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Generative Design in the Urban Planning Process

Exploring the Potential Role of Generative Design in the Swedish Detailed Development Planning

Master's thesis in Design and Construction Project Management

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ABSTRACT

With the increased demand for sustainable solution in urban development project. Municipal planning process are obligated to manage the challenges that comes with the demands. Previous research has identified generative design as a response to the challenge. This research aims to understand how current planning practices relate to the potential implementation of generative design tools in a Swedish environment. The study employed semi-structured interviews with five key actors in Swedish urban sector. While generative design is valued for its function to automate repetitive tasks that are time-consuming. The interviews illustrate that there exist several institutional and organizational barriers, which would limit the possible use of the tool. The barriers relate to aspects such as interoperability & data fragmentation, varying digital maturity between municipalities and limited function towards abstract social values. The study findings demonstrate that the role of generative design and its future integration would depend on the institutional and organizational development. As even if the tool can bring value to the planning process, the value it can currently create would be limited in the current detailed development planning process.

Keywords: Generative design, detailed development planning, Sweden, institutional barrier, organizational barrier.

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List of abbrevations

3D modelling	3 dimenisional modelling
2D modelling	2 dimensional modelling
CAD	Computer Aided Design
GD	Generative Design
BIM	Building Information Modelling
GIS	Geographic Information System
PBL	Plan- & Bygglagen (Planning & building act)
PBF	Plan- & Byggförordningen (Planning & building ordinance)

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1 Introduction

This chapter will give context to the report. It will address the current process for urban planning and the necessity for innovative technology to be introduced in the workflow. Furthermore, the chapter will discuss the research gap that exists within the field and the aim and research question that addresses said research gap. Lastly, the limitation of the report is outlined.

1.1 Background

The construction sector has consistently strived for efficiency by minimizing cost and time, while maximizing aspects such as quality. This has led to an increased reliance on data-driven decision-making. As there are rapid technological advancements, it requires the construction industry to continuously adapt to emerging developments (Chen et al., 2022; Lostumbo et al., 2025). At the same time, almost half of the global population already resides in cities. With projection indicating that the proportion of population living in cities is expected to grow. This creates pressure and a high demand for sustainable urban solutions (UN DESA, 2025). Particularly from an environmental sustainability perspective as cities generate the majority of the global warming.

Municipal planning has a critical role in addressing these challenges, especially in the detailed development planning process, as it guides how the land and water areas are used and shaped. Decisions made in the detailed planning process have long term implications in terms of sustainability. However, urban development has become increasingly complex. Actors in the detailed planning process need to balance and handle conflicting objectives, such as stakeholder interest, economic constraint, social well-being and regulatory requirements. The complexity has been, and are, making current practices unable to manage the challenges that urban projects face today (Kaur et al., 2020; Koenig et al., 2020; Varela et al., 2022).

The design phase becomes especially essential within this context, as it translates the conceptual ideas into feasible and buildable solutions. Despite this fact, the constraints and limitations of the current workflow are several. Varela et al. (2022) research indicates that the economic viability of an urban development project is established at this stage. With the environmental and social values also being heavily impacted by the design and plans made at this stage. Nonetheless, the development and evaluation of design iteration are constrained in terms of

time and manual process. This results in a limited capacity of exploration for design solutions, minimizing the ability to explore optimal or more sustainable alternatives.

To address the problem of the current practice, Varela et al. (2022) suggest digitalization as a viable solution, especially generative design. By algorithmically generating and evaluating multiple alternatives based on objectives and parameters as input. Khan et al. (2025) explains that solutions involving generative design that have been attempted before included development of urban-scale generative design framework, hybrid workflow (combination of generative design and traditional design approach) and more. However, these solutions are often project-specific which makes it hard for it to be implemented as a globalized solution.

1.2 Problem formulation

Research articles and studies today often explore generative design's technical capabilities and tool application. However, while the research does present the capacity generative design has in generating and evaluating design alternatives. There's a lack of research that indicates how generative design should integrate with the existing municipal planning process, particularly the detailed development plan processes in Sweden. This process is deeply characterized by its legal determinacy, negotiated legitimacy as well as progressive stabilization, which shapes how design iterations are designed, evaluated and adopted.

Despite the researched potential of generative design methods, there is still a lack of knowledge on how such methods relate to the requirement and conditions of detailed development planning processes. As a result, it's unclear of how generative design can be meaningfully applied and to what extent the process enables or constrain its use within a Swedish context. This creates a gap between the theoretical potential of generative design and the practical use in the workflow.

1.3 Aim and research question

The aim of the thesis is to understand how generative design can be applied in the planning process. More specifically it's the urban design stage of which the detailed development plan is being formed. The report seeks to understand the actor's perception and evaluation of the role generative design could have in the process. Lastly, the aim is to further comprehend the

associated challenges and opportunities that generative design has from an organizational and professional perspective.

Main research question

How does municipal planning practices relate to the possible use of generative design tools in detailed development planning?

Sub research question

How are detailed development design alternatives currently developed and evaluated in detailed development planning?

How do current practices enable or constrain the integration of generative design within detailed development practice?

1.4 Delimitations and limitations

The report is delimited geographically to the Swedish urban planning context. The focus will primarily be on the development of detailed development plans within the municipal urban planning process. This delimitation is motivated by the need to examine how generative design methods relate to established planning practice. The Swedish detailed development plan provides a structured process where design alternatives are designed, evaluated and refined. This establishes a basis for understanding generative designs application in a relevant context. However, this also results in the findings possibly not being directly transferable to different planning processes.

The study is further delimited to generative design and will not extend to other digital tools beyond the scope. The reason for focusing on generative design is to have an analytical focus into how design alternatives are currently developed and how it could be developed with this method, as there are a broad range of digital tools. The results are therefore specific to generative design and not digitalization overall.

In terms of limitation, the research findings rely on a semi-structured interview. However due to the limited number of interviewees it restricts the findings generalizability. The result should therefore be understood as an indicator and not representative to all detailed development

planning practices. Furthermore, as the study is based on qualitative methods such as interviews, it introduces a potential research subjectivity in the interpretative analysis. Reflexivity has therefore been an essential part to ensure transparency and consistency. However, the findings should still be interpreted as contextualized and not as a generalizable conclusion

2 Theoretical framework

This chapter will put forth a theoretical framework for the subsequential interviews. The aim is to give an overview of the existing research on urban planning & design. Furthermore, generative design and generative urban design will also be discussed. The chapter will also address current research on the hinders and opportunities of integrating generative design (GD) in urban design & planning phase.

2.1 Urban planning in a Swedish context

Urban planning is commonly defined as the process where the urban landscape is designed, regulated and planned. It addresses how urban landscapes such as cities and towns is to be developed, and is a process involving political, technical, social, economic and environmental perspectives. The increasing population, urbanization and climate change are some of the factors that have forced urban planning to have a sustainable planning paradigm.

Swedish urban planning places strong emphasize on the social, economic and environmental sustainability. The planning and building act (PBL) has several laws and regulations in order to develop social, economic and environmentally sustainable buildings and cities. The planning process is based upon three main plans, as per the PBL; a regional plan, a comprehensive plan and a detailed development plan. The three plans differ as the regional plan is prepared by the region while the other two plans are produced and adopted by the municipalities themselves. It's important to note however that there are national interests above the municipal urban planning. This shapes the direction for the municipalities, as to not infringe on the states interest (Boverket, 2023b)

The comprehensive plan of the planning process could be described as an overview plan of an area's future by the municipality. It's a plan for how an area's landscape and development is envisioned to be used and preserved. A comprehensive plan must also have in consideration the plans and regulations from the national and regional level, as to not disregard national interests. The regional plans similarly to the comprehensive plan, are a basis for the changes to water and land areas. Regional plan is the foundation for the comprehensive, detailed and area regulations. The main goal for producing comprehensive plans in addition to giving an

overview to stakeholders, is facilitating and guiding decision making for zoning and land use (Boverket, 2023b, 2025c). The levels of the different plans can be seen in figure 1.

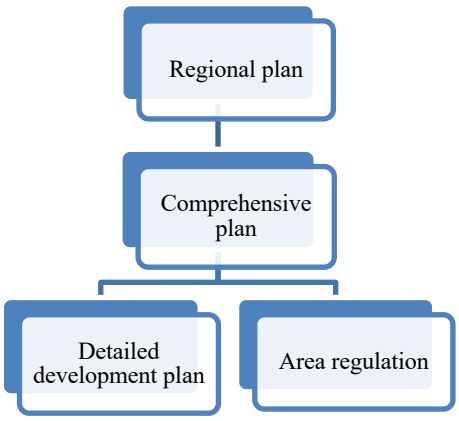

Figure 1: *A depiction of the different plans during a planning process*

Legislation and requirement

Urban development, as mentioned, is regulated by laws and regulations. The planning process is mainly regulated by the PBL. The PBL is the main and central legislation for planning and building. An example is how the different procedures when developing a detailed development plan are legislated by the PBL. The PBL legislates so that planning and building are developed in a sustainable manner (Boverket, 2023b, 2024, 2025b).

While PBL gives a comprehensive legislation, a more detailed legislation complements the PBL, the planning and building ordinance (PBF). PBF as a complement to the PBL contains requirements such as what information documents and report's need, how announcements should be done and so forth. An example clarifying the relation between PBL and PBF is how PBL legislates what stages should be in the procedure, while the PBF directs how each stage should operate. The PBL and PBF together make up the main legislation framework for the planning process (Boverket, 2024).

In addition to PBL and PBF, other legislation also affects the detailed planning process. One that is essential is the environmental code, especially as sustainability and resource efficiency is a major discussion point. The environmental code affects projects on aspects such as environmental impacts, by setting requirements on environmental assessment on projects. Furthermore, the National Board of Housing, Building and Planning's building regulations, BBR, are regulations and general advice that further explains and specify the technical aspects

of PBL. The regulations are legally binding, while the general advice is not. The laws and regulations create a system in which the detailed planning process becomes lawful and takes into account both public and individual interest (Boverket, 2024, 2026a).

2.1.1 Detailed development plan

Detailed development plan similarly to comprehensive plan shows the plans for how an area's landscape will be developed. The difference however is that detailed development plans is a plan which encompasses what is intended to change in detail. While the comprehensive plan also addresses change broadly, it further explains aspects such as how to preserve. However, a detailed development plan is a legally binding document that describes the changes that are allowed to be made to the landscape (Boverket, 2023b).

The process for developing a detailed development plan and for it to take effect is several. A planning process starts with a planning notice that is submitted to the municipality by property owners or developers and includes factors such as intended measure and site boundary. The planning notice is submitted if there's no detailed development plan over an area. The process for a notification at the latest four months after the submission. The next step diverges, depending on the situation and can be omitted as there's no requirement. The difference lies in the choice of having a programme or not. A programme refers to a document where the starting point and objectives are stated. This step is often used when there are benefits due to having multiple different interests and complex plans (Boverket, 2023b).

Standard procedure

A standard procedure involves six main steps: consultation, notification, review, review statement, adoption, with the last step being when the detailed development comes into effect. When developing a proposal for a detailed development plan, different procedures can be used, with the principally used procedure being the standard procedure (Boverket, 2025b).

Consultation refers to the proposal of the plan to relevant stakeholders such as the county administrative board and land registration authority. This process is done in order to refine the proposal by inquiring with the relevant actors for comments, thereby improving the basis for future decision-making. The comments and input are used for refining the proposal, thereafter, notifying the actors, which is the second step of the process before a review. Public review or

exhibition is the stage where the public and other concerned stakeholders submit comments on the refined proposal. The comments and statements are then put into account by the municipality and compiled into a report on how the submitted comments were accounted for or dismissed. The detailed development plan is thereafter adopted and comes into effect, if not appealed, and becomes legally binding (Boverket, 2025b). The process of producing a detailed development plan is a process amounting in years. The process ranges from a minimum of about two years. The timeline for developing a detailed development plan is influenced by factors such as political support, resources and design changes in response to comments and feedback (Göteborgs Stad, n.d.; Varela et al., 2022).

Figure 2: *The major stages in a standard procedure, inspired by (Boverket, 2025b)*

Extended procedure

When a plan proposal is not in line with the comprehensive plan or if the land- and water change could potentially bring about an environmental impact that is considered significant an extended procedure is used. Other criteria that can make a project requiring an extended procedure is if the project is of such a scale or interest for the public. Extended procedure is somewhat similar to a standard procedure. However, there are some extra fundamental steps that are needed compared to the six steps in a standard procedure. It can be summarized as two extra steps with one being before consultation and the other one being after the consultation (Boverket, 2026b).

An extended procedure is used when the proposal is not in line with the comprehensive plan or other changes previously mentioned. An announcement is therefore required prior to the consultation. Announcement is a public message used in order to notify the public, authorities and other affected parties. The intended effect is to have a more democratic process by giving stakeholders the opportunity to participate and influence decisions in a plan proposal that could have major consequences on the environment. The announcement could include aspects such as a plan proposal has been developed, that it deviates from the comprehensive plan and time & place for a public meeting, if the municipality intends to have one (Boverket, 2026b).

The consultation report is another step needed in an extended procedure in addition to the stages from the standard procedure. The consultation report is produced after a consultation, compiling the comments and discussions during the consultation. Additionally, the report also presents the municipality's official stance with regards to the comments. The consultation report is done to ensure transparency and insight to the process. Consultation report can also be done in a standard procedure, but is not legally required (Boverket, 2026b).

Figure 3: *The major stages in an extended procedure, inspired by (Boverket, 2026b)*

2.1.2 Current practice for developing detailed development plans

The development of detailed development plan is an iterative process which involves interrelation and intercommunication with several actors and stakeholder. There is often early communication between the municipality and developer to develop a common understanding to best leverage their strength (Abd Elrahman & Asaad, 2021; Högström et al., 2019). The practice of developing detailed development plans in Sweden has seen principle of collaborative planning and participatory design theories, with the increase of public participation. The consultation where the public can comment and input and approaches like "STEP", which is participatory method where the public can have dialogues with the designers, are an indication of the application of these two approaches in the development of details plans (Najar et al., 2024). A consequential effect of collaborative planning is the risk of having to compromise, which could result in a suboptimal design alternative (Kumar, 2005).

In Sweden, the digital aspect of developing detailed development plans has seen an increase in interest, especially in the last decade. Furthermore, the requirement for digital detailed plans is an indicator of the interest translating into progression. While there has been progress, most notably with digital detailed plans being required since 2022 (Boverket, 2025a). There is still a gap between the theoretical and the practical implementation, as the digitalization progression seen has instead of fundamentally transform the process, layered the digital tool onto a process that still revolves around documents (El Masry & Chronéer, 2026).

Digital detailed plans refer to the standardization of detailed plan information being digitized and structured according to national specifications. The regulations and geographic information are structured to be machine readable. The aim with these digital detailed plans is to achieve uniformity across the different municipalities and enable accessibility digitally. In addition, it is to also increase the efficiency for processes such as handling of applications (Boverket, 2025a).

Design and iteration

3D modelling has been increasingly used in the municipal design. Reason for the increase in use is the possibility that 3D modelling offers. It's ability to do analysis on metrics such as volume, sun light and noise impact (Judge & Harrie, 2020; Varela et al., 2022). Design iterations for the detailed plans are currently developed manually by architects and designers. This introduces influence on the design, as the architects and designers iterate based on experience and judgment, which can invisibly change the design to fit their preferences (Nisha & Nelson, 2012). Due to project constraints such as scheduling, personnel and facilities. The number of design solutions that can be explored is largely established. Furthermore, as the iterations are made by humans, there exist a limit in the amount of information that the brain can processes. These factors result in the number of alternatives produced and what the produced iterations displays (Jiang et al., 2024; Talmor Blaistain & Fisher-Gewirtzman, 2025).

Information transfer and representation

While there is an increase of design process that utilize 3D modelling, the lack of utilizing the digital model during communications is a point highlighted by Varela et al. (2022). The study indicate that communications fails to utilize digital models and instead are translated into PDF's and 2D drawings. From a BIM perspective this essentially breaks down the lifecycle of information, as it prevents and hinder actors from accessing or building upon the digital models. Information which could prove vital for analysis is lost and the receiving actor will have to independently reinterpret the data (Disney et al., 2024). However, the reliance of 2D depictions are justified by legal requirements and public accessibility. PDF-formats ensures access to all stakeholders. This ensures that the actors are reviewing in the same format, as all actors do not have the access to either hardware or software needed for a 3D model (Boverket, 2026c).

Inefficiency is an aspect that could be a consequential effect of translating 3D models to 2D drafts. After all, when reinterpreting the data, there is potential for inconsistencies. This result

in the process undermining the potential of cumulative knowledge progressing the model. Meaning that instead of knowledge and perspectives from different actors advancing the model, it regresses. This is due to an informational inconsistency between actors, as the data model fragments when it is translated from a digital 3D model into 2D drawings (Lostumbo et al., 2025; Varela et al., 2022).

Evaluation and studies

While there are several documents and studies such as sun and noise studies provided as early as in the review process. However, current practices are still inherently design first and evaluate later. This refers to on how different design are made before evaluating its performance with sun studies etc. This is a reactive approach which fundamentally contradict with the established theories such as MacLeamy curve. The MacLeamy curve demonstrate that by influencing early in the process not only will the cost of the project be lower but there is also a larger leeway in the ability to impact the project (Talmor Blaistain & Fisher-Gewirtzman, 2025; Varela et al., 2022). However, according to Högström et al. (2019) to conduct all investigation and studies to early in the process is neither ideal nor feasible, as it may cause the project to progress to quickly without leaving enough resource to manage any unseen issues along the process.

2.2 Generative design

Generative design refers to generating design alternatives based on predefined parameters and constraints automatically. Several methods can be used during the process of generating, such as algorithms, evolutionary processes and deep learning. Generative design allows for the generation of design solutions that can be simultaneously evaluated against factors like environmental performance and spatial efficiency. This approach of design shifts the method of design in the construction sector by introducing a process that doesn't require to be manually designed by individuals (Abrishami et al., 2014; Filippo et al., 2021).

In the traditional planning workflow, the design process is explained as linear and manually directed by designers. This results in developing a limited number of design proposals through experience and iterative refinement. Generative design, on the other hand, follows a data-driven workflow. This approach can address problems that humans individually would not be able to address due to the complexity and number of variables involved. This represents a significant

shift compared to the traditional design process (Jiang et al., 2024; Talmor Blaistain & Fisher-Gewirtzman, 2025; Varela et al., 2022).

Technical methods of generative design

Algorithmic design refers to the design process that utilizes scripting and programming in order to automate the design processes. Parametric design can be understood as a subset of algorithmic design. However, it utilizes a design method that enables designers to define relationships between building elements. This allows for the design to automatically update related parts if one parameter is modified. An evolution of these two design approaches is generative design. At its core, it is closely linked with developments in parametric modelling and algorithmic design and utilizes the methodology of these two design approaches. Generative design combines parametric design with optimization algorithms and simulation software (Filippo et al., 2021; Khan et al., 2025; Schlickman & Magana-Leon, 2024; Varela et al., 2022).

Generative design methods can be categorized into two main methods. Firstly, there is the rule-based generative design. This category follows a step-by-step sequence, which is controlled by constraints, in which the design alternatives are generated by an algorithmic process. While these categories of generative design also enable exploring a large number of design alternatives. It lacks the ability to "learn" compared with a generative design tool utilizing artificial intelligence (AI) (Jiang et al., 2024; Khan et al., 2025).

One of the beneficiaries of AI is generative design. Generative design uses deep learning, a subset of AI, and is referred to as "deep generative design". By using deep learning, it can learn from previous data. Thereby increasing the tools potential to synthesize new content. An essential point of notice is that evolutionary algorithms are also categorized as a subset of AI. It differs however from deep learning as instead of learning from vast data, it functions in a similar way to an evolutionary process. The design alternatives are improved by a repeated process in which they are modified or combined. This process of "evolution" helps in establishing optimized solutions without learning from large datasets (Jiang et al., 2024; Khan et al., 2025; Talmor Blaistain & Fisher-Gewirtzman, 2025).

Function

While generative design utilization and functionality are several it can be summarized as a systematic and collaborative process, in which human and computer act as partners to iterate design which involve complex design problems (Mukkavaara & Sandberg, 2020).

The primary function of generative design is its ability to generate design iterations by exploring extensive solutions in the solution space. By utilizing algorithms and AI, its ability to explore design solution are neigh impossible for a human to do. It thereby effectively enhances designer efficiency by automating repetitive design tasks. Furthermore, as design iterations involve several interests, objectives and requirements that could be conflicting. Generative design is able to balance these aspects by revealing the trade-offs early in the process (Jiang et al., 2024; Mukkavaara & Sandberg, 2020; Schlickman & Magana-Leon, 2024).

Beyond the mentioned function, GD can provide quantitative feedback on evaluation such as sunlight, noise and energy. The tool can therefore minimize the need to order these evaluations from several different companies and centralize the evaluations, providing a more economical solution (Varela et al., 2022).

2.2.1 Generative design for developing detailed development plan

Generative design in the design process could be used in several different situations beyond just generating design solutions. This includes aspect such as evaluation studies, scenario planning and feedback on detailed metrics, which is done simultaneously as the generation of the design. GD is a digital tool which functions can be used already in the initial phase based on objectives and constraints as input. It is of vital importance that the input parameter is defined correctly. Therefore, the initial steps in order to utilize GD in the detailed planning process is to weigh and balance the competing objectives and interests (Mukkavaara & Sandberg, 2020; Talmor Blaistain & Fisher-Gewirtzman, 2025; Varela et al., 2022). This phase is referred to as design problem formulation by Jiang et al. (2024). Additionally, it's important to not only define factors such as urban elements but also do relevant investigations on the selected site, including geology and hydrology. Given that these elements are then translated from abstract into objective parameters and input into the GD tool to shape what's being designed (Jiang et al., 2024; Talmor Blaistain & Fisher-Gewirtzman, 2025).

When the parameters are inputted into the GD tool, it operates based on different methods to select and refine the design alternatives before outputting the final optimized design proposals. During this process to best optimize different methods are used such as MOO to reconcile the different variables and machine learning as to learn from datasets and past experiences. While the traditional planning process often follows by making evaluation studies after a proposal is developed, GD enables evaluation to occur simultaneously with the design iteration. The process thereby facilitates continuous feedback which produces optimized design alternatives. This process of generation and evaluation simultaneously is referred to as design option generation (Jiang et al., 2024; Talmor Blaistain & Fisher-Gewirtzman, 2025; Varela et al., 2022).

Generative design advantage does not only lie in its capability of generating alternatives and evaluations. When developing design iteration, it's mainly based upon designers' experience and judgment (Jiang et al., 2024). GD incorporation in developing detailed plans imply a transition to a more data-driven and arguably transparent decision-making (Lostumbo et al., 2025). With multiple generated alternatives, stakeholders are able to compare and contrast different scenarios and its trade-offs. This is of essential relevance as the planning process could be defined by its competing interest (Filippo et al., 2021; Koenig et al., 2020; Mukkavaara & Sandberg, 2020). This phase of choosing the final design alternative is called decision-making and is the last phase of a GD-approach in detailed development planning (Jiang et al., 2024). However, while multiple design alternative increases the possibility of comparing and contrasting different solutions. It could develop decision paralysis, inability to choose, due to the number of alternatives (Aguilar & Kreinovich, 2023).

Nonetheless, while generative design application in developing detailed plans shows several advantageous aspects, challenges still remains. With the current document-based communication and fragmented data environment, there exist a lack of data interoperability. Data and information that is necessary for input is distributed across several formats and files. This creates limited usability and inefficiency in its utilization for generative design systems that operates on structured and machine-readable data (Jiang et al., 2024; Khan et al., 2025; Varela et al., 2022).

2.3 Barriers and opportunities

Generative design is not a tool which could solve of the challenges faced today in the planning process. The tool itself faces difficulties in its application and integration. However, there still are several advantages in the implementation of GD, as well as aspects of the planning process which are compatible with said integration.

2.3.1 Barriers

The implementation of GD faces hinders across several dimensions including technical, organizational and legal.

Technical hinders and tool limitations

The incompatibility between GDs reliance on clear and precise parameters for input and the complex, interconnected nature of urban planning creates a barrier for its implementation. The urban planning process involves balancing overlapping factors, including technical requirements, social expectations and political priorities. This difference in logic and nature makes it difficult to fully implement the tool (Jiang et al., 2024).

A hindrance described by Talmor Blaistain & Fisher-Gewirtzman (2025) is the scale of the design. While GD can efficiently process and optimize isolated design problems, its performance degrades as the scope expands to encompass larger areas. This is due to more variables being included. The design thereby becomes more complex to balance and reduce to a common set of metrics. Without clearly defining the inputs, the GD outputs could become unrealistic or abstract alternatives, indicating difficulty in representing complex urban conditions as input parameters. This reinforces the argued “wicked problem” by Jiang et al. (2024). While GD can generate design iterations, it is limited in its ability to handle complex urban conditions, which often increases at scale. However, GD tools using deep learning could resolve this issue by learning from large datasets. The resulting alternative would then be more realistic as the complexity would be managed through knowledge from previous data (Jiang et al., 2024; Talmor Blaistain & Fisher-Gewirtzman, 2025).

To utilize GD, one inputs parameters and constraints to generate relevant design alternatives. However, converting these inputs into realistic and optimized design solutions can be perceived as disturbing. This is due to the fact that the process, especially for GDs utilizing AI, have

learned from large datasets, which makes it difficult its process of transforming and synthesizing the learned information into generated outputs. This renders actors unable to understand the tools thought process, which is known as the black box effect (Schlickman & Magana-Leon, 2024; Talmor Blaistain & Fisher-Gewirtzman, 2025). The black box effect also hinders GD implementation in the planning process. Being unable to explain to the actors how the outputs are reasoned, transparency suffers. The lack of clarity with automated design processes is therefore seen as a major concern, which hinders its integration (Jiang et al., 2024).

The technical threshold for implementing GD is also a hindrance, as institutes are not prepared to invest in a tool requiring a high level of skill and knowledge (Varela et al., 2022). GD requires its users to understand its underlying reasoning process in order to eliminate the black box effect. This creates a challenge for urban planners, planning architects and other actors involved in the design. As they are expected to engage in developing and controlling computational processes, which they lack expertise in (Mukkavaara & Sandberg, 2020). This is particularly relevant as GDs have difficulties in managing abstract social factors, thereby prioritizing environmental and economic metrics. Human judgment is therefore needed to help manage the qualitative factors in the design (Schlickman & Magana-Leon, 2024). The reason it struggles with social sustainability aspects is the difficulty in quantifying factors which are subjective, abstract and context based (Jiang et al., 2024).

Organizational hinders

There exists an interoperability issue within the planning process. Meaning that as the actors utilize different software, communication issues occur when attempting to import files from one software to the other. A lack of coordination between actors within the municipalities themselves and with external stakeholders causes fragmentation of data. This lack of interoperability also stems from the discrepancy in digital maturity between actors such as municipalities and developers (El Masry & Chronéer, 2026; Varela et al., 2022). It's important to highlight that larger municipalities even with higher resources and digital maturity doesn't necessarily facilitate implementation of advanced digital tools easier (El Masry & Chronéer, 2026). However, a resulting factor of varying digital maturity is fragmentation of data during communication. This fragmentation of data disrupts the continuous data exchange required for effective utilization of input as parameters for GD-tools. Additionally, many organizations depend on formats and forms of communication that further limits the data exchanged. The underlying reason are mainly the previously mentioned difference in systems and programs.

The static drawings and document-based approach are ill-suited for a data-driven workflow (El Masry & Chronéer, 2026; Varela et al., 2022).

The professional culture of design is grappling with the emerging technologies and the challenges that comes with GD. One of the main concerns that designers and actors in the urban design stage have is the diminished control over the design (Schlickman & Magana-Leon, 2024). The lack of control and inability to discern the reasoning behind the design attracts skepticism towards GD-tools. Additionally, to the black box effect, there is also the idea that GD utilization would hinder or impede the creativity and intuition from experience used when designing (Jiang et al., 2024; Talmor Blaistain & Fisher-Gewirtzman, 2025).

There is also a culture hinder, in terms of having a conservative attitude in a transitional phase of new technology (Chen et al., 2022). While the traditional and current method of urban design relies on manual iteration. A transition to an autonomous process changes the designer's role. Instead of being the primary controller over the design, the designer becomes a collaborator, representing a significant change in the role and cultural workflow. However, the transition to collaborate with GD needs actor with enough technical and knowledge to accurately and effectively to implement it. According to Varela et al. (2022) there exist a gap in terms of both technical and knowledge among actors minimizing the use of advanced digital tools. A solution could potentially be outsourcing as highlighted by Högström et al. (2019) especially so for smaller and rural municipality due to the lack of knowledge and skill.

Institutional and legal hinders

From an institutional and legal perspective, there are also several hurdles to overcome. Firstly, the current legal framework necessitates formats such as PDFs to ensure traceability and availability for all parties. Furthermore, laws and regulations can be ambiguous and unclear in certain circumstances. The implementation of GD becomes complicated, as the tool requires clear and understandable parameters. Translating ambiguous laws and regulations into input the tool can follow raises the possibility of appeals and legal disputes (Boverket, 2023a; Varela et al., 2022). Additionally, from an institutional perspective, there are political and stakeholder factors that must be considered. Political support or the lack thereof can result in a process being delayed or even stopped. Specifically, even if GD outputs an optimized design solution, the political aspect is a major factor for the success of a detailed planning process (Abd Elrahman & Asaad, 2021; Varela et al., 2022).

It's important to highlight that the limitations and hinders of incorporating GD in the detailed development plan are not separate, but instead are interconnected. Ultimately, these barriers are challenges needing solution if there is to be an adoption of generative design in the planning process.

2.3.2 Point of compatibility

While there are several challenges and hinders that needs to be overcome. The aspects of compatibility and the opportunities that incorporating GD represent cannot be diminished. GD do have strong compatibility and offers solution to the current workflow of the detailed development plan. However, even though the tool offers transformative opportunities, current research suggests the tool as a complement and supportive to the designers, rather than an autonomous replacement (Talmor Blaistain & Fisher-Gewirtzman, 2025; Varela et al., 2022).

GD is highly compatible with the design-phase of the current workflow, particularly the early stages of said phase. GD, at its core, actually addresses one of the most persistent issues of the planning process today, time. While the draft plan is time-consuming and resource intensive, GD can accelerate the drafting and preparation by generating spatial alternatives, that shortens a process that potentially take years into days or even hours. This is not only a matter of efficiency increasing, it's also a fundamental change in how to approach iteration and evaluations in the processes (Jiang et al., 2024; Talmor Blaistain & Fisher-Gewirtzman, 2025; Varela et al., 2022).

Another significant aspect beyond speed is the ability to handle multi-layered objectives. Multi-objective optimization (MOO) is an approach in which to utilize computational algorithms to handle and address complex multi-layered objectives. As detailed planning process involves several goals and objectives, it's is essential to balance priorities and factors such as sunlight and noise. GD capacity in handling aspects like this is a fundamental point of compatibility. This is especially so as it allows the planners to investigate several different configurations. additionally, GD can do these evaluations much earlier in the process than traditional workflow would be able to do (Lostumbo et al., 2025; Mukkavaara & Sandberg, 2020; Talmor Blaistain & Fisher-Gewirtzman, 2025).

Structural similarities between the planning process and GD also exist, which further strengthen their compatibility. Jiang et al. (2024) argues that the logic of GD coincides with how the detailed planning process function in relation to defining the boundaries of the site, organizing infrastructure, shaping building volumes etc. This sequence of actions is highly compatible with the logical of GD, thereby simplifying the process from this perspective of incorporating GD in the planning framework, as actors is familiar with the approach.

An important aspect to highlight is how current direction is moving towards a more digitalized environment in the construction sector. An example of this is the requirement of digitized detailed development plans. These digital detailed plans are projected to make the handling process for proposal of change or creating detailed development plans more efficient. This would thereby streamline and create the way forward for a digital urban development process (Boverket, 2025a).

3 Method

This chapter will clarify the reports methodology. It will start with by establishing the qualitative research approach and abductive logic of the study. Thereafter, an explanation of the studies data collection procedures for data collection detailing the literature search and interviews processes. Lastly, a description of how ethical considerations is taken into account during the writing of the report.

3.1 Research approach

This study employs a qualitative research approach. The reason for utilizing qualitative research methods is due to it enabling an in-depth understanding of perception, experience and several other phenomena (Busetto et al., 2020; Lim, 2025). Within a qualitative research, multiple different approaches can be applied. This study is using an abductive research approach as to be able to continuously transition between the theory and empirical findings fostering an iterative process instead of a strict linear process.

Initially, a document analysis was conducted as to have a solid theoretical basis to establish the current state of research. Additionally, it was also to have an initial analytical framework of themes in order to know how to structure the semi-structured interviews. This was done to ensure that the interviews stay relevant and provides the possibility to expand or give new interpretations to existing theories, which also enable the flexibility and receptivity of data.

However, while the theoretical framework guided the initial data collection, the empirical findings also identified gaps and perspective not fully covered in the theoretical framework inducing a return to the literature to expand and refine the theoretical framework. This iterative loop ensure that the final analysis is both context-sensitive and theoretically rigorous. Figure 3 is a suitable depiction of this research process. The figure revels the influence that the data collection and data analysis have on the whole research.

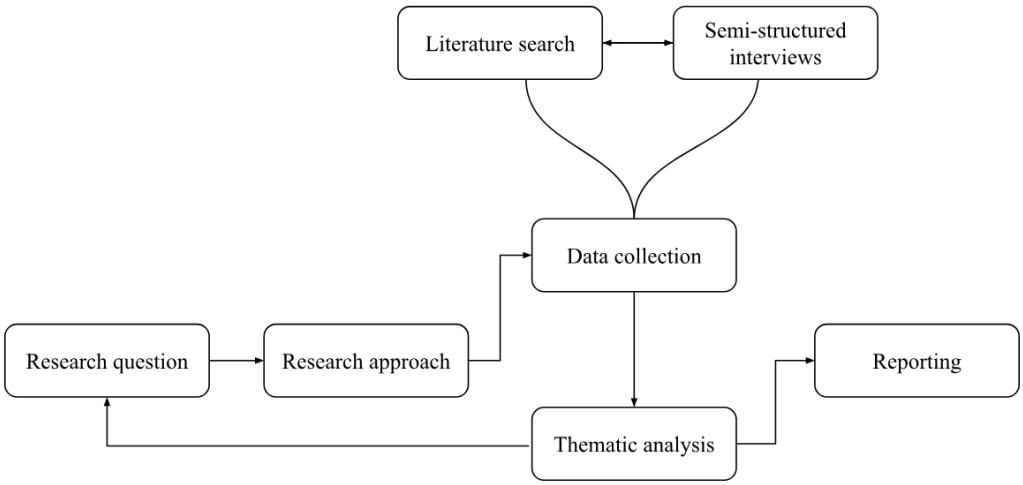

Figure 4: *A depiction of the study's research process inspired from (Busetto et al., 2020)*

3.2 Data collection procedure

This research employs two approaches for the data collection, document analysis and interviews. As data collection is the practice of acquiring information, the gathered information could be from several different sources such as articles, books, interviews and surveys. This section of the chapter therefore explains the process of data collection, allowing for the possibility of future research to replicate and expand on the study, thereby achieving reliability.

3.2.1 Literature search

In this report, a theoretical framework was provided in order to understand the current state of research in regards of planning practice and generative design. In order to find relevant literature, it is essential to do a systematic and methodological literature search. The process of this study's literature search can be defined as a process that utilizes mainly three steps. Firstly, it was the process of establishing which databases to actually do the literature search. The databases that was chosen was based on characteristics like academic width and context (construction industry and digitalization). To ensure wide coverage, but still remain relevant, reliable and high quality the search focused mainly on peer-reviewed articles, journals, books etc., see table 1 for the databases.

The second phase was to identify keywords, themes and concepts as to have an efficient literature search. The keywords, themes and concepts started with the keywords for the study, for example generative design, planning process, detailed development plan etc. These keywords were refined and utilized in different key strings to find literature, see table 1. By using words that are necessary for the research and adding "AND", "OR", "NOT". The search base is expanded and the result of the search is more substantial in its essence.

The last stage can be summarized as consecutive steps done in a short amount of time. The steps mainly consist of to read the abstract and see if the article is relevant or not. If it was, the article was accessed to read the introduction and conclusion to get a more in-depth insight, that goes beyond the surface level understanding from the abstract. Once it was established that the article was relevant and the information was suitable, the article, journal etc. was used for the study.

Keywords	Databases
Urban planning AND Generative design AND Detailed development plan	Google scholar, ScienceDirect, Scopus,
Urban design AND Generative design AND BIM	Emerald insight, Sage journals,
Urban planning AND Design AND Evaluation	Taylor & Francis

Table 1: *Some of the keyword strings and databases used for finding literature*

3.2.2 Interview

To acquire new knowledge, interviews were conducted for the empirical chapter. For this study, semi-structured interview was utilized as this reports interview method. The interview had pre-determined questions that was sent to the interviewees before the interview took place. But as the interviews followed a semi-structured approach, there was a certain amount of flexibility in the questioning. The flexibility refers to asking to follow up questions based on the answers. This allows for a more natural conversation, as it facilitates a comfortable environment, resulting in deeper insights (DiCicco-Bloom & Crabtree, 2006; Lim, 2025).

The interview focused on “how” and “why” questions, as to aim for depth in answers. This approach of questioning was intentional as to minimize and even eliminate “yes” and “no” answers. Additionally, if the answer seemed ambiguous or unclear, follow-up questions was asked aiming for clarification. This ensured that that in the data analysis, there wasn’t a need for hypothesizing on what the interviewee said (DiCicco-Bloom & Crabtree, 2006; Lim, 2025).

The interview for this report consisted of five participants from different municipalities in Sweden and architectural firms. The interviewees were selected based on five criteria; involvement in detailed development planning, experience with digital tools, knowledge about GD and experience in a project involving GD. This ensure both the width and depth of information and knowledge that wouldn’t be possible if only individuals from a single sector or organization were to contribute. While the small sample size presents a limitation in terms of generalizability. The study compensates for this through the participants long experience, expertise and a variety of perspectives. It’s important to note that not all participants meet all the criteria but do meet at least three out of the four criteria.

Interviewees & role	Experience (year)	Sector
Project manager A	16	Municipality
Project manager B	9	Municipality
Planning architect A	13	Architectural firm
Planning architect B	13	Municipality
Planning architect C	14	Architectural firm

Table 2: *Representation on the participants based on role, experience in the industry and sector*

The interviews were conducted online through Microsoft Teams. The timespan of the interviews was mostly about 30 minutes and were performed in Swedish. This creates the possibility of informational and meaning loss during translation. To eliminate said risk, the transcriptions translated into English were sent to the interviewees to assert if the transcription are correct.

After the interviews were conducted, the online interviews which were done through Microsoft Teams were transcribed live during the interview by the apps AI-driven motor. The transcription generated during the interview are further refined by cross-checking with the recorded session in order to ensure accuracy and completeness.

3.3 Data analysis

The data analysis method chosen for examining the data collected through semi-structured interviews for this report is thematic analysis. Thematic analysis was chosen mainly due to it allowing for a systematic analysis and interpretation of pattern of qualitative data. In addition, the analysis method is ideal for investigating subjective in qualitative data, which align with the qualitative nature of the report. A multi-step analysis process is employed in this report. The process of this report is inspired by the six-step approach to thematic analysis presented (Ahmed et al., 2025; Braun & Clarke, 2006).

The first step of the analysis process was to get familiar with the data collected. That is to say after the interview was done, the data that was transcribed, was read repeatedly and corrected by listening to the recorded interview. This helped in getting familiar with the data as well as finding preliminary patterns of themes from the interviews. After the familiarization of the data, the analysis delved deeper on the preliminary patterns by generating initial codes. The coding was produced by systematically reviewing the data and thereafter assign descriptive labels to segments that is found significant. The descriptive labels are words that may be in the sentence itself or a word which aim to capture the sentence essential meaning.

The initial codes when produced were rudimentary. Therefore, they were gathered into blocks, as to have broader categories which are the basis for the refined codes. These categories are used to identify pattern and themes, which is used for comparing to the original data collected. This is to ensure that the analysis remains coherent and relevant to the report.

The final phase of the analysis process is to finalize the themes. Finalizing the themes imply to structurally define and name each of the themes. It's essential to emphasize that the analysis is not isolated to semi-structured interview but done in conjunction with the theoretical background. Consequently, this allows for interpretative refinement and theoretically informed explanations based upon data.

3.4 Ethical consideration

The study adheres to the principles of "General data protection regulation" (GDPR), as to ensure an ethical and lawful processing of the interviewees data. As mentioned, the online

interviews were recorded and transcribed in Microsoft teams. However, consideration to sensitive information were taken. Measures that were taken before the interviews included consent and informing the interviewee of how their data will be handled. Additionally, the data will be deleted after the finalization of the report to ensure privacy. Personal data is processed according to the data minimization, purpose limitation and storage limitation. To ensure the privacy of the interviewees, they are pseudonymized in the report, see table 2.

In terms of AI usage, it was utilized in order to refine the textual aspects of the text. This includes aspects such as grammar in order to have a more coherent report. However, the output from the AI, wasn't directly applied in the text but reviewed, refined or even discarded. Additionally, while the interviews were ongoing it was recorded, the in-built AI-motor of the program transcribed the text.

Reflexivity

An aspect that needed to be considered during the research process was the fact that there was a possibility of research bias that could affect the objectivity and reliability of the data (Busetto et al., 2020; Lim, 2025). Therefore, reflexivity has been a vital component throughout this report, through continuously being mindful of the subjectivity, by questioning and analyzing, sending transcriptions to interviews and discussing with peers & others to identify blind spots in the thinking process review. By being reflexive, the research maintains and increases the data's reliability, transparency and dependability.

4 Result & Analysis

This chapter represent the empirical findings derived from semi-structured interviews with five participants. The participants include three planning architects and two project managers which are from different sectors but is still involved in the detailed plans and urban development process. The result is structured thematically and reflects the recurring patterns in how the participants discussed their roles, workflows, tools and experience with GD.

4.1 The seven themes found

The empirical findings can be analyzed from the perspectives of seven themes. The detailed planning process, especially detailed plans, were heavily discussed, as seen in the figure 4. Another heavily emphasized discussion point were investigations and studies. This theme includes aspect such as, noise, sunlight and volume studies. These two themes can be noted as vital factors to be able to answer the research questions. These two themes address the current workflow of detailed development plans and its design iteration process. Thereby effectively discussing the research questions and how GD is enabled or hindered in its incorporation in the detailed planning process.

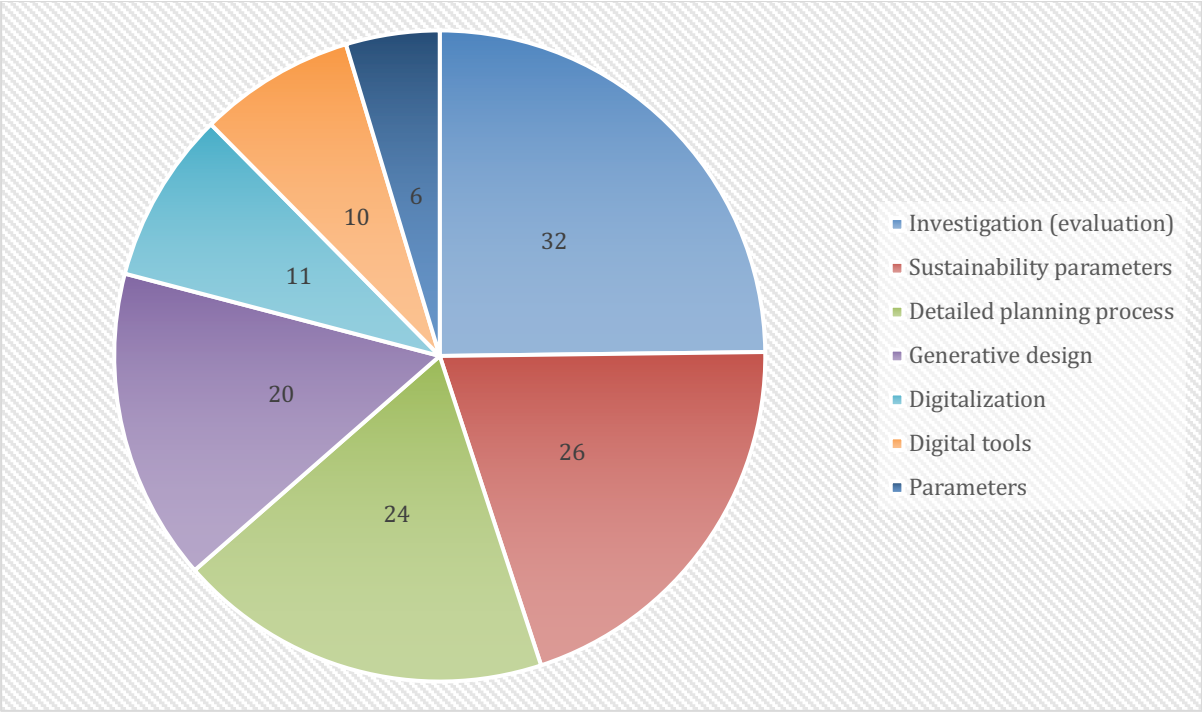

Figure 5: *Diagram of themes, based on keywords and the frequency it was mentioned*

4.2 The professional role in detailed development plans

The task varies between project managers and planning architects, but there are several similarities in their tasks and responsibilities. Across the interviews, the participants describe their role as requiring coordination, mediation and oversight. Rather than individual design authorship, with planning architect B describing the work as following:

> *"We are "the spider in the net", as we are the ones who keep the dialog with developers, other officials in the municipality and companies to find out which issues that needs to be investigated in relation to the detailed development plan"*
>
> – Planning architect B (translated from Swedish)

The main function of their task is their function as a link between multiple stakeholders, including developers, technical consultants, politicians and the public. The planning architects emphasized their role in the design process, particularly in maintaining communication flows and ensuring alignment between actors through the process.

Planning architect A mentioned that already in the start of the planning process with the planning notice being submitted, is where the work starts. The work in the beginning involves doing early assessments on if what's planning to be built is appropriate for the area and if it's in line with the comprehensive plan. The role as planning architects is further described by the planning architect participants as a role were, they are involved in several aspect of producing planning documents, illustration map etc.

In terms of project manager specific tasks and responsibilities, differs depending on the department. The tasks could involve the long-term involvement with projects extending over a long-time frame. Project manager A states that project could extend for multiple years and even decades. While for Project manager B, who digitalize detail plans, is responsible for the transfer from analog detail plan into digital detailed plan.

Participants consistently highlights the different trade-offs, with all planning architect especially emphasizing the need to balance social, economic and environmental considerations.

- Economic feasibility for developers
- Social value, including accessibility and public space
- Environmental concerns

Conflicts between these trade-offs are dimensions that both planning architects and project managers needs to have in consideration, as it is a common phenomenon in the planning process.

4.3 The detailed planning processes

The detailed planning process is described by planning architect A as a process were from initiation to adoption usually takes a minimum of about two years, with project extending significantly longer in some cases. The process follows a sequential structure, were the consultation and review were highlighted. Planning architect B note that the period between these two phases is particularly intensive needing to manage and refine the proposal and iterations due to response from stakeholders, including the public and authorities.

Project manager A also reports an increase in the number and scope of the required investigations within the detailed planning process. These investigations and evaluation have become increasingly important and complex with issues such as noise, biodiversity and stormwater being stated specifically. The complexity lies in the fact that investigations that previously only needed to be done in the building permit phase now have to be done in the detailed planning process.

4.3.1 Current method of developing and evaluating design alternatives

The development method for design iteration is described by the participants as a manual and iterative process. The initial proposals and iterations are typically produced as 2D sketches. Despite the availability of 3D modelling tools, drawing in 2D is a practical necessity in the initial phases. Project manager A reports that 2D formats are typically used due to municipal data (primary data and elevation curves) being structured for DWG files. If 3D modelling is used, compatibility issues between software would occur. This is also one of the reasons for

communication and documentation being through PDF's and 2D formats. Another aspect is that designing in 3D models initially would be considered an unnecessary increase in workload, as in the early phases, there exists an uncertainty about the location of factors like buildings and roads. However, an important distinction highlighted by Project manager A is that 3D modelling is utilized in the design process. It's used in the early design process for studies like volume masses, though it's a bit later in said process. Planning architect B reports that there has been an increase in 3D modelling. Especially with dialogue with developers. They receive 3D models that they then import into their 3D modelling software to assess the "big picture".

There was also a description of data fragmentation, with examples of technical investigation being delivered in separate formats and locations, which fragment the data. That fragmentation of data is then needed to be compiled by project managers and planning architects. When trying to communicate the fragmented documents, there's negative consequential effect, as stated in the interview:

"They are separate documents or in separate files, so you don't have all the information gathered in one place. … It's easy for there to be a loss of knowledge between the different investigations"

– Project manager A (translated from Swedish)

A recurring issue that was brought up was the impact of design change and how it affects the investigations done previously. Changes in the design, even if minor, was reported to may require needing new investigations and studies to be redone. As these investigations are mostly done by hiring external consultants, the process was described as not only time-consuming but also economically inefficient.

Evaluation of design alternatives is reported as both technical and communicative. From a technical perspective, it's about the design process itself and having to revise proposal and alternatives, to find the "right" or "optimal" solution. This is done by having meetings discussing the design proposal. The comments and feedback are then used to revise the alternative.

Another communicative part of the process for developing design iteration is the communication with politicians and the public. Participants brought up that visual 3D models and renderings are more effective than the technical drawings or textual description.

4.4 Digitalization

Participants report that the planning process and construction industry as a whole is moving towards digitalization. However, currently there is challenges related to the interoperability between different digital systems. Municipal data is often managed in GIS platforms, while use CAD and 3D modelling tools. This makes it so the transferring of data between systems is reported as difficult, with issues related to compatibility of data.

The new regulatory requirements mandate detailed plan is fully digital and machine-readable. This include linking planning regulations to specific geographic areas. Participants describes this process, especially with digitalizing older detailed plans as requiring additional work in structuring and formatting data appropriately. There are challenges with interpreting unclear or ambiguous regulations as well as verifying property boundaries.

4.5 Actors perception of generative design

In terms of GD, some participants have practical experience from involvement in pilot projects. They describe the tool utilization in areas such as:

- Generating building volumes
- Calculating exploitation rates
- Assessing building heights

A commonly reported use of GD tools by the participants was the ability of generating multiple design alternatives in a short amount of time. These alternatives are described as useful for discussions with decision makers, such as politicians to compare different development scenarios, by planning architect A. On the other hand, Planning architect B means that GD tools in its current form should be primarily used as an idea generator for the early stage of the design process.

Furthermore, there are several limitations described by the participants;

- Output is primarily quantitative
- Limited ability to incorporate site-specific complexities
- Lack of incorporation ability with broader planning data
- Difficulty in handling larger scope

Additionally, they also highlight the tools inability or difficulty in incorporating social aspects including such as public space quality, including identity and comfort.

4.5.1 Constrains and enablers for generative design iteration

The constrains and enablers for implementing GD in the design process is another dimension that was discussed.

Constrains

A recurring issue was the previously mentioned fragmented data environment. With the data being distributed across several documents and formats, including maps and reports, there's a challenge for digital tools that require for the data to be structured and centralize for data input.

Another constrains found in the interviews is the difference in the technical capacity between municipalities. Smaller municipalities are described as having limited access to digital expertise and infrastructure as a whole compared to larger cities, municipalities and private sector firms. While digitalization has been a direction of promotion, participants reports that there is a prerequisite for GD's adoption. The prerequisite is that the output has a certain level of reliability and legitimacy in order to replace or reduce manual investigation and iterations.

Enablers

In terms of enablers, the interviews showed a need for tools in detailed development plan that can automate repetitive and time-consuming tasks. This was especially expressed in terms of investigations and studies. GD is further described as most applicable in the early design phase by all interviewees, due to the ability to explore multiple alternatives. Additionally, the function of visual representation of alternatives and studies is identified as valuable by planning architect

A & C, especially for communication with actors that don't have in-depth knowledge of the technical aspects of drafts and plans.

That there exists digital detailed plan now that compiles detailed plan information digitally in one location, is also seen as very advantageous according to project manager B. As detailed plans are not done in isolation and needs information of the surrounding, the parameters become easier to find and establish.

4.5.2 Future role of GD

If there is an integration of GD in the detailed development plan, participants describe a potential shift in their role in relation to it. They describe they changes as following:

- Defining parameters for design generation.
- Reviewing and validating design alternatives and generated outputs.
- Ensure alignment with planning goals and regulations.

That is to say, that even if GD is incorporated, the participant note that it wouldn't deprive their role, instead it would shift to a collaborative role with the tool. They emphasize that human judgments are essential and necessary in relation to qualitative and context specific aspects of the design process and detailed planning process as a whole.

> *"... the knowledge, expertise, education and professional experience found within architectural firms and municipal urban planning offices cannot simply be replaced by different types of generative tools. There is still a need for people to review and assess proposals and to ensure that projects are genuinely feasible"*
>
> – Planning architect A (translated from Swedish)

5 Discussion

The purpose of the chapter is to get a deeper understanding of the empirical findings through interpreting the empirical findings and understand how it stands in relation to the current literature and established theoretical concepts.

5.1 Design and evaluation cycle

The development of design alternatives is a complex process that involves multiple stakeholder, tools and iterative decision-making. In practice, the design generation and evaluation often create a bottleneck. This results in a siloed workflow, wasted time & cost and challenges in integrating technical, environmental and social considerations effectively.

5.1.1 Current practices and challenges

Development of design alternatives

The interviews show that the current process for developing design alternatives is primarily an actor-dependent process. For projects proposed by, e.g., developers, the design development is largely carried out by the developers themselves or an architectural firm commissioned by the developer. On the other hand, municipally driven projects rely on internal departments or external consultants. In both contexts, the design process is predominantly developed through 2D sketches, with volume studies being explored in 3D models. These findings align with Varela et al. (2022), who identified 2D and GIS as the most utilized digital tools in the design process for detailed development plans. However, this reliance on CAD and GIS tools may also constrain the integration of complex performance data, which further separates the design generation from technical evaluations.

The development of design alternatives is described by interviewees as an iterative and collaborative process, with regular status meetings serving as a place to exchange ideas among the planning architects, consultants and developers. Through these interactions, proposals are refined to establish a shared project vision by testing different solutions. This is highly consistent with the findings of Högström et al. (2019) and Abd Elrahman & Asaad (2021). However, while this reflects elements of collaborative and information exchange found in collaborative planning and participatory design, there is a risk of an imbalance in influence that

takes away from the approach itself. This raises the question of the extent to which a shared vision is actually achieved, as opposed to compromises that can result in diluted design outcomes. Kumar (2005) findings show that decision-making due to compromises and balancing acts leads to suboptimal results. This indicates that the process of developing design alternatives is not merely a technical one. One could even argue that the process is political and social. The socio-political aspect provides the technical aspects of the process with the objectives and goals, which are then developed technically. Furthermore, the objectives and goals are set through discussion where values and interests are involved. This also shows that behind the technical models are political values and interest. This entails that the challenges today aren't actually a lack of design alternatives. Rather it's the management of trade-offs and interest, as well as the collaboration and coordination between actors.

Design first, Evaluate later

A core conflict identified in the interviews and literature is the prevailing "design first, evaluate later" approach. As described by project manager A, there exists a dilemma regarding determining the timing of investigation and evaluation. Conducting studies early risks rendering them obsolete if there are design changes later in the process. However, delaying the studies carries the risk of identifying technical or environmental constrains too late, resulting in wasting resources for design changes. Varela et al. (2022) emphasize this aspect by noting that there is a relation between the design phase, which includes the studies & evaluation and the total project cost. As the design phase dictates the majority of the project cost, having evidence-based assessment to base the design on would be the more favorable. This would thereby effectively minimize the life cycle cost. Nonetheless, this perspective assumes that reliable and comprehensive data can be obtained early in the process, which is not always feasible in practice. Furthermore, it also assumes that the project will be developed. However, as highlighted by Varela et al. (2022) and Abd Elrahman & Asaad (2021) there also political nuances that have an impact if the project can be successfully developed. After all, without political backing, to invest into the project would be detrimental as the project could be delayed or even stopped. The importance of the politician support is also an aspect brought forth by the interviewees.

This limitation is discussed by Högström et al. (2019), which found that in practice, as projects are unique, actors in the planning process actually argues that the planning process is inherently a process with uncertainties and having all the information early isn't desirable or practical.

Instead, adaptability and the capacity to respond is what's desired. Yet, both the interviews and the literature indicate that late discovery of critical information is a major factor for increased cost and delays in the timeline. The issue therefore isn't solely about the timing of evaluation, but the management of uncertainties in the design process. This indicate that the management of these uncertainties can differ between organization, due to workflow and culture.

5.1.2 Generative design and the politics of design decision

GD and design-evaluation paradox

The current workflow reveals a structural conflict in which design and evaluation are interdependent yet operate separately. The current workflow forces a trade-off between certainty in the early design process and having greater flexibility later in the process. Neither approach fully resolves the risk associated with incomplete data or late design changes. While GD can generate and evaluate a large number of design alternatives. The interviews highlighted that it requires significant manual data input. Without doing so the output iteration would be technically infeasible or misleadingly optimized, as highlighted by Jiang et al. (2024) and Varela et al. (2022).

GD can potentially alter the workflow by embedding evaluation criteria directly when generating design alternatives. This would fundamentally shift from a sequential process of "design first, evaluate later" to a process where it happens simultaneously. This could reduce the risk of late-stage failures and support more informed decision-making early. However, this shift also introduces new challenges. By prioritizing quantifiable criteria, GD may privilege measurable factors such as cost and environmental performance, while more abstract factors, such as social value and spatial quality are given less weight in the design alternatives, as highlighted by Schlickman & Magana-Leon (2024). However, a solution that was brought up in the interviews was the human-tool collaboration, in which the actors oversee, thereby ensuring that social value and qualitative spatial qualities aren't lost in prioritizing quantifiable criteria. It's important to highlight that GD can still handle some social sustainability factors and what it struggles with is the more abstract and context-based aspects. There are still factors that can be quantified such as green areas, walkability and other similar social metrics. These are quantifiable metrics that can be inputted and evaluated in the GD tool as highlighted by Talmor Blaistain & Fisher-Gewirtzman (2025) research.

Furthermore, rather than eliminating the paradox, GD may reframe it, as uncertainties wouldn't be removed but instead embedded into the input data and evaluation parameters. This would make the effectives of GD depend not only on the technical capabilities, but also incorporate uncertainties, interdisciplinary knowledge and different priorities. From this perspective, GD use in the workflow wouldn't represent a complete resolution. Instead, it would be a redistribution of how and where essential decisions are made, as proposed by Jiang et al. (2024) three-step approach.

Decision-making

One of the main aspects of GD's function, often highlighted by the interviewees, is its ability to generate multiple design alternatives. A large number of design alternatives provide perspective into different solutions, increasing the effectiveness of finding an optimal solution. However, a large quantity of alternatives carries the risk of making the process longer as the actors need to review said alternatives.

Reviewing a large number of alternatives and having to decide on an alternative can lead to longer decision-making, especially due to aspects such as decision paralysis. While using GD shortens the length of time for the design, it redistributes the complexity to the decision-making process, making decision-making more time-consuming in comparison to the traditional design process. After all, just reviewing a large number of alternative needs long period of time and is laborious. Furthermore, a challenge regarding choosing an alternative also exists. With an overwhelming number of choices, there is a risk of cognitive overload, leading to indecision and difficulty in choosing an alternative.

While Lostumbo et al. (2025) note that AI can potentially help filter the solutions until where the design solution can't be optimized without another metric diminishing. The remaining design alternatives would then be the optimized solutions. However, this risk adding on to the black box effect, especially as there is now an additional step in the design generation. After generating a large number of design alternatives, it would then need to filter these alternatives. Even if humans set the criteria and are in the loop for the filtering. It still does not eliminate the complexity, as it merely redistributes it from reviewing a large quantity to managing the political decision-making. This raises the question if the shortening of time in the design process justifies the increased complexity and time of the decision-making process. Furthermore, this also illustrates that as the values and interests are processed through dialogue and democratic

processes, the planning process cannot be reduced to an optimization problem. Therefore, GD can be seen as a tool that supports decision-making, rather than a decision-making tool.

Decision-making in the detailed development planning process is done through democratic processes. Using GD in such an environment introduces the risk of seeming objective. When in fact the output is determined by subjective parameters, set by the decision-making actors such as developers, designers and politicians. As stated by Jiang et al. (2024), there exists a "wicked problem", referring to the interests and trade-offs. Therefore, transparency is of vital importance as the input into the GD tools is affected by variables such as political values. Without sufficient transparency, the political values and interests embedded in the parameters and objectives become obscured in a seemingly objective model. This was also a point of highlight by the interviewees, who emphasized that trade-offs are different between projects based on variables such as the actor and site. As each project is unique, the process and parameters for the input become especially important to be presented in the democratic process. Otherwise, there exists a risk that the democratic process, especially with the public feedback being diminished in their ability to affect the development of detailed plans.

5.2 Data fragmentation and interoperability

Data fragmentation and interoperability emerge as a central challenge in both the interviews and literature. These doesn't only limit the adoption of advanced digital tools, but also hinder efficient information exchange between actors.

5.2.1 Challenges of data fragmentation and interoperability

A key barrier identified in the interviews is the lack of compatibility between software. One aspect that was highlighted was how exporting data from software used by the municipality to the developer's team or vice versa frequently resulted in time-extension due to unusable files as a result of compatibility issues. This incompatibility could explain the continued reliance of communication using 2D sketches and PDF-formats. This conclusion is supported by Varela et al. (2022) survey which indicates that communication is predominantly exchanged through PDF and 2D documents, rather than interoperable digital models.

Another issue highlighted was the scattered information, such as investigations, reports and other documents, leading to inefficiencies, duplication of work and knowledge gaps. An underlying reason for this could be the former compatibility issue in software and platform, resulting in the data being spread across actors and software, rather than being centralized. Varela et al. (2022) explain that the knowledge gap is a result of a lack of a centralized platform, while Lostumbo et al. (2025) argue that productivity is directly connected to the effectiveness of data exchange and knowledge acquisition. This collectively suggests that data fragmentation isn't merely a technical challenge but also a structural barrier.

5.2.2 Centralization through digital detailed plans

Digital detailed plan could be argued to be the single most important aspect of difference in the Swedish planning process compared with previous research environments. This is due to the fact that digital detailed plan has shift the planning dynamic compared to other planning processes. According to project manager B, with the digital detail plan becoming a requirement and even some municipalities digitalizing old detailed plans, it becomes easier to access the hard parameters (height, roof angle etc.) information from a centralized database. When such data is available from a centralized database, it simplifies in garnering data and utilizing it in the design process. As Lostumbo et al. (2025) highlighted, productivity is correlated with knowledge acquisition. This enables more efficient design iteration, particularly with advanced digital tools like GD. However, digitizing older detailed plans comes with a variety of difficulties. This is further underscored by Jiang et al. (2024) as GD's effectiveness is dependent on the data input for a more realistic and optimal output. However, there is a challenge in terms of the "translation" of older analog detailed plans. As noted by project manager B hand-drawn elements are often imprecise with thick lines and ambiguous boundaries making it challenges to determine exact geometries. Manual interpretation is therefore needed to fit into modern, standardized digital system.

5.2.3 Limitations and standardization gaps

Additionally, there exist a standardization gap where historical planning regulation do not always align with modern digital data models and classification systems. This makes certain older data harder to be fully machine-readable or standardized. This could be observed from the perspective of the regulations being "fragmented and not up to date" as stated by Varela et al. (2022). The current system is based upon data and categories that are structured and

standardized, which makes older plans messy and ambiguous, thereby complicating the transition.

Overall, this indicates that data fragmentation and lack of interoperability doesn't only introduces technical inefficiencies. It also fundamentally constrains the incorporation of generative design in the detailed development planning process. While ongoing digitalization such as digital detailed plan suggest that planning workflow is moving towards better data accessibility. Thereby supporting more efficient design iteration. However, there are also hurdles in the "translation". Successful implementation of GD in the workflow is not only based on the technological advancement, but also a systematic change in the method of information exchange.

5.3 Organizational and legal dimensions for GD

The organizational and legal maturity for GD within the DDP process is currently within a transitional phase characterized by new digital requirements and ongoing pilot projects. However, there are both organizational and legal frameworks that constrain as well as enable the adoption of GD.

5.3.1 Digital maturity

How advanced digitally an organization is shapes the feasibility, effectiveness and scope on how GD is utilized in the detailed development planning workflow. While the technical and certain institutional factors have been discussed in section 5.2, organizational digital maturity analysis provides a different perspective. From an organizational perspective digital maturity addresses human, cultural and institutional readiness.

The interviews acknowledge an uneven capacity between municipalities. According to the interviewees, the difference of technical skill and digital maturity between municipalities can largely be determined by the size of the municipality. Larger municipalities possess greater resources, technical expertise and organizational structure that enables utilization of advanced digital tools and cooperation with pilot project for digital initiatives. In contrast, smaller municipalities frequently lack dedicated staff with computational skills. This indicate a consequential effect of limited exploration and slower adoption with GD. This expounds on El Masry & Chronéer (2026) research which highlighted the "lack of skills and uneven digital

maturity". However, the research further indicates that even larger municipalities that are well resourced aren't necessarily without difficulties. To utilize advanced tools can be slow and fragmented due to reason such as disconnected workflows and a lack of oversight by the leadership.

Correspondingly there is an increase of expectation of active actors in the planning process and design workflow to oversee automated outputs, despite limited formal training in computational design. As highlighted by the interviewees perspective of having humans oversee the outputted design alternatives and refine upon the iteration. However, as mentioned there exist a certain technical competence that is needed, due to the high technical threshold. This gap also contributes to the black box effect, as the professional doesn't have the skill or knowledge to understand the reasoning behind the automated process. Furthermore, the premise of a human-tool collaboration argued by the interviews could be regarded from the perspective of lack of control over the outputted design highlighted by Schlickman & Magana-Leon (2024), where professionals raise concerns regarding accountability for generated solution in cases where it's difficult to understand the tools reasoning for the outputted design alternatives. Building competence in digital design tools is therefore vital for achieving mature adoption of GD.

Cultural factors also have a crucial role in digital maturity. As noted by the interviews, the planning architect see themselves as mediators, mediating between developers, politicians, the public etc. The introduction of GD challenges the professional role by shifting from managing the design and development of detailed plans to evaluating and validating generated outputs. As discussed by Chen et al. (2022), there often exist an inherent opposition to change for new technologies. From a culture perspective, this resistance to change come from the reluctance of transforming the dynamics and structure already in place.

Lastly, organizational digital maturity depends on systematic alignment between the process of development, professional roles and decision-making methods. In order to achieve such an alignment, in addition to building technical and theoretical competence as previously mentioned, the internal processes also need to be adjusted to effectively implement and utilize GD. The adjustments would need to address aspects such as coordination routines and validation procedures. Coordination routines refers to the fragmented data environment, while validation procedure is to encourage design actors to explain the reasoning behind design

decisions, in order for GD outputs to be assessed in relation to public value and legitimacy as highlighted by Kumar (2005).

5.3.2 Legal framework

The legal framework for Swedish detailed development planning both enables and constrain the integration of GD. The 2022 legislative mandate for machine-readable detailed plans provides a standardized dataset necessary, "hard parameter", for GD to function. By linking planning regulations and geometries to specific geographic areas, the legal framework enables a basis for automated process of design, such as building heights and plot boundaries. The significance from a legal perspective lies in the fact that it increases the potential for transparent automated design process while supporting regulatory compliance. However, as highlighted by Varela et al. (2022) the practical implementation remains uneven across municipalities due to digital maturity but also that many planning regulations contain ambiguous element were subjectiveness and professional judgment are needed which is difficulty to fully operationalize computationally.

Despite the advancement in the legal framework, GD introduces challenges in terms of transparency and accountability. PBL and related laws and regulations require the information and decision be presented by means of that allows for the public and related parties to understand and access (Boverket, 2025b, 2026c). As algorithmically generated design necessitate a certain threshold of knowledge and skill to interpret and understand, without having said knowledge and skill it creates a black box effect hindering the transparency. As mentioned by the interviewees, planning architect are responsible for reviewing and validating design iteration as to ensure that decision align with the regulation and laws. From this perspective, legal accountability ensures that GD function as a tool to support human judgment rather than replacing it. This aspect is also highlighted by El Masry & Chronéer (2026) arguing that the responsibility of decision lies with the actor from the municipality.

The professional judgment isn't solely needed due to digital advancement, but also ambiguous regulations and policies, as well as political, social and ethical priorities. These aspects need actors like planning architect and relevant stakeholder to acts as governance actors. This refers to acting as evaluators, coordinators and validators in order to integrate automated outputs into legally defensible and socially legitimate decision-making process.

5.4 Method discussion

Based on the methodology chosen, the results one gets can differentiate, even if the subject researched is unchanged. It's therefore critical to reflect on how the method chosen effects the findings.

5.4.1 Selection limitation

As mentioned in chapter 3, the interviewees were selected based on four criteria. These criteria serve as a framework for identifying relevant and experienced interviewees with knowledge and expertise in the subject of study. However, the criteria also limit the breadth of perspective that could be included in the study. A less restrictive selection criterion could potentially capture experiences and perspectives that have not been found. On the other hand, a less restrictive selection also risks that the interview becomes less relevant to the subject under research.

5.4.2 Interviewee bias

Another aspect of reflection is the potential bias of the selection that can affect the findings. The five interviewees were selected based on four criteria and each interviewee fulfilled at least half of the criteria. The consequential effect is that the interviewees from municipalities were from medium sized or larger municipalities. This affect the representative of the findings, as the participants and literature describe that the digital maturity, resources and organizational conditions differentiate. Furthermore, there are indication that this is often correlated to the size of the municipality. Larger and medium sized municipalities have more resources and opportunities to collaborate with companies involved in new innovations. This makes their experience and conditions not representative of smaller municipalities. The result should therefore be interpreted as an indicator and not representative of all municipalities in Sweden.

5.4.3 Municipality- and private actors

Including more municipality- and private actors could potentially nuance the findings, especially so if actor from small municipalities was involved. A larger selection of interviewees, if not for the time-constraints, could give a broader overview of the varying prerequisite and levels of digital maturity. Even if the study included interviewees from both the public and private sector, the number of representatives was limited. Additional interviews

with actors from both of the sectors would give the possibility for wider correlation between organizational conditions and workflows. This could potentially contribute to a more comprehensive understanding of the research subject. It is important to highlight that one of the interviewees has previously worked in a municipality that is classified as small. This somewhat contribute insights into the conditions of smaller municipalities. However, as these are only insight from one interviewee, these findings cannot be assumed to directly represent smaller municipalities perspective in general.

6 Conclusion & recommendation

The Swedish detailed development planning process is in a transitional stage in which the document-approach and data-driven computational paradigm affects the planning environment and the possible use of GD. The findings indicate that current workflow in the detailed development planning both enable and constrain the implementation of GD. However, ongoing digitalization as a whole in the construction and planning practices creates opportunities for planning processes to utilize computational approaches.

The study's findings highlight like previous research that current design and evaluation practices in the process remains largely manual and iterative. Although advanced digital tools and process like 3D modelling and BIM are used. Communication still mainly rely on 2D sketches and PDF documents. This are reasoned by legal requirements such as public accessibility and traceable review processes. A defining characteristic of the current workflow is the "design first, evaluate later" approach in which the design alternatives are developed before technical evaluations are conducted. The resulting effect is the inefficiencies and resource waste. Additionally, while collaborative planning processes aim to establish shared vision among actors, a consequential effect of compromises could potentially be design outcomes which are lacking and unsatisfactory.

The implementation of GD within this context have both enabling and constrains factors. The research found that one important enabler is the transition to digital detailed plans. This creates a structured data environment necessary for GD tools. There are also enablers such as rapid design generations and evaluation, visual representation and MOO which improvise efficiency and asses cost and environmental factors.

Even though digital detailed plans have enabled for a more structured data environment, during the process planning data is often fragmented across separate technical reports and datasets, limiting the structured information required for GD tools. Furthermore, while GD enables and handle quantitative parameters effectively, it struggles with qualitative values like social experience and cultural factors. This makes professional expertise essential for interpreting and refining generated alternatives. There are also regulatory and institutional challenges where planning policies are difficult to translate into parameters and constrain, and municipalities vary in digital maturity and technical capacity.

The study indicates that generative design is currently limited by several factors. However, the primary barrier is not a technical factor. Rather, it is institutional and organizational barriers that affect the opportunities for integration. This means that the implementation of generative design should be considered a paradigm shift. Where workflow, competence and collaboration are as important as the technical solutions themselves. The results illustrate that the institutional and organizational hurdles include factors such as digital maturity, data management and legal planning process. This therefore indicates that even if the tool has reached a level of maturity where it brings value to the detailed development planning process, its integration is dependent on the institutional and organizational structure develop to allow for a more data-driven workflow. A shift towards digital detailed plans demonstrates that the Swedish planning process is currently undergoing such changes.

6.1 Future research

While the study found some valuable insights in how GD relates to the municipal planning process and the current enablers and constrains. There are still many aspects worthy of investigations and future research. One direction of research is to conduct studies involving practical pilot project. This would enable a deeper level of insight through observation. Furthermore, it would also be beneficial in understanding the evolving role of municipal actors in relation to GD.

In line with this direction of research could involve exploring the ethical and governance related implication of utilizing GD tools, in regard to transparency, accountability and communication to stakeholders. Other research direction could involve understanding the implication of involving GD in the municipal planning practice and opportunities in integrating it with the already prevalent GIS and BIM tools to support easier access and decision-making through the process.

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8 Appendix

Interview questions

General questions

1. Can you describe your role in the detailed development planning process and how you work with detailed development plans?

2. What part of the process do you experience as being complex, time-consuming or having bottlenecks?

3. How do you handle the weighing and balancing of interest in the process?

4. How does the collaboration and information exchange between actors function?

5. What kind of tools do you use today for developing detailed plans? How does that affect how you handle data?

6. Does the kind of tools and software used affect the information exchange?

7. How have digital tools development affected your work and role?

8. How do you develop and evaluate different design solutions today?

9. Are there situations where decisions could have been faster with better material?

10. How do you think your role will change if there's an increase of digitalization?

11. What do you think are the primary hinders for moving towards a more digitized planning process?

Specific questions

12. What where your role in the pilot project?

13. What parameters and objectives were important in the use of generative design?

14. How would generative design weighing of interest contribute towards better informational material for decision-making?

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