definition, ideation, and knowledge production processes in managing the risks of climate change impacts.

The outcome of this investigation provided a guideline aiming to design the MCA's elements in the DAPP approach through the co-creation process. It can develop the products of the process by using different sources of innovation and mitigate the bias and subjectivity of the MCA process. In contrast to the existing guide limiting participation, it allows the participation of all actors in the process of co-creating the dynamic planning from the beginning steps. It can enable the active participation of all actors due to their equal level of awareness about the problem and the context. Regarding the main research question, the study's outcomes can develop the guide to dynamic planning through co-creation in various ways. Co-creating the dynamic planning assists in establishing new relations and networks through the stakeholder characterization framework. Integrating the variety of participants from the first steps of the dynamic planning, where the acceptable risks and uncertainties are described, not only provided a shared understanding of the context but also enabled them to formulate the problem together. It also provides an opportunity to harness local knowledge, ensuring the integration of all perspectives and ideas from the local knowledge. The developed process of defining the elements of the MCA can also stimulate learning among participants and increase their awareness of changes in climate, especially with their uncertainties and their responsibilities.

Regarding the second step of dynamic planning, which aims to provide a series of visions and ideas, the co-creation process can develop the process by providing sources of innovation from different actors, ranging from public authorities, industries and businesses, and academia to civil society. Furthermore, as plans addressing the risk that induced by climate are a layer of other urban development plans, the co-creating process of the dynamic planning can also provide a context where all layers of development plans, along with the risk management plans and climate adaptation plans, become aligned and correlated. In generating the pathways composed of dynamic measures, co-creation can develop the process by bringing new ideas and experiences based on a shared understanding of the context and its uncertainties. Eventually, due to the shared understanding of the actors about the challenges and problem and the transdisciplinary integration of participants in the process, the bias and subjectivity of criteria and their weightings can be mitigated through co-creation.

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Appendices

Appendix A

Table 1. Tools and methods of co-creation (made by the author).

	Tools	Description	Resources					
			Time frame			Group size		
			1< hr	1-2 hr	More	Up to 6	Up to 15	+15
Hazard, exposure, vulnerability data collection	Focus groups	It represents of multiple participants sharing opinions (Discuss, n.d.).						
	Participatory mapping	It involves in creating maps in order to determine how various stakeholders perceive the connection between locations and individuals within a particular setting and throughout a period of time (UnaLab, n.d.).	*			*	*	*
Need finding	Geographic mapping	There are several reasons to choose it, depending on the stage of the workshop. In the initial stages, it help to informally identify the nature and location of problem areas. It role is to involve participants in a hands-on approach to discuss and map the issues themselves, allowing them to fully comprehend the extent of the problem at hand (UnaLab, n.d.).	*			*	*	*
	Power interest matrix	Based on this grid, power indicates the level of influence the stakeholder can exert on the project, whereas interest denotes their interests about the issue.	*			*	*	
	Visual mindmap	It represents an overview in visual form depicting all information pertaining to your issue or resolution and the environment in which you are operating. This resource assists in organizing and arranging thoughts and knowledge, and identifying connections between ideas. This visualization aids in making ideas more tangible and promotes inclusive brainstorming (UnaLab, n.d.).	*			*	*	*
	Commons mapping	This tool needs a wall canvas that provides an open platform for individuals to write their contributions in the process. These contributions could include resources (e.g. sensors, meeting space, funds), time, or specific skills (UnaLab, n.d.).	*			*	*	*
For stakeholder engagement	Actors' map	It visually represents the crucial organizations and individuals that impact a particular subject, offering a glimpse into the entities involved in a system. The mapping typically involves three main phases: preparation, facilitation, and revision (UnaLab, n.d.).		*		*	*	

	Stkaeholder CV tool	The Stakeholder CV tool integrates a range of established stakeholder analysis methods to facilitate a deeper understanding of stakeholders, encompassing their backgrounds, perspectives, beliefs, expectations, and relationships (UnaLab, n.d.).			* 1 day	*		
	User persona	This tool is created to help visualize and gain a deeper understanding of the stakeholders. It serves as the initial step in your journey to explore the problem. You will continuously update it as you collect more stories and insights from your interactions with real customers (UnaLab, n.d.).	*			*		
For stakeholder engagement	People and connection map	It serves as a means of visualizing the stakeholders. It is implemented to map the individuals and groups who have the potential to become collaborators, users, or supporters. These can encompass individuals, communities, financiers, and networks, and they all have the potential to serve as valuable resources for innovation (Nesta's DIY Toolkit, n.d.).						
	Service blueprint	It is a visual representation that illustrates the complete service delivery process, detailing all the actions carried out at each phase by the various roles involved. (service design tools. n.d.).						
	Team canvas	It is a framework that helps build a community or analyze and enhance an existing community (UnaLab, n.d.).		*		*		
	People shadowing	People Shadowing involves temporarily becoming someone's shadow, following them or a group of individuals as they go about their daily routines or work. This practice helps us comprehend their environment and enables us to personally observe the contextual factors that can impact a person's actions and drive (UnaLab, n.d.).			* 1 day	*		
	Building partnership map	It is a process of making maps aiming to recognzing how various groups of stakeholders understand the relationship among people and apaces in a specific context and over time (UnaLab, n.d.).	*			*	*	*
Ideate and generate innovations	Brainstorming	It is considered as an effective tool to generate ideas.It encourages people to bring all of their ideas. It provides a relaxed and free space for participants (De Los-Rios White et al., 2020).	*	*		*	*	*
	Mindmaps	It assists in capturing and structuring the thoughts and expertise, and in establishing connections between ideas, opportunities, and potential challenges within the specific	*			*	*	*

		situation. It generates a visual representation of all the information related to the issue or resolution and the environment (UnaLab, n.d.).					
	Wall of ideas	Research wall or design wall are the other names. The purpose is to provide a large surface to show the ideas and information. It helps better visualization and investigation of the data (De Los-Rios White et al., 2020).	*	*		*	*
	Lego serious play	It provides a game in which participants tackle challenges by using Lego bricks to construct 3D models of their thoughts. The workshop is based on a well-established process of building and reflecting, establishing an equal and inclusive platform for all participants to play, think, share, and learn. Through the creation and discussion of Lego models and their stories, valuable insights and ideas can be generated addressing significant challenges (UnaLab, n.d.).	*			*	
	5 whys	It provides a simple and efficient method for pinpointing the underlying cause of an issue. It is also suitable for pointing to problems, enhancing quality, and finding solutions, and it is particularly effective for resolving straightforward or moderately challenging issues (UnaLab, n.d.).		*			*
Tools for designing strategies	Strategic canvas	It provides a simple and user-friendly tool for recognizing stakeholders' requirements, ethical and legal concerns, crucial success factors, outcomes, risks, and more. When used alongside the Practical Canvas, it can optimize the identification of stakeholders' needs (UnaLab, n.d.).		*			*
	6 thinking hats	It represents a classic method for generating ideas. It teaches you how to divide thinking into six distinct functions and roles. Each thinking role is represented by a colored symbolic "thinking hat." By mentally putting on and changing "hats," you can effectively concentrate on or shift thoughts, discussions, or meetings (UnaLab, n.d.).		*			*
	SWOT workshop	A bottom-up strategy development processes with various stakeholder groups, particularly in regional or municipal strategy development settings. It aids in gathering and presenting data that characterizes a group's current situation (UnaLab, n.d.).		*	*		*
	Road mapping	The goal of the this workshops are to create plans for the future development of cities. This workshop aims at establishing			*		*

		a connection between the present and the future of the city through collaborative efforts (UnaLab, n.d.).		2 days			
	Communication map	A visual summary of the communication methods utilized (or not utilized) by a particular target audience. Evaluate the methods and appraise the frequency of usage, the social context in which they are employed, and the kind of information shared through each one (UnaLab, n.d.).	*		*	*	*
	Vision development	Its objective is to establish the envisioned future outlook for a city. It involves a sequence of sessions with decision-makers, planners, and both in-house and external specialists. Local stakeholders are welcome to participate (UnaLab, n.d.).		* 3 ddays			*
	Data discussion sheet	During citizen sensing, participants engage in the collection, analysis, and sharing of data. It also assists participants in deliberating the technology utilized, the gathered data, data ownership, privacy issues, and identifying additional data they wish to gather. It helps in expressing concerns and encourages awareness of data and decision-making (UnaLab, n.d.).		*	*	*	*
Select	I like, I wish, what if	It's a tool that offers a framework for gathering feedback from users using three types of statements. "I Like…" statements encourage users to highlight the aspects of the prototype they enjoyed. "I Wish…" statements prompt users to suggest changes or improvements, collection of negative feedback and constructive criticism. Lastly, "What If…" statements allow users to propose new ideas that may not be directly related to the prototype (UnaLab, n.d.).	*		*	*	*

Appendix B: Interview guides

Interview 1: Interview with Mette Betzer Lundov and Rick Pieter Kool

1. **Stages and process**
    1. What were the objectives of implementing the participatory and co-production method in the case of Skive?
    2. How was the Multi-Criteria Analysis step? Which criteria and weightings were selected?
    3. Have you experienced any limitations in any of the project's steps (such as time, resources, the unwillingness of some stakeholders, and so on)?
2. **Stakeholders**
    1. Who was involved as a research group or facilitator expert?
    2. How many participants participated in the process?
    3. Who were the participants?
    4. How did you define the target group for participation? (the criteria for selecting the participants)
    5. When did the stakeholder participation happen? What were the objectives? (at the whole DAPP process)
    6. What was the participation range in each step of DAPP? (from very open to closed technocratic)
    7. Who participated in the MCA step? Only municipality? (what was their expertise?)
    8. How did you bring the participant's visions and interests into the MCA process?
3. **Methods and tools**
    1. According to the participatory and co-production process, what tools and methods were implemented for stakeholder engagement? (workshops, questionnaires, and so on)

Interview 2: Interview with Ulla Pia Geertsen

1. **Co-creation and other participatory practices**
    1. How did the Vejle municipality manage previous co-creation practices?
    2. What was the purpose of that process?
    3. According to the co-creation city vision, is there a guide or process the city follows?
    4. Is there any set of processes or roles for these participatory?
    5. Who participated in the process?
    6. How do they invite? What other means do municipalities use for inviting, sharing knowledge, etc?
    7. What kind of tools did the municipality use to run the participatory processes?
    8. Have you experienced any limitations in participatory processes?
2. **The actors in the East district in Vejle**
    1. Who are the participants in the area?
    2. Who is responsible for (affecting) the actions based on the risk management plan?
        1. Who is responsible for prevention?
        2. Who is responsible for participation?
        3. Who is responsible for preparedness in the area?