PERFORMATIVE DESIGN THINKING IN ARCHITECTURAL PRACTICE

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ABSTRACT

PERFORMATIVE DESIGN THINKING IN ARCHITECTURAL PRACTICE

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During the last decades, the increasing need to ensure building performance during architectural design practices has led to highly interactive relations between architecture and various other disciplines, in which performance concepts are tightly integrated into the building design process. Computational tools supporting performative architectural design processes make this interdisciplinary integration possible. The critical consequence of the early consideration of performative principles and the collaborative synthesis process is widely emphasized both in theory and practice. This research aims to contribute to the current understanding of performance-based architectural design practices by investigating the key performance concepts, supporting computational tools and finally the current practices of performative design through case studies. The main research aim is to explore, understand and conceptualize the performative architectural design and the existing practices. It is also aimed to demonstrate the integrated design strategies along with the potentials of computational design throughout the design process including early phases.

Keywords: performative design, architectural practices, design synthesis, computational design, integrated design approach

ÖZ

MİMARİ UYGULAMALARDA PERFORMANS TEMELLİ DÜŞÜNME

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Son yıllarda, mimari tasarım uygulamaları sırasında bina performansını sağlamaya yönelik artan ihtiyaç, performans kavramlarının bina tasarım süreci ile sıkıca bütünleşmiş durumda olduğu, mimarlık ve çeşitli diğer disiplinler arasında son derece etkileşimli ilişkilere yol açmıştır. Performans temelli tasarım süreçlerini destekleyen hesaplamalı araçlar bu disiplinlerarası bütünleşmeye olanak sağlamaktadır. Performans temelli tasarım ilkelerinin erken değerlendirilmesinin ve işbirlikçi sentez sürecinin önemli sonucu, hem teori hem de pratikte geniş bir şekilde vurgulanmaktadır. Bu araştırma, ana performans kavramlarını, destekleyici hesaplamalı araçları ve son olarak örnek çalışmalar ile performans temelli tasarımın mevcut uygulamalarını inceleyerek, performansa dayalı mimari tasarımların mevcut anlayışına katkı sağlamayı amaçlamaktadır. Araştırmanın temel amacı, performans temelli mimari tasarımı ve mevcut uygulamaları keşfetmek, anlamak ve kavramsallaştırmaktır. Erken aşamalar da dahil olmak üzere tasarım süreci boyunca bütünleşik tasarım stratejilerinin, hesaplamalı tasarımın potensiyelleri ile birlikte gösterilmesi ayrıca amaçlanmıştır.

Anahtar Kelimeler: Performans temelli tasarım, mimari uygulamalar, tasarım sentezi, hesaplamalı tasarım, bütüncül tasarım yaklaşımı

To my dearest little niece,

Eda.

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LIST OF ABBREVIATIONS

BIM	Building Information Model
BREEAM	BRE Environmental Assessment Method
BPS	Building Performance Simulation
LEED	Leadership in Energy and Environmental Design
PA	Performative Architecture
PD	Performative Design
TQ	Translated Quotation

CHAPTER 1

INTRODUCTION

This research focuses on PD strategies, the computational methods for evaluating building performance and their potentials and obstacles in the architectural design practices.

1.1. Research Motivation and Goal

The design activity is a complex and multidisciplinary process, which consists of people, process and products. This process includes an ecosystem of analysis, considerations, evaluations, intuitive and rational decisions throughout the process in order to create an original product.[1] In this sense, design activity is defined as a process that aims at generating a description of a design product according to a set of given requirements and objectives,[2] and any design process is considered and conducted through these factors, regardless the type of the object. To this end, design activity can be described as creative problem solving, which is often measured in terms of a number of interrelated processes or components.[3] When architectural design is on focus, the requirements combine a large number of design objectives in various aspects, and therefore, interdisciplinarity becomes essential in design process. Architectural design, therefore, is not an individual experience anymore. Rather, architectural design is based on the integration of a wide range of involved parties from

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[1] Cross, N. (1999). Design Research: A Disciplined Conversation. *Design Issues 15 (2)*, 5.

[2] Van Langen, P. H. and F. M. Brazier (2006). Design Space Exploration Revisited. *Articial Intelligence for Engineering Design, Analysis and Manufacturing 20 (2)* , 113-119.

[3] Dumas, D., L. C. Schmidt, and P. A. Alexander (2016). Predicting Creative Problem Solving in Engineering Design. *Thinking Skills and Creativity 21*, 50-66.

different disciplines and their knowledge. The process of designing is iterative since a change in a design factor might cause various changes, similar to a ripple effect. In this kind of a process, continuous evaluations and modifications are required and the design artifact changes numerous times together with the problem formulation and process objectives.[4] This change especially occurs when the process includes a higher number of requirements, targets and disciplines, since the process transforms to an exploratory design activity that aims at integrating different disciplines into the design process and the end product.

Within the whole design process, the interconnection of the design artifact, which is the building in architecture, with the surrounding environment is on focus in terms of local environmental conditions along with negative environmental impact. When the human contribution to climate change and global warming is considered, the building industry might be the most significant factor in the disruption of the environment. Since the built environment expands gradually, there is an uncontrollable change on the physical and biological systems of earth. To this end, achieving well performing buildings has become a major challenge. The potential of performance factors for reducing the heavy environmental footprint and improving the energy efficiency of the built environment is on focus in architectural research.[5] Building performance has become an essential aspect of building design to create more responsive and sustainable built environments. Architects and designers aim to achieve acceptable building performances with applicable costs while providing the necessary user comfort levels in buildings. The significant role of designing high energy efficiency buildings with low environmental impact has been increasing rapidly.

In the most current architecture practice, building performance issues are taken into account according to technological developments, which provides high efficiency systems, performance equipment and materials, and renewable energy technologies.[6] [7]

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[4] Ibid.

[5] Gursel, I. (2010). CLIP: Computational Support for Lifecycle Integral Building Performance Assessment. TU Delft.

[6] Lee, D. K. (2013). *High Energy Efficient Building Envelope Design with Integrated Workflow in Multidisciplinary Performance Criteria.*

[7] Shi, X. and W. Yang (2013). Performance-Driven Architectural Design and Optimization Technique from A Perspective of Architects. *Automation in Construction* 32, 125-135.

Consequently, architects have started to delegate performance-related problems and solutions to engineering counterparts and other consultants. At the end, the building's performance targets are achieved with energy efficiency and low operation costs, however, other architectural requirements run the risk of being ignored when the external parties become more determinant than architects. Although a holistic and collaborative design approach is aimed in sustainability, architects are excluded from performance-related decisions in general and a segregation occurs in many of the performative buildings eventually.

In accordance with this, Aaron Betsky wrote a commentary in 2010 and underlined the disintegration between sustainability and architecture by saying that:

> "Sustainable architecture justifies itself by claiming to be pursuing a higher truth — in this case that of saving the planet. The goal justifies many design crimes, from the relatively minor ones of the production of phenomenally ugly buildings... to the creation of spaces and forms that are not particularly good for either the inhabitants or their surroundings."[8]

Therefore, architects and architecture can benefit from integrated design approaches to support all performance factors and incorporate them into the whole design process with all involved parties from the early design stages. In other words, performance should be integrated into the design activity from the beginning of the conceptual design phases for a holistic multi-disciplinary design process. Through this kind of design processes, efficient integration between architecture and engineering is achieved, which also provides quantitative performance improvements and evaluations towards desirable building performance.[9] It also leads to a more rational decision making process in terms of many design factors such as materials, form, site use, fabrication details and so forth within a reasonable design direction.[10] This design strategy means that building performance is no longer merely a technological issue, indeed, it could be taken into account as design matters.[11] As a result, architects take the responsibility of PD decisions and provide a design workflow with accurate building

[8] Hosey, L. (2012). *The Shape of Green: Aesthetics, Ecology, and Design.* Island Press.

[9] Lee 2013, op. cit.

[10] AIA (2012). Architect's Guide to Integrating Energy Modeling in The Design Process.

[11] Ibid.

performance evaluation particularly during early design phases, which might have significant influences throughout the rest of the design process about the decisions on the building performance.[12]

Along with this increasing awareness of integrated design strategies, various computational design tools coupled with building simulation tools have shown significant potentials and become increasingly widespread in fulfilling key roles in different aspects of architectural design. The definition of performance has extended its scope and building performance has become the determinant force in architectural building designs by means of these tools. However, advanced simulation tools that promote detailed simulation and evaluation on building performance are not preferred by architects due to their inherent uncertainties and inherently limited information provided in the early design phases.[13] Therefore, new computational tools are introduced for architects, which allow to conduct an investigation and comparison of various design alternatives under certain conditions.[14] These tools are suitable in terms of proposing systematical evaluations on building performance with the consideration of architectural requirements and objectives. They offer necessary linkage between different fields of architecture and engineering from the early design phases to the end of the design process.

The importance of integrating different disciplines during design process and the effects of computational tools on this integration underlined by Branko Kolarevic as follows:

> "The increasing emphasis on building performance - from the cultural and social context to building physics - is influencing building design, its processes and practices, by blurring the distinctions between geometry and analysis, between appearance and performance. By integrating the design and analysis of buildings around digital technologies of modeling and simulation, the architect's and engineer's roles are increasingly being integrated into a relatively seamless digital collaborative enterprise from

[12] Attia, S., E. Gratia, A. D. Herde, and J. L. Hensen (2012). Simulation-Based Decision Support Tool for Early Stages of Zero-Energy Building Design. *Energy and Buildings 49*, 2-15.

[13] Petersen, S. and S. Svendsen (2010). Method and Simulation Program Informed Decisions in The Early Stages of Building Design. *Energy and Buildings 42* (7), 1113-1119.

[14] Ibid.

the earliest, conceptual stages of design."[15]

Consequently, different parameters for PD are introduced by means of the computational tools. In line with this, perspective toward performance has changed both in theory and in practice. A range of parameters in the built environment is redefined as performance levels including human needs and architectural requirements.[16] Architects have adopted new design strategies that systematically relate buildings and settings to users and their environmental needs.[17] With the help of design and performance computation, PD advocates a process-oriented approach, which includes concepts that are applicable any type of building or environment.

This thesis is motivated by the increasing need to ensure building performance during architectural design, especially with the support of computational tools and methods. To this end, this thesis aims to explore, understand and conceptualize the performance-based architectural design practices through a number of consecutive phases. First, a review of the existing literature on building performance, performance assessment approaches during design processes and the supporting computational approaches is presented (Chapters 2 & 3). Following, a case study with 9 architectural practices in Turkey was carried out to understand the existing practices of performance-based architectural design processes. Finally, a discussion is carried out according to the results of semi-structured interviews in order to demonstrate the integrated design strategies along with the potentials of computational design throughout the design process including early phases.

Nevertheless, this research does not aim at proposing a new strategy for PD or creating new formulations for design process. It is also not the goal of this research to develop new computational procedures within performative architectural designs. Instead, this research aims at proposing an assessment on performative design thinking within architectural practices and stressing the conditions, potentials and barriers of the current situation by considering interdisciplinarity. Performance aspects are

[15] Kolarevic, B. (2010). *Performative Architecture: Beyond Instrumentality.* Spon Press.

[16] Preiser, W. F. and J. C. Vischer (2005). *Assessing Building Performance.* Elsevier.

[17] Ibid.

on focus through computational tools that are intended to strengthen PD process. In practice, the integration of different disciplines into the design process started to be supported with a holistic design approach.

1.2. Research Questions

Considering the discussion in the previous sections, this research addressed the following research question:

- *What are the ways in which performance aspects can be embedded into building design process by means of computational tools, methods and techniques?*

In order to answer this main question, a number of sub-questions have been addressed in the chapters of this thesis, which are listed as following:

CH2

- What types of performance criteria exist in architectural design process?
- What methods are in use for performance based architectural design?

CH3

- What changes occur in the PD process by means of computational tools?
- What changes occur in design synthesis in computational PD?

CH4

- What relationships exist between architects and other disciplines?
- What are the architects' competences in PDs?
- What conditions and barriers exist in PD practices?

1.3. Research Methodology

This thesis aims at exploring the PD processes in architecture. It aims at this goal by integrating architectural knowledge with other disciplines during the research process. In this manner, this research is pursued, firstly, in order to understand the current state of PA and design approaches in detail, and secondly, to extend it beyond the cases in which sustainability principles were not considered as part of the design process, which has been already analyzed and experienced. The necessity of extending the existent knowledge shows that it is not sufficient enough to encourage architects to adopt this new design paradigm in their designs. This thesis, thus, aims to explore the alternative extensions of PD approach not just from a researchers' perspective, but also for those of practitioners.

As a result, this research combines two perspectives. The first one is to benefit from and relate to previous knowledge and theories in this field, which is conducted through a literature review. Literary theory is important since it increases the quality of practice.[18] Therefore, linking theory and practice is considered as a fundamental part of academic education and research.[19] This part of this research aims to study a wide range of resources that aims to systematically describe the theoretical approaches as well as the practices and regulatory frameworks that have an influence on sustainable design. These resources include mainly a large number of scholarly articles. Concurrently, the second perspective provides a ground to this research in architectural practice and therefore, methodologies related to semi-structured interviews and case studies are used.

Case studies are significant for this thesis as a research methodology. Robert Yin provides the following definition in one of the most frequently cited books on case study research: "A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between

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[18] Fraser, M. (2016). Design Research in Architecture: An Overview. Routledge, Taylor & Francis Group. p142.

[19] Ibid.

phenomenon and context are not clearly evident."[20] Therefore, the case study research method is a powerful way to examine an existing system of values and human interaction.[21] It provides a deep investigation on a specific process, issue or feature within its real-life context by using a variety of sources of evidence. Thus, case studies are especially important for this research in terms of their explanatory and exploratory aspects.

Case studies can be applied both in case of quantitative and qualitative research. In this thesis, they are used for their qualitative ways to generate data that include observations, texts, pictures, documents of visual architectural representations, and so forth, which reflect the design process itself. These qualitative methods that are collected during the case studies help the interpretation and discovery of the concepts and relations coming from data and analysis.[22] In this thesis, architectural projects with performative aspects, including commercial, mixed-used, educational buildings, are examined from architects' point of views. The data collection and analysis process aims to understand, describe, and explore the practices within a domain of inquiry. Therefore, the knowledge obtained from literature review is not only tested by using the case studies, but also extended. Case studies are very useful in this research of PA that problems and definitions, which create complexity and variability of the existing practices, have not been clearly defined. Therefore, a systematical consideration of the collected data is required in their contemporary contexts through the case studies.

In order to systematically collect and evaluate the data, personal communication with a number of architectural practices is conducted within this research. In this phase, semi-structured interviews are used as the main research elements, which are in-depth interviews consisting of open ended questions are presented to the respondents.[23] A schematic presentation of questions or topics is given as an interview guide and it needs to be explored by the interviewer.[24] These interview guides are useful for ex-

[20] Yin, R. K. (2003). Case Study Research: Design and Methods. Sage Publication.

[21] Ibid.

[22] Corbin, J. M. and A. L. Strauss (2015). Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. SAGE.

[23] Jamshed, S. (2014). Qualitative Research Method - Interviewing and Observation. *Journal of Basic and Clinical Pharmacy 5* (4), 87.

[24] Ibid.

ploring respondents more systematically and comprehensively while keeping the interview focused on the desired direction.[25] The interviewer presents these core (guiding) questions along with a number of associated questions in order to further improve and explore the topic. In this sense, personal communication via semi-structured interviews becomes very useful in the context of this research to collect data.

The personal communication through semi-structured questions is especially useful for this research since this study is centered around people whose meaningful actions are under study. The aim of this method is to combine two perspectives while developing the inquiry and the research questions, that of theory and of practice.[26] In general, both sides benefit from the research process. The research process allows researchers to examine existing everyday challenges from a distance in order to question and rethink accustomed interpretations of situations and strategies.[27] It is a very demanding process that combines two involved parties, theory and practice, in order to meet, interact, and develop an understanding for each other,[28] which is one of the main focuses of this research.

The research process, therefore, can be organized into three phases. The first one is focusing on literature review while the second and the third ones are case studies through data collection by means of personal communication with existing architectural practices in Turkey. Each phase has a number of sub-phases as follows:

Literature review:

- The first phase contains a literature review on the notion of performance, its definitions and criteria. This part will be concluded by examining the ways in which performance is integrated into the architectural design.
- The second phase includes a literature review on the computational design since this thesis also focuses on the novelties of computational design in PA. Perfor-

[25] Ibid.

[26] Bergold, J. and S. Thomas (2012). Participatory Research Methods: A Methodological Approach in Motion. *Forum Qualitative Sozialforschung 13* (1).

[27] Ibid.

[28] Ibid.

mance is redefined in this new medium by computational tools. Therefore, a clear understanding of these tools and strategies is needed, which is the goal of this phase.

- The third phase includes the correspondence of PD in architectural practices. This phase aims to investigate the design synthesis process with visual representations used for different purposes.

Case Studies:

- This phase provides a perspective on the ways in which performance criteria are considered through the architectural design practices. All design process is taken into account to propose a systematic assessment, from conceptual design to the detailed design phases.

- Selected case studies are particularly crucial for this part of the thesis; they relate this research to architectural practice and reinforce the academic knowledge within their real-life context. Data collected through case studies are discussed according to the previous research steps with a focus of interdisciplinarity and design integration. These case studies will provide the necessary diversity and depth to this research.

Personal Communication:

- Architectural practice through PD strategies is the focal point of this phase. The main emphasis is on the perspective of architects and the ways in which they get involved in the design process. This phase is important since it is the process of framing the main conditions and potentials of PA practices from the architects' point of view.

- The aim of this phase is to underline the differences and obstacles of the current practices. This phase leads this research to a make an assessment of PD thinking and its practices. According to the answers of the respondents, subcategories are constituted and a discussion is pursued according to them.

- This phase consists of interview records along with documents including drawings, models, simulation results, photographs and so forth, which are used for extending the process beyond the presented interview questions and providing a better understanding of the design processes in this specific domain.

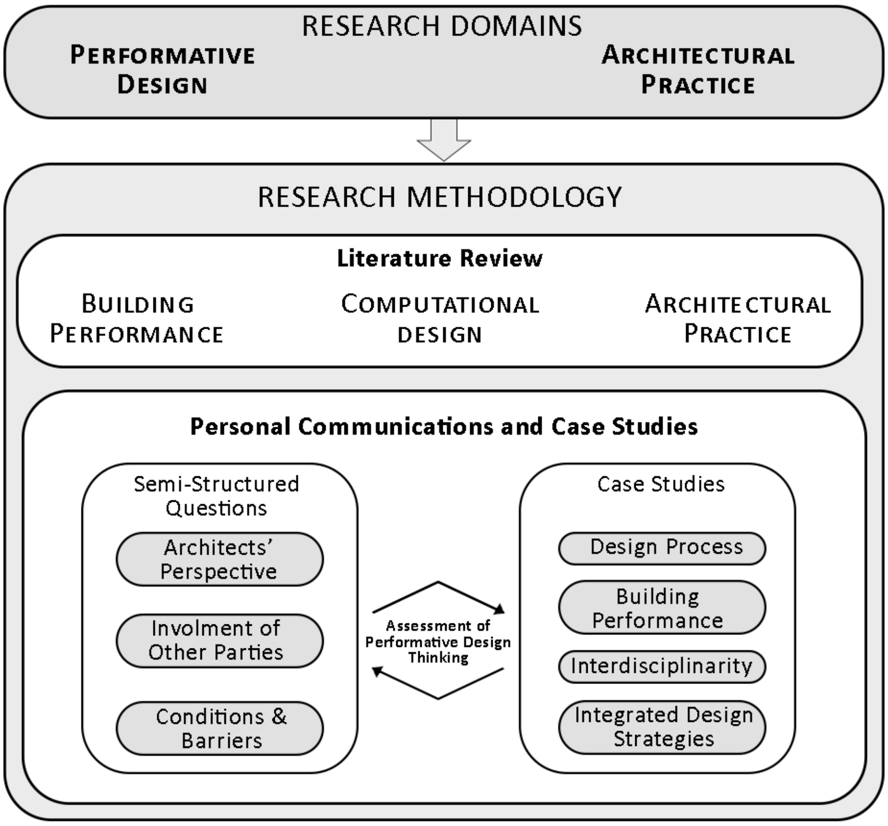

Figure 1.1: Illustration of the overall research process.

As the outcome of this research process, it is aimed at presenting an assessment of performative design thinking within architecture in terms of understanding building performance, using computational tools and exploring potentials and barriers of PA. To this purpose, the literature review will provide the necessary background and definitions for PA, computational design, and architectural design strategies. This theoretical knowledge will be investigated and extended through examining a number of case studies and personal communication in order to analyze and strengthen this knowledge within design practice. The design processes will be taken into account as a whole, and therefore, the focus will not only be on the end results but also be on the relations between design activity, involved parties and building performance. The border of these two research phases, which are the case studies and personal communication via semi-structured interviews, is permeable to allow them to affect each other and conduct a proper assessment.

1.4. Limitations

The limitation in this research might be the fact that the case studies represent (a) only the Turkish condition and (b) only the selected set of architectural practices. Only architectural offices in the two major cities in Turkey are visited and generalizing the results onto the whole breath of architectural practices in Turkey is not possible. However, based on the fact that these architectural practices are selected based on their "good design practices", this thesis assumes that they have the potential to represent the design process and integrated strategies in PA. Moreover, the practices also work at international projects with partners in other countries; therefore, the results of the Chapter 4 & 5 do not present only the conditions in Turkey. However, this research also opens the way towards similar research work that can be pursued with architectural practices located in different countries in the future in order to compare location differences in detail.

1.5. Chapter Outline

Chapter II: The Notion of Architectural Performance

This chapter aims to discuss the notion of performance and PD approaches, and how the understanding of designers and architects has changed towards performative architecture.

Chapter III: Computational Design for Performative Architecture

Chapter III discusses the relationship between computational design and PA, and how performance simulation affects PD process and strategies.

Chapter IV: Performative Design in Architectural Practice

This chapter presents and exemplifies PD processes within architectural practices by means of case studies and semi-structured interviews.

Chapter V: Discussion

In Chapter V, the results of the case studies and semi-structured interviews are discussed. In this chapter, current conditions and obstacles to PA are presented.

Chapter VI: Conclusion

Chapter VI is the conclusion of this thesis which summarizes the research process and findings and suggestions for the future study.

CHAPTER 2

THE NOTION OF ARCHITECTURAL PERFORMANCE

Chapter II aims to discuss the notion of performance and PD approaches, and how the understanding of designers and architects has changed towards PA.

2.1. Performative Design in Architecture

The meaning of performance, either as a general term or as in architecture, is multiple and intertwined, and irreducible to a simple, laconic definition. Stein (1983) defines performance as the manner in which or the efficiency with which something reacts or fulfills its intended purpose.[1] Similarly, it is explained as the execution of an action, something accomplished, or the manner in which a mechanism performs in Merriam-Webster's Collegiate Dictionary.[2] Based on these definitions, performance is explained as a notion that consists of one or multiple objectives determined at the beginning of the task, and mechanisms or subjects are expected to meet these previously stated objectives. In this manner, performance becomes the fulfillment and the ability of a practice that is achieved through a process. Therefore, a significant part of the performance notion is to identify the intended purposes (or objectives) of the subject, and the capacity that the subject has to accomplish such expected tasks.[3]

Performance became a significant factor in contemporary theory and practice of architecture as well. The increasing awareness of the environmental impact of buildings is

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[1] Stein, J. e. (1983). *The Random House Dictionary of the English Language.* Random House.

[2] (1983). *Websters Ninth New Collegiate Dictionary.* Merriam-Webster.

[3] Turrin, M. (2013). Performance Assessment Strategies: A Computational Framework for Conceptual Design of Large Roofs. TU Delft.

receiving growing interest among architects to design projects that aim to achieve ecological, sustainable, green or performative architecture. The word "sustainability" became an important concern in architecture and secured its place in the consciousness of architects[4]. Performance became a particularly outstanding and permanent discourse in this sense.[5] The rise of the notion of environment and the cross-disciplinary movement in PA emphasized this critical discourse. Architects realized that building performance can be the determinant input for the design process.

In the built environment, the sector also shows new demands, not only the designs of innovative forms of buildings for environment, but also in other aspects such as comfort, safety, wind, energy efficiency, health, indoor climate, building services and the new requirements on logistics, new construction techniques and materials, which serves the overall performance of a building.[6] However, it still remains ambiguous what building performance is. According to the American Institute of Architects (AIA), the aim of building performance is:

> "To ensure individual effectiveness over time through functional and environmental quality in buildings, e.g. thermal, indoor air, acoustical and visual quality, [...] to ensure organizational effectiveness over time through the integrity of buildings, e.g. flexibility, durability, and structural and fire safety, [...] to ensure societal effectiveness over time through equitable resource utilization and integration with the surrounding built environment, e.g. materials, land, water, energy, waste and infrastructure."[7]

Along with the new definitions of building performance, The European Performance Building Directive (EPBD) supports sustainability notion with a paradigm shift in regulations from individual component and system requirements to a framework for the total energy performance of the building.[8] Many countries follow the shift and

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[4] Williamson, T., H. Bennetts, and A. Radford (2004). *Understanding Sustainable Architecture.* Spon Press.

[5] Hensel, M. (2013a). A Brief History of the Notion of Performance in Architecture. *Performance-Oriented Architecture*, 23-30.

[6] Sariyildiz, S. (2012). Performative Computational Design. In *ICONARCH I: Architecture and Technology. November 15-17 2012. Proceeding of the International Cogress of Architecture-I.* p315-344.

[7] Fasoulaki, E. (2008). Integrated Design: A Generative Multi-Performative Design Approach. Ph. D. thesis.

[8] Lee, S. H., F. Zhao, and G. Augenbroe (2013). The Use of Normative Energy Calculation Beyond Building Performance Rating. *Journal of Building Performance Simulation 6* (4), 282-292.

change their traditional perspectives into an understanding which focuses on the performance requirements. As a result, by giving enough flexibility to architects in their designs, this new paradigm needs to be adapted through a new architectural design methodology.

For architectural design and evaluation in regard to 'building performance', Kalay (1999) proposed a more objective and rational design decision-making process, which is opposite to the traditional, subjective and intuition-oriented design methodologies.[9] His proposed approach is based on examining the alternatives for meeting certain conditions in a given context in an iterative process of exploration.[10] However, even in this iterative exploration process, it is still the designers' ability to represent and reflect upon the desirability of the performance of a certain alignment of form, function, and context to make actual design decisions.[11]

Performance-based design approach, therefore, can be defined as a process in which performance requirements are translated and integrated into a building design.[12] Since identifying performance requirements is the initial step of the design activity, performance becomes the guiding element in designing. Performance-based models in architecture may be considered as the utilization of building performance evaluation.[13] In other words, performance is an important concern and considered as an essential component of the design process. Oxman (2008) emphasizes performance and design relationship by saying that:

> Performative design suggests that in creating simulation environments for performance-based architectural design both generative and evaluative capabilities can be integrated within performance-based simulations.[14]

The significant role of performative design approach is emphasized in the Journal

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[9] Kalay, Y. E. (1999). Performance-Based Design. *Automation in Construction 8* (4), 395-409.

[10] Ibid.

[11] Petersen, S. and S. Svendsen (2010). Method and Simulation Program Informed Decisions in the Early Stages of Building Design. *Energy and Buildings 42* (7), 1113-1119.

[12] Becker, R. (2008). Fundamentals of Performance-Based Building Design. *Building Simulation 1* (4), 356-371.

[13] Oxman, R. (2008). Performance-Based Design: Current Practices and Research Issues. *International Journal of Architectural Computing 6* (1), 1-17.

[14] Ibid.

of Architectural Design (2008) as a new phrase, morpho-ecological design, which is explained as a focus on the integral relationship between form-generation, material behavior and capacity, manufacturing and assembly, environmental modulation and a type of spatial conditioning that is set to deliver a richly heterogeneous space.[15] In other words, morpho-ecological design aims at combining several performative aspects of architecture in order to provide all performance requirements for a building. The new design approach does not exclude soft aspects of buildings, such as geometrical form, spatial qualities, cultural aspects, and so forth. Indeed, different sets of performance criteria are covered within, and thus, performance becomes the process itself which starts with performance-based decisions, but design activity does not stop when the requirements are identified and the target is set. It continues through the whole design process by using building performance as a guiding design principle and adopts new performance-based goals for the designs[16]. In this sense, performance becomes a factor not only for form-making, indeed, architecture that utilizes the digital technologies of quantitative and qualitative performance-based simulation offers a more comprehensive design approach for the built environment, which is called as 'Performative Architecture'.[17] Kolarevic (2004) defines performative design broadly as following:

> [...] its meaning spans multiple realms, from financial, spatial, social and cultural to purely technical (structural, thermal, acoustical, and so on.). If understood in those terms, performance-based design, or performative architecture, can be furthermore described as a "metanarrative" with universal aims that are dependent on particular performance-related aspects of each project. [...][18]

While adopting an extensive design approach in PA, it is essential to emphasize the importance of the designer in the design process. This comprehensive design approach also takes into account the first principles, the experience gained over time

[15] Hensel, M. and A. Menges (2008). Inclusive Performance: Efficiency Versus Effectiveness Towards a Morpho-Ecological Approach for Design. *Architectural Design 78* (2), 54-63.

[16] Branko Kolarevic talks about not only the design of buildings here but also for the design of cities, landscapes and infrastructures in a broader sense. See: Kolarevic, B. (2009). *Architecture in the Digital Age: Design and Manufacturing.* Taylor & Francis.

[17] Ibid.

[18] Kolarevic, B. (2004). Back to the Future: Performative Architecture. *International Journal of Architectural Computing 2* (1), 43-50.

and the observations in the fields and laboratories about performance elements and components[19]. Therefore, experience and principles have fundamental potential in the new design philosophy. Moreover, this design approach gives the responsibility and accountability into the designers' hands directly, without hiding design decisions behind the regulations or building codes.[20]

In this manner, PD can be seen as an ordinary design activity which should be sustained throughout the design process. Performance is not just a part of building design or a path to follow. PA should not be seen as a prescription. It is an approach, an attitude, which spans the whole design process,[21] combines a list of criteria to sustain overall performance of a building.

2.2. Determination of Building Performance

While designing, designers ask themselves how good their design is. This is actually a self-assessment of how well the design will perform after it is built. In order to understand the overall performance of a building, it is needed to look at several aspects of the design, and this realization process constitutes the basis of PA. When architecture is on focus, the performance aspects and the intended purposes are numerous, interrelated and dynamic, which makes the concept of performance complex and multi-composed.[22] Performance of a design is a result of the multi-criteria and multi-disciplinary performance evaluation without any predomination.[23] When building performance is in focus, it becomes a notion that aims to fulfill human needs and architectural requirements, along with the key role of environmental aspects of design.

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[19] Branko Kolarevic claims that PD approach embraces the concept of evaluating the functional aspects of entire systems and not just the components. It is engaged in systems thinking rather than in elemental segregation. See: Ibid.

[20] Ibid.

[21] Guy, S. and G. Farmer (2001). Reinterpreting Sustainable Architecture: The Place of Technology. *Journal of Architectural Education 54* (3), 140-148.

[22] It is mentioned before in performance definition as identification of the intended purposes of the subject and the capacity of it. See: Turrin 2013, op. cit.

[23] Kalay 1999, op. cit. p395.

Architecture holds its performative capacity within embedded orders of complexity and auxiliary to countless conditions and processes.[24]. Expectedly, architectural design process is very complex since it aims at converting human needs to architectural requirements. When performance becomes a part of the design activity, architectural requirements are defined as a combination of data coming from the human needs and the local environment. In this sense, environmental factors can be considered in the early design phases with an integrated perspective while defining architectural requirements. It implies the early awareness of the environment, and architectural requirements can be embedded the effects of the environment on the human needs. In this sense, architecture should be able to evaluate building performance within one comprehensive solution list based on architecture in order to cover all human needs and architectural requirements. A significant synthesis is needed in formulating them, and this formulation is generally based on the human perception of complex factors. In order to be able to determine the architectural requirements, which fulfills the specific needs including performance issues, they usually have to be separated into their subparts to be understood.[25]

Since architecture serves to all human needs and architectural requirements, multiple performance objectives and design parameters need to be considered simultaneously and in an integrated manner. In different analytical and generative modes, the key role is given to efficiency and optimization with the underlying aspects of computational processes. This multi-parameterized performance understanding embraces all design process and seeks the interactions of different conditions and stimuli.[26] The new PD paradigm needs to reflect the complexity and the multi-dimensional character of sustainable development, including 'different magnitudes of scales (of time, space, and function), multiple balances (dynamics), multiple actors (interests) and multiple failures (systemic faults)'.[27]

Several performance aspects need to be considered while proposing a systematic as-

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[24] Hensel, M. (2013b). Non-discrete architectures. *Performance-Oriented Architecture*, p31

[25] Turrin 2013, op. cit., p56.

[26] Hensel and Menges 2008, op. cit.

[27] Hensel, M. (2013c). Traits of Performance-Oriented Architecture. *Performance Oriented Architecture*, 53-132.

sessment of design performance. These aspects, which affect building performance in various ways, constitute the total degree of satisfaction of design requirements[28] that reflect a designer's intended purposes.[29] It is incorrect to evaluate performance by looking at only one criterion, indeed, the essential part of a proper performance evaluation is to link the overall design performance to the given requirements. In order to evaluate building performance, the designer needs to capture the relationship between design variables and total performance. This relationship might be challenging since the number of different kinds of criteria that contributes the overall design performance brings complexity to the design activity.[30]

The final success of a building design is determined according to several conditions within the context of total building performance. Performance conditions include user satisfaction, organizational flexibility, technological adaptability, and environmental and energy effectiveness, which are substantial to improve individual comfort with building performance and systems integration approaches.[31] The conditions refer to user psychological needs; constant improvement or exchange of technology; construction, operation, and maintenance of the building and so forth, which are interrelated and cannot be dealt with in isolation.[32] In general, technical systems stand for physical factors which provide a better and safer building, however, they do not include the perspective of users and occupant needs and goals.[33] Indeed, performance and functionality are directly related to occupancy, thus, while the designer try to have a technologically superior building in terms of energy, material or all other technical aspects, it may provide a dysfunctional or uncomfortable environment for people.[34] At this point, it becomes problematic to tell how good a design is when, for example, the building uses little energy but does not function well, or how well performance it

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[28] The term requirement is used in a broad sense, which covers the concepts of desire and demand as well.

[29] Bittermann, M. S. (2009). *Intelligent Design Objects (IDO): A Cognitive Approach for Performance-Based Design.* TU Delft. p80

[30] Ibid. p81.

[31] Hartkopf, V. and V. Loftness (1999). Global relevance of total building performance. *Automation in Construction 8* (4), 377-393.

[32] Ibid.

[33] FFC (2002). *Learning from Our Buildings: A State-of-the-Practice Summary of Post-Occupancy Evaluation.* National Academy Press. p10.

[34] Ibid.

has when it contains low cultural value even if it is highly functional.[35]

The historic understanding of building performance, as in Vitruvius suggested, has been transformed into a system, and synthesized into a framework which consists of three levels, as Preiser and Vischer stated in 2005, which are:

1. Performance of health, safety, and security;
2. Performance of functionality and efficiency;
3. Performance of psychological, social, cultural and aesthetic aspects of buildings.[36]

As it is understood, each level focuses on different parts of building performance, however, the overall building performance is evaluated by combining a variety of criteria. The evaluation process may also differ from one to another. For example, in the first category above, building codes and standards dominate the building designers and professionals while in the second one, design process refers to a state-of-the-art knowledge about building types and systems.[37] The last category is less codified as compared to the first and the second ones, nevertheless, it is also equally important for designers.[38]

Because the performance levels are interwoven to each other, it is not easy to detect their influences on the overall performance of the building. A number of performance criteria, such as structural performance, material performance, energy performance, aesthetic performance, cultural performance, functional performance, and so forth can be listed. However, since categorizing these criteria does not have a certain method, it is difficult to determine the borders of the total building performance. At this point, Structural Frame Performance Criteria (SFPC) is constituted in order to assess potential performance of a structural frame, which is the building in this case. As integrated parts of the total building performance, the frame addresses both ‘hard’ and ‘soft’ issues in itself.

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[35] Bittermann 2009, op. cit., p81.

[36] Preiser, W. F. and J. C. Vischer (2005). *Assessing Building Performance.* Elsevier. p5.

[37] Ibid.

[38] Ibid.

2.2.1. Hard Performance Criteria in Building Design

The hard performance criteria contain performative factors which are quantifiable in nature, and therefore, they enable to conduct objective assessments through the design process.[39] These hard criteria are related to the technical performance of a building and listed as follows:

Structural Performance is a very basic aspect of the overall building performance since the primary aim of a building design is to provide safety of occupants and properties under the shelter of the building.[40] This criterion considers building's ability to resist effectively and efficiently to the expected forces such as live loads, dead loads, wind loads, and earthquake-induced forces.[41] It is a well-known topic in structural morphology studies which commonly investigate the relationship between building form and structural performance. This criterion may include minimizing the weight or structural supports, and is considered within form finding processes as well.[42] In accordance with the structural performance criterion, structural codes and regulations are established in almost every country to satisfy the requirements for structural safety.

Material Performance is another hard performance criterion, which affects a set of other performance factors including structural performance, energy performance, and aesthetic performance. During building design, materials are chosen either pragmatically according to their utility and availability, or formally due to their appearance qualities.[43] In this manner, material behavior has a significant potential for the overall building performance. Their specific compositions may affect the structure from

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[39] Sariyildiz, S. And B. Tuncer (2005). *Innovation in Architecture, Engineering and Construction: Proceedings of The 3rd International Conference On Innovation in Architecture, Engineering and Construction (AEC) Rotterdam, The Netherlands, 15-17th June 2005. Innovation in Technology and Management in AEC. Number 2.* C. Delft University of Technology, Faculty of Architecture.

[40] Shi, X. (2010). Performance-Based and Performance-Driven Architectural Design and Optimization. *Frontiers of Architecture and Civil Engineering in China 4* (4), 512-518.

[41] Bittermann 2009, op. cit., p79.

[42] Turrin, M., P. V. Buelow, And R. Stouffs (2011). Design Explorations of Performance Driven Geometry in Architectural Design Using Parametric Modeling and Genetic Algorithms. *Advanced Engineering Informatics 25* (4), 656-675.

[43] Addington, D. M. and D. L. Schodek (2005). *Smart Materials and Technologies in Architecture.* Elsevier. p2.

which their properties arise[44], as well as the possible contributions to the energy performance of the building and its appearance. With a variety of properties and behavior, material performance provides a significant opportunity to satisfy the purpose of PA.[45]

One of the most dominating hard criteria in PA is the *energy performance* of a building. It includes solar, thermal, moisture, acoustics, lighting, wind and air, and many others that affect the quality of built environment both indoor and outdoor.[46] The common feature of all these energy-related factors is the fact that they are all quantifiable in different degrees within the consideration of energy performance. The factors related to energy performance might be taken into account one by one as different categories such as thermal performance, lighting performance, acoustic performance, and so forth. Nonetheless, even if the coverage of the issues changes, the intended purpose of designers remains in favor of the overall building performance.

Since the 'sustainability' concept is the new target of architecture, hard performance criteria took their places on the focus of architects due to their computability, who take the design responsibility on themselves. In order to make an environmental assessment of a building design, several objectives are determined based on these hard criteria, which designers address either explicitly or implicitly.[47] Consequently, architects delegate performance aspects of a building design to certain standards and technologies, which focus on the hard performance criteria with a quantitative point of view.

Unquestionably, quantifiable performance criteria are important since they allow designers to see the results of their decisions before the building is built. Along with the developments in architecture, especially with the help of simulation-based modeling tools,[48], hard performance criteria fall under the scope of architecture, which gives the ability and responsibility to architect, who can control and modify their design to

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[44] Hensel 2013c, op. cit. p59.

[45] Ibid.

[46] Shi 2010, op. cit.

[47] Soebarto, V. and T. Williamson (2001). Multi-Criteria Assessment of Building Performance: Theory and Implementation. *Building and Environment* 36 (6), 681-690.

[48] See: Chapter 3.3.Developments in New Simulation-based Parametric Modeling Tools

provide a better performance evaluation.

2.2.2. Soft Performance Criteria in Building Design

In contrast with the hard performance criteria, more subjective factors depending on individual perceptions exist, which are called as ‘soft criteria’ within the performance frame. Soft factors are difficult to assess since they are often difficult to quantify. The potential value of the soft factors to the users are captured by alternative measures.[49] The assessment is based on many factors, which might be personal preference or taste as well since the design activity is a goal-directed activity and therefore, conventional ways can be the directing methods to reach the intended satisfactory level of the subject.[50] Soft performance issues have already been at the focal point of architectural design, especially from the PD perspective. The form, organization of space, material selection, color, shape, and details all contribute to the overall building performance as soft factors.[51]

Formal Performance is one of the soft criteria, which is directly related to a number of hard and soft issues of building design. Energy performance, structural performance, material performance, aesthetic performance and many others can be a part of the form conception process. Formal performance might direct the designer to fulfill several hard and soft performance requirements while different performance criteria may affect the building form bi-directionally. Since form finding is one of the most determinant process in building design, formal performance provides significant opportunities in PA as well.

Functional Performance is another soft criterion which is not computable and therefore, the evaluation of functional performance is also difficult. The validity of this criterion changes according to the circumstances of certain economic, social, personal situations.[52] As a result, functional criterion, including other soft factors, is

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[49] Sariyildiz 2005, op. cit.

[50] Archer, L. B. (1969). *Structure of the Design Process.* Humphries.

[51] Shi 2010, op. cit., p513.

[52] Bittermann 2009, op. cit., p16.

changing during the design process since the influencing factors are also in a constant state of flux. Consequently, the change of a building's functionality makes it difficult to decide on valid design solutions under the specific and inequable conditions.[53]

The notion of performance is explained from an argument which focuses on the relationship between form and function. This relationship is context-based rather than causality based. Therefore, the performance evaluation of a proposed design might be interpretive and judgmental even if it considers the form and other physical attributes and functional objectives and goals.[54] In this manner, PD is under different circumstances including soft issues in which different factors come together according to personal preference and perception.

When *Aesthetic Performance* is taken into account, the measurement units can be simply the scales of success, even if it might be largely arguable. Aesthetic design can be associated with feelings of beauty or newness,[55] which are difficult to agree upon. Similarly, *social performance* refers to the social aspects of buildings, which can cause disagreement that arises from the concurrent use of the building by different people.[56] These criteria are directly related with the experience of the users and designers, therefore, it is possible to advert new aesthetic and social trajectories within the field of PA as well.

It is important to understand that in spite of their subjective and unquantifiable nature, soft performance criteria are also within the design requirements in PD process. Therefore, they can also be modified and changed through the design activity. Moreover, they are evolving from abstract aspects of design toward measurable criteria since in the latest researches, the attention is given to the concerns on the softness of overall building performance in the design process.[57]

There are surely different ways to categorize these criteria. The significant point is

[53] Ibid.

[54] Kalay 1999, op. cit., p396.

[55] Preiser and Vischer 2005, op. cit., p5.

[56] Ibid.

[57] Van Langen, P. H. And F. M. Brazier (2006). Design Space Exploration Revisited. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing 20* (2), 113-119.

to understand that all these quantitative and qualitative building performance criteria should be considered together in a holistic design approach. In order to evaluate building performance properly, the complex relations between design variables and design performance should be considered,[58] regardless of their softness or hardness.

2.3. Performance Inclusion Methods in Building Design

Building performance has become a significant factor since it affects the decision making process in the design activity. As a result, it has become mandatory to integrate performance into the design process and the building. Here, the notion of building performance covers all the issues from building physics to cultural and social context. Building performance affects the design itself, the process, the practice, and eventually, it combines building form and analysis, and appearance.[59] Building performance, therefore, should not be a concept to be considered after the construction. Indeed, it should be analyzed and evaluated from the beginning of early design phases, the results of performance-related decisions should be foreseen, and the assessment should be done according to it. The early consideration is important since PD decisions change the whole design process and affect the overall building performance.

Recently, the search for well-performing solutions has gained a crucial importance since PD has become the keystone of building design in an inseparable way. The solutions emphasize design exploration rather than taking decisions in a preferred design direction only.[60] In other words, PD methods support a larger generation and use of design alternatives and cope with the limitations of time without conflicting any privileged design decisions.[61] However, design exploration is mostly possible when performance evaluation starts from the early stages of design activity since it is easier to make modifications on design at these stages. In that case, PD approach consists

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58 Bittermann 2009, op. cit., p79.

59 Kolarevic, B. and Malkawi, A. (2010). *Performative Architecture: Beyond Instrumentality.* Spon Press

60 Turrin, op. cit., p62.

61 Ibid.

of two parts, which are generating design alternatives with given parameters, and then using performance in the evaluation of those.[62] The generation and evaluation processes are pursued concurrently since performance becomes a continuously driven factor at each phase of the design activity in PD.

At this point, it must be underlined that in order to develop effective techniques to conduct PD, the perspective of designer towards performance becomes crucial in the design process. When performance issues are considered for architecture, architects are under the risk of being excluded from the design process to leave performance-related problems to other experts.[63] However, the segregation caused by the exclusion of architects from performative decisions breaks the continuity of design and the end result may contradict with architectural requirements. Indeed, PA should combine performance solutions and architectural requirements in regards to the comfort of the occupants according to the functions and activities of that building. In that respect, inclusion of architects to the whole design activity is essential in order to apply performance-related solutions systematically throughout the design process and the building lifecycle as well. As Becker (2008) explains the performance concept:

> "[...] is supposed to enable the design and execution of buildings that are highly suitable for the functions and activities of their occupants, provide thermally, acoustically and visually comfortable and healthy internal conditions while conserving energy and the environment, are pleasant and harmless from the tactile point of view, are sufficiently safe under regular and extreme loads that may occur during the life expectancy of the building, do not compose a fire hazard to their surroundings and are sufficiently safe when a fire starts within their spaces, are easy to evacuate upon emergency, do not leak and are not inflicted by moisture, condensation or mold, are free of cracks and frequent mechanical damage, do not have any of the symptoms of the sick building syndrome, are maintenance friendly and can easily be modified in order to cater for new demands. All these qualities are expected to be realized during the service life of the building without excessively increasing its lifecycle cost".[64]

[62] Turrin, Buelow, Kilian and Stouffs followed a case study in their paper in order to explain parametric variations of a curvature in a roof structure by means of daylight and solar exposure of the covered space. See: Turrin, M., P. V. Buelow, A. Kilian, and R. Stouffs (2012). Performative Skins for Passive Climatic Comfort. *Automation in Construction 22*, 36-50.

[63] Shi, X. And W. Yang (2013). Performance-Driven Architectural Design and Optimization Technique from A Perspective of Architects. *Automation in Construction 32,* 125-135.

[64] Becker, R. (2008). Fundamentals of Performance-Based Building Design. *Building Simulation 1* (4), 356-371.

In the context of PA, performance can be included in building design in various ways. However, the essential point here is to correlate performance and building holistically. Integrated design methodologies for PA are being emphasized by scholars and practitioners assertively, which gives the explorative and enduring features to PD.

2.3.1. Performance as Technology

If the ongoing process within the field of PA is examined, it can be seen that it includes the research, development, and utilization of new materials and mechanical equipment largely. Architecture and engineering professions are facing enormous technological changes and challenges in compatible application of PA practices. Indeed, the technological developments in architecture become the leading factor, since they work as easily additive design components which can be precisely calculated and applied after the architectural design process is finished. The designers, who are willing to apply their normative practice precisely, consider the new and sophisticated materials and technologies for their designs.[65] Thanks to these developments, architects and designers can create any effect in terms of both soft and hard performance criteria (from energy consumption to the visual appearance of a building) without the risk of unforeseen consequences and monotony.

Currently, numerous new materials and technologies are introduced to architecture, which have great potential and applicability for building performance. New approaches are pursued for working with these materials and technologies, along with for understanding and implementing the properties, behaviors, materials and technologies in a combined way to create new responses. This process creates a transformation, and performative buildings become high-tech architectural machines with highly advanced materials and technologies. It might be mentioned several risk within this kind of a PD approach. The first trouble is that although these technologies and materials make designs simpler and more accurate, they shift the responsibility of the designer to the technology itself.[66] There is no need of carefully and tediously

[65] Addington and Schodek 2005, op. cit., Preface.

[66] Ibid.

considering a wall articulation to create a visual effect, since the capability of doing any effect is already given to certain materials and technologies. Additionally, while the as-yet undefined technologies and materials gain control over, the actual behavior and potential of the developments are neglected by framing them from within the design practice. Architects and designers just follow the hegemony of existing practice rather than exploiting unique properties and behaviors that would have been leading to radically different approaches for design.[67]

As a result of the new developments in technology, engineers and architects must be able to deal with a rapid pace of technological change. More rational thinking and scientific analysis are needed for PD in order to provide multidisciplinary solutions for complex design problems. At this point, architects who cannot adopt this way of PD thinking remain incapable within the field. If the architect does not design a performative building with an integrated and controlled way, it might be possible to apply additive performance-related solutions after the design finishes with the help of advanced technologies. Yet, since it is not conceived that how performance would be a part of the building during the design process, architects are under the risk of falling behind other professionals such as consulting companies or mechanical engineers. In this case, buildings are analyzed according to their performance requirements, and then green technologies are applied to them. Under these circumstances, architects cannot find a place for themselves to get involve and have no other option but to trust those professions on highly advanced performance technologies and their implementation. In the end, the building is covered with various supportive technologies through a separate procedure, and building design transforms into a high-tech architectural machine mentioned before.[68]

It is certain that PA has been evolved with developing technologies, which provide novel solutions to the problems coming from performance requirements. Current approaches in PD also focus on the technical solutions, and great efforts are invested in the progress of more efficient technological regulation of environmental exchange

[67] Ibid.

[68] Shi and Yang 2013, op. cit.

between interior and exterior[69] as it is seen in the figure 2.1 These solutions can be exemplified such as façade systems, active or passive systems for energy efficiency, performative material applications and so forth. In this context, technology-dominated solutions serve as a rather recent phenomenon.[70] With the increasing awareness of the role of the architect, technological developments may have a significant role in PA in the event that they are combined with architectural design as performative solutions through the design process in a more integrated and holistic way.

Figure 2.1: The building of the Shearer's Foods, Inc. The main performance success is centered around the machinary systems and advanced technologies of the building.

Source: "New Massillon Production Facility." Web. 10 June 2018. <http://www.schumacherconstruction.com/shearers/shearers_middle.jpg>

2.3.2. Performance with Certificate Systems

Along with the developments of certain technologies and materials, conventional architectural design methodologies fall into the danger of being seen as inefficient systems. In order to promote quantifiable aspects of designs, which focus exclusively on the hardness of building performance, a number of standardization certificate system is introduced to the architectural practice internationally. These certificate programs initially aim at assessing the total building performance, and aiding designers in their

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69 Hensel 2013b, op. cit., p32.

70 Ibid.

decision making process to achieve successful, durable and environmentally friendly buildings.[71] The implementation of performative decisions becomes more applicable since certificate systems establish all the quantifiable performance requirements in order to direct and manage the design process.[72]

Different certification programs are promoted in various countries, and each of them deals with performative issues differently. Some of them focus on performance in order to orient designers while some others can be strictly prescriptive. A number of programs, i.e. Swedish P-mark, Canadian R-2000, Quebec's Novoclimat, US Energy Star, aims at evaluating the performance of only selected aspects, such as energy efficiency and quality of materials and workmanship. The assessments basically conducted with only 'fail' or 'pass' categories of the assessment. Other programs, such as BREEAM in UK, LEEDTM in US, CASBEE in Japan and international GBTool programs evaluate the level of sustainability and the environmental impact of the building.[73] They aim at introducing different methods of assessment for more efficient performance of the building. Their assessment is usually conducted through several categories of performance and building rating systems.

Currently, standards and certification systems that aim at evaluating building performance have become the predominant factors in architectural PD. The major problem in such approaches is that design actors, who adopt these certificate systems as the main PD strategy, could neglect the underlying building type of the design. In order to be compatible with the standards, new greener components, such as more efficient mechanical systems and better wall insulations might be added without considering creative architectural design solutions. The additional systems, in spite of their partial success, leave architectural aspects such as forms, structural systems, aesthetic or cultural performances untouched.[74] It is possible to claim that those standards stand there as a checklist to show how performative a design is from a quantitative perspec-

[71] Horvat, M. And P. Fazio (2005). Comparative Review of Existing Certification Programs and Performance Assessment Tools for Residential Buildings. *Architectural Science Review 48* (1), 69-80.

[72] Hamedani, A. Z. and F. Huber (2012). A Comparative Study of DGNB, LEED and BREEAM Certificate Systems in Urban Sustainability. *The Sustainable City VII.*

[73] Horvat and Fazio 2005, op. cit.

[74] Mehaffy, M. and N. A. Salingaros (2017). Toward Resilient Architectures: Why Green Often Isn't. http://www.metropolismag.com/ideas/sustainability/toward-resilient-architectures-2-why-green-often-isnt/

tive in good purposes. The trouble here is that this checklist does not include most of the soft criteria, and therefore, performance certification systems may cause a separation between architectural design and PD, even though their initial idea serves for a good intention.

The content of performance and energy standards may include water efficiency, indoor environmental quality, materials and all other energy-related issues. The content and scoring of BREEAM certificate is presented in table 2.1 as an example. Although the titles of each category may differ from one system to another, basic principles remain similar and look out for criteria which are just related to the quantitative building performance exclusively. Therefore, an architect who aims at making a PD only by considering this content is under the risk of falling into the trap of a building design that of using repetitive solutions for performance improvement even if designer intends to have a unique and comprehensive perspective. The results of these 'green' designs, which are based upon certain certificates, are standardized performative buildings whose performance values are certified while all architectural meanings stay alienated.

Table 2.1: BREEAM certificate scoring and rating methodology.

BREEAM Scoring		
Issue & Category	**Category Weighting**	**BREEAM Score**
Management	12%	Pass (≥30)
Energy	43%	Good (≥45)
Water	11%	Very Good (≥55)
Materials	8%	Excellent (≥70)
Pollution	6%	Outstanding (≥85)
Waste	3%	
Health & Wellbeing	17%	
Innovation	10%	

The potentials of PA and regulating certificate systems on building performance are numerous. However, focusing on just one side of it might end up with an unachieved design product whose architectural features are immature. The validities of the certificate systems might seem dominant in the field of PA, but if designers and architects continue questioning only the performance-related values of buildings, they would eventually risk the architectural aspects of a project. As a result, disintegration between performance and architecture will widen, which will make people perceive performance just as a label at a point where PA means just an automated process and nothing more.

2.3.3. Performance in Conceptual Design Stage

Technological developments and certificate systems have inevitably redefined the relationship between performance, architecture, and architects in different ways. Their advantages in PA are undeniable, however, they transfer performance side of design to other professionals in general, and shift PD thinking process toward the end of design since these technologies and programs require detailed considerations on building designs, which is not clear in the early stages. As a result, PD approaches are isolated from the early design process, where the most important design decisions are taken.

In order to emphasize a more holistic PD process, the inclusion of performance into the conceptual design stage became a significant approach in this field. It is true that more accurate performance considerations require a strong basis of quantitative criteria, which is mostly simulated during detailed design stages. However, since it is also necessary to consider required performance needs, coming from human needs and local environment, within architectural requirements at the beginning of the design process, the environmental factors can be early integrated into the conceptual design stage of design activity.[75] An integral approach is important since this perspective of combining performance needs with architectural requirements emphasizes an early awareness of the environment.[76]

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[75] Turrin 2013, op. cit., p57.

[76] Ibid.

When design activity is taken into account, conceptual design shows itself as a process which aims at the generation of promising concepts about design requirements, which are going to be further developed and revised in detailed design phases.[77] Since early stages of the design process are highly intuitive and non-structure, they do not show the quantitative aspects of the performance requirements.[78] During conceptual design phases, PD decisions rely mainly on basic knowledge and physical principles,[79] however, early PD solutions are still crucial since such developments are not possible without the creation and selection of basic concepts, which occur in the early design phases.

Early integration of performance has changed the conceptual design process itself. The emphasis is now gathered on performative aspects of design such as structure, acoustics, environment, technology, and so forth. Performative strategies have provided new opportunities for designers to assess performance aspects of their designs, which become more realistic at the end.[80] Some parts of the architectural design process, such as form generation, start to be affected by early integrating performance simulations since it gives an emphasis on the evaluation of different geometrical alternatives during the conceptual design process.[81] PA is broadly understood from a very substantial point of view and building performance becomes a guiding principle of design.[82]

At this point, it becomes essential to indicate that performance issues should not be considered subjectively even if they are taken in conceptual design phases. Architects, who take these decisions intuitively without any specialized knowledge and technique on PD, may lead the result to a quite subjective and very inconsistent place due to the difficulty of deciding whether these concepts correspond a PD or not. It is always possible to rely on the previous knowledge and experience on performance-related decisions, however, this might be ineffective and insufficient in an architec-

[77] Ibid. p61.
[78] Becker 2008, op. cit.
[79] Ibid.
[80] Sariyildiz 2012, op. cit.
[81] Ibid.
[82] Ibid.

ture practice in which more complex design solutions are required in order to fulfill the architectural and performative requirements. Therefore, early consideration of performance-related issues is necessary, but only when architects have the ability and possibility of controlling, simulating, optimizing and evaluating the results of their decisions at early stages, without using the comfort of the accustomed ones. This situation is presented in the figure 2.2. The first performance simulations of a building design are pursued by designers in the early phases in order to find the most optimum building form for the design problem in this example.

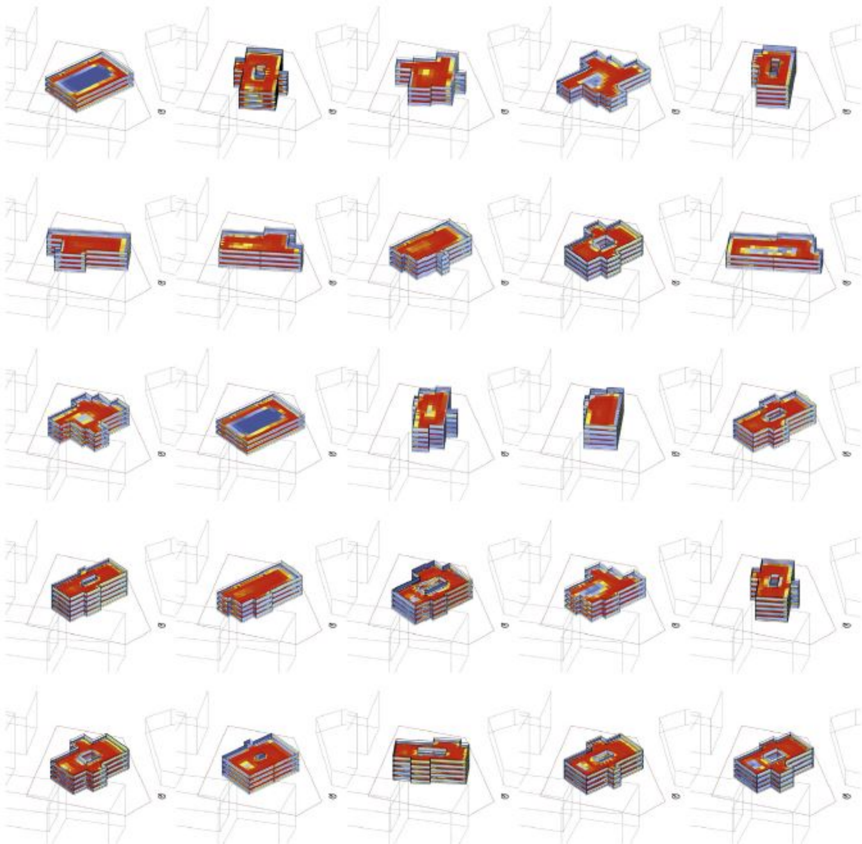

Figure 2.2: The first 25 simulation iterations of an optimization conducted at the early design phases.

Source:Konis, K., A. Gamas, and K. Kensek (2016). Passive performance and building form: An optimization framework for early-stage design support. *Solar Energy 125*, 161-179.

From architects' perspective, it becomes crucial to see the immediate result of their decisions in the conceptual stages, which allows them to understand the effects of changes which they made. The immediacy and clarity of information play a decisive role in early design process.[83] For building energy evaluation, for example, early simulations are important since they reduce the risks of high uncertainty and the excessive amount of calculations in the detailed design phases. It is easier to modify designs in conceptual phases, where information levels are low and design changes occur frequently.[84] Early evaluation and modification provide a holistic approach which includes different disciplines and shows the compulsory and demanding use of optimization and simulation in the early design stages.

PD, undoubtedly, serves an important purpose and all criteria and regulations exist in order to help all professions related to performance. However, performance concept should be embraced holistically and not exclude architectural features of building design. With the help of recently introduced tools to the field of architecture, more integrated performative architectural designs have started to be applied. Optimizing performance becomes an important aspect of the design activity, but it is a necessity to satisfy the design constraints as well. At the end of a holistic design approach, performance will not be the result of a design process, indeed, it will be integrated into the whole process, either as end-validation with embedded technologies or as PD decisions taken in the conceptual design phases.

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[83] Holzer, D., R. Hough, And M. Burry (2007). Parametric Design and Structural Optimisation for Early Design Exploration. *International Journal of Architectural Computing 5* (4), 625-643.

[84] Negendahl, K. And T. R. Nielsen (2015). Building Energy Optimization in The Early Design Stages: A Simplified Method. *Energy and Buildings 105,* 88-99.

CHAPTER 3

COMPUTATIONAL DESIGN FOR PERFORMATIVE ARCHITECTURE

Chapter III discusses the relationship between computational design and PA, and the different ways in which the use of computational methods and tools can support PD process and strategies.

3.1. Performative Design and Computational Design Processes

As Malkawi states, interactive relations between architect and engineers lead buildings to a point in which performance concepts are integrated into building designs.[1] The integration process is mainly encouraged through the advancements in computational technology, which bridge the gap between active design members, including architects and engineers.[2] Recent advances include simulation and construction techniques that aim to fulfill the contemporary complex demands of PA. However, evaluating building performance is an exhaustive process that requires an intensive knowledge. This evaluation process generally includes a number of disciplines that get involved at different parts of the design activity in different time periods.[3] Therefore, multiple assessment strategies integrated into the building phases are required for a comprehensive and long-term performance evaluation approach.[4] The integration of various disciplines into architecture also takes its place in computer science

[1] Kolarevic and Malkawi 2010, op. cit., p247.

[2] Ibid.

[3] Gursel, I., R. Stouffs, and S. Sariyildiz (2007). A Computational Framework for Integration of Performance Information During the Building Lifecycle, pp. 379-385. Faculty of Civil Engineering.

[4] Ibid.

in architecture. The craftsmanship that we have in the past is supported by the new craftsmanship, in which the machine, namely the computers and fabrication tools, takes its place to use knowledge in the architectural design process.[5]

As a result of the current relationship between architecture and computer science, computers started to be used in architectural design for sketching, 2D drafting and later for 3D modeling as a tool. Currently, computational design has reached a point in which designers are able to formulate design needs, architectural requirements and necessities, and then convey them into computers that generate building designs.[6] Eventually, computational design extends beyond the use of computation just for representation and drafting, indeed, it becomes an approach including new computational tools, methods, and techniques for design generation.

Performance has become a substantial concept for computational architectural design approaches. However, its causality and control is not well-determined since PA consists of multi-level interactions which have contingent effects.[7] The complex relationships make it difficult to decide which multiple-ways cause-effect relationship should be considered.[8] Therefore, the complexity of a given problem is reduced and separated into a number of subparts for comprehensibility and ease of use.[9] At this stage, computational design becomes useful to formulate the relationships between the subparts of PD problems and analytically evaluate building performance during the design activity. Computational approaches support design through the generation and transformation of a model in accordance with the environmental performance after evaluation.[10]

The value of parametric design systems which increase computational control over design process is emphasized by İpek Gursel Dino in 2012 as well. In PD, parametric design systems become particularly valuable since they allow the integration of

[5] Sariyildiz 2012, op. cit.

[6] Ibid.

[7] Hensel 2013c, op. cit., p55.

[8] Ibid.

[9] Ibid.

[10] Oxman 2008, op. cit.

performance analysis into design activity.[11] Parametric modeling tools provide the necessary adaptability and responsiveness in order to consider complex and dynamic design criteria, which also support design exploration.[12] Design problems usually require being explored since they are not fully predefined in design process.[13] In this manner, design activity is an iterative process of exploration in which desired requirements and solutions are defined to be evaluated in order to determine the desirability of the combination of these requirements and solutions within the given context.[14] However, using computational tools to encourage design exploration is another challenge for designers since it is not clear the ways in which their designs can be applied to these tools. The best way of determining applicability is to adopt an initial understanding of the problem, and then refine it through an iterative design process.[15] Within PD process, computational tools reveal performance capacities of a building design, including material systems and specific environment relations along with performance requirements, through computational form-generation and analysis methods.[16] With the support of computational design tools, design parameters that have an influence of building performance can be integrated and evaluated throughout the design activity.[17] Computational tools become an inseparable part of the PD, and their use and effectiveness increase day after day in the architectural design process.

[11] Gursel Dino, I. (2012). Creative Design Exploration by Parametric Generative Systems in Architecture. METU Journal of the Faculty of Architecture.

[12] Ibid.

[13] Soebarto and Williamson 2001, op. cit.

[14] Kalay 1999, op. cit.

[15] Ibid.

[16] Hensel explains PD approach as a highly integrated process, which has enhanced context-sensitivity. He emphasizes this approach, entitled 'Morpho-Ecologies', and states that computational methods are as important as physical analysis. See: Hensel 2013b, op. cit., p55.

[17] Oxman 2008, op. cit.

3.2. Transition from Analog to Digital Performative Design Strategies

PD is traditionally based on design synthesis that is regarded as a consecutive process of generating and testing.[18] Analytical feedbacks and visualization techniques within traditional methods provide a performance evaluation, and all modifications and changes are conducted through human-based control in order to improve building performance.[19] However, performance factors taken into account in conventional PDs are limited due to the required human power. In PD, by contrast, analytical techniques directly contribute to the digital model and modifications are done immediately according to the desired physical and environmental goals.[20]

Recent developments in computational design tools provide a new perspective and redefine the relationship between performance, including both hard and soft performance criteria[21], and building design. New PD approaches have adopted by architects and designers, and these approaches provide a perspective that does not exclude architectural concerns, such as architectural form, program, spatial qualities, and so forth while looking at building performance. Potential innovative solutions for environments are beginning to emerge in theory and technology of digital design that supports PD on the basis of sustainability problems in the field of architecture.[22] Computational tools and new design strategies aim to shorten the distance between performance aspects of architecture, and provide an opportunity of controlling advanced performance requirements from the perspective of architects through the design process in a more integrated way.

[18] Oxman, R. (2009). Performative design: A performance-based model of digital architectural design. *Environment and Planning B: Planning and Design 36*(6), 1026-1037.

[19] Ibid.

[20] Ibid.

[21] See: In the previous chapter, hard and soft performance factors and their determination is comprehensively explained. See: 2.2. Determination of Building Performance

[22] Oxman 2008, op. cit.

3.2.1. Traditional Performative Design

Traditionally, design synthesis process in design generation is completed by an analytical performance evaluation. The generation and evaluation processes are complementary as two different parts of the design activity. Building performance evaluation is only possible after model generation is completed. Although it is possible to move backward and forward sequentially during design activity, evaluation is barely a part of the generation process in an integrated way. Conventional PD strategies do not take specific performance requirements as a basis to direct generation processes. In this sense, the notion of performance is not continuous throughout the design, which is the core of the current PD approach. Human designers often need to interfere as mediators between evaluation and generation processes[23] in order to provide the required continuity in traditional PA strategies.

Nevertheless, when human interaction is the link between generation and evaluation, it is only possible to explore only a small number of alternatives, and therefore, a relatively narrow range of possibilities is on focus during design process.[24] Since such alternatives are only a small subset of all possible design solutions, traditional processes only include a limited selection of performance criteria,[25] which do not provide a total performance evaluation. Furthermore, in traditional PD strategies, advanced performance assessments are generally not made in the initial design phase, where a broad range of possible optimal solutions may exist. Since performance is not a solid factor during the conceptual design phase, the number of alternatives analyzed through the whole design process decreases significantly.

It is already accepted that PA is a result of a multi-disciplinary design process. The main advantage in encouraging such a multi-disciplinary architectural design approach is that building performance is evaluated not only by the performance criteria of individual disciplines but also by the complex interactions that take place in between them.[26] At this point, the conventional relationship between the architect and

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[23] Sasaki, M., A. Isozaki, and T. Itoo (2007). *Morphogenesis of Flux Structure.* AA Publications.

[24] Turrin 2013, op. cit., p62.

[25] Ibid. p64.

[26] Martins, J. R. R. A. and A. B. Lambe (2013). Multidisciplinary Design Optimization: A Survey of Archi-

engineers must be also questioned since each of them serves within different disciplines toward a common target. Engineers are used to processes in which they take a tame problem, convert it to a well-formed problem and then solve it through a well-defined way. All the necessary information becomes available to the problem solver in such problems.[27][28] In architecture, on the other hand, the design activity is primarily considered as a creative act, and architectural design is defined as an ill-defined activity, especially at the conceptual phases. Design problems are called as ill-defined, ill-structured, or 'wicked' problems since they are not susceptible to exhaustive analysis and can never be a guarantee that 'correct' solutions can be found for them.[29] In traditional strategies, due to the differences between the accepted design methods by each profession, creating an environment in which engineers and architects work together at the same time is challenging.[30][31][32] However, it is obvious that PA requires the coordination between designers and multiple experts through the design activity.[33] The need for this coordination is also valid for the tools that lack the integration for different performance simulations used by a number of different professions.[34] Multiple interfaces that are required for multi-disciplinary design problems and limited data exchanges through performance-related tools constitute the main issues in conventional PD strategies.[35] When different disciplines are connected only by human interaction without a common working medium, the design process is sharply divided

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tectures. AIAA Journal 51 (9), 2049-2075.

[27] Cross, N. (1993, Jun). Science and Design Methodology: A review. *Research in Engineering Design 5* (2), 63-69.

[28] Cross, N. (2010). *Designerly Ways of Knowing.* Springer London Ltd.

[29] Ibid.

[30] Shen, W., Q. Hao, H. Mak, J. Neelamkavil, H. Xie, J. Dickinson, R. Thomas, A. Pardasani, and H. Xue (2010). Systems Integration and Collaboration in Architecture, Engineering, Construction, and Facilities Management: A Review. *Advanced Engineering Informatics 24* (2), 196 - 207.

[31] Kamara, J., G. Augenbroe, C. Anumba, and P. Carrillo (2002). Knowledge Management in the Architecture, Engineering and Construction Industry. *Construction Innovation 2* (1), 53-67.

[32] Charles, P. P. And C. R. Thomas (2009). Four Approaches to Teaching with Building Performance Simulation Tools in Undergraduate Architecture and Engineering Education. *Journal of Building Performance Simulation 2* (2), 95-114.

[33] Gerber, D. J. and S.-H. E. Lin (2013). Designing in Complexity: Simulation, Integration, And Multidisciplinary Design Optimization for Architecture. *Simulation 90*(8), 936-959.

[34] Malkawi, A. (2004). Developments in Environmental Performance Simulation. *Automation in Construction 13*(4), 437-445.

[35] Holzer, D., Y. Tengono, and S. Downing (2007). Developing A Framework for Linking Design Intelligence from Multiple Professions in the AEC Industry. *Computer-Aided Architectural Design Futures (CAADFutures) 2007* , 303-316.

into phases, in which one discipline dominates and the other one stands clear of the process. In the end, the lack of proper coordination and communication within design activity creates a discontinuity of design, which may diminish the consideration of performance criteria during building design.

3.2.2. Integrated Performative Design

Today, PA is experiencing a paradigm shift, which provides a focus on architectural design requirements and building's quantifiable and physical performances along with formal and aesthetical aspects.[36] The balance between traditional concerns and new performative approaches is crucial to suggest better design solutions, especially for structural and environmental performances. The complexity of the building performance concepts challenges the existing knowledge on architectural design. Therefore, supporting this paradigm shift with a set of specific techniques becomes essential as well, including new knowledge on different performance criteria,[37] such as energy efficiency, solar, thermal, comfort, acoustics, lighting, wind and air, and so forth. As a result, performance becomes a continuous and integral part of design and engineering processes.[38]

In the current state of performative design, synthesis becomes a part of the generative process, which is directly affected by analytic procedures.[39] In order to meet evaluative criteria, optimized solutions are generated to reach desired performance levels through integrated PD strategies.[40] The multi-disciplinary nature of PD provides new performative models, which are highly discipline-specific and task-specific, including both formal generations and performance evaluation concurrently.[41] However, although a wide range of computational tools, which are capable of analyzing and evaluating physical and environmental performance, is available for architects and de-

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[36] Shi 2010, op. cit. p517.

[37] Ibid.

[38] Sariyildiz 2012, op. cit.

[39] Oxman 2009, op. cit. p1027.

[40] Ibid.

[41] Ibid.

signers, these tools do not provide an integrated generation capability. New technologies are still using the traditional model of performance evaluation, which requires a human interaction as an intermediary.[42] In contrast, integrated design approach suggests a new model in which information can generate and modify a geometric model instead of testing and analyzing a given design to meet the performance goals.[43]

An integrated performative design model offers a new understanding in which performance is considered as a force of shaping design rather than merely acting as the evaluation criteria. In this sense, it is different from conventional CAD models, that are not programmed for integrating specific performance requirements into design generation. Indeed, design responsiveness towards the data input of performance simulations becomes the focal point of PD,[44] which designers cannot find in the conventional CAD models. Performance simulations and design generation processes are tried to be synchronized to provide generative responses in design activity.

Consequently, the conventional interaction between the architect and engineer has changed to support integrated multi-disciplinary design synthesis and analysis.[45] In integrated PD, sequential analysis and evaluation process gives its place to a cyclic one, which is essential for the necessary iterative and dynamic coordination between different disciplines. In order to support the integrated design process, two possible performative models can be suggested. The first one is the model in which performance factors are encoded in the parametric model, which generates alternatives that fulfill the given performance criteria.[46] In such a parametric PD approach, the desired performance can be obtained through a digital mechanism that combines generation and modification of designs. Most of the international research aims at succeeding a higher level of integration between generation and evaluation, which becomes achievable through the developments on parametric design.[47] The second model is the one that is coupled with external performance simulation tools in search of the optimal

[42] Sasaki, Isozaki, and Itoo 2007, op. cit.
[43] Oxman 2009, op. cit. p1027.
[44] Ibid.
[45] Dino 2012, op. cit., p213.
[46] Ibid.
[47] Kolarevic and Malkawi 2010, op. cit.

performance.[48] Since the limit of performative knowledge in parametric modeling is not comprehensive in some cases, the latter model is more suitable for combining complex performance issues within a cycle of generating, evaluating and modifying.[49]

3.3. Digital Models and Computational Design Tools

The developments of computational design approaches and techniques leads to essential changes and modifications in traditional models as explained in previous sections. In any modeling process, the reference system and the description of the appropriate parameters which are in relation with the context become significant to construct the model.[50] Models constituting through observing a process or a thing aim to find a solution or an answer.[51] Within these models, the complex relationship between users, tools and design media is considered in order to relate the changes to the overall design process along with the design concepts.[52] These concepts include PD, tectonics, geometry and material expression, which criticize the formally developed complexity of the previous models.[53] The recent models combine performance with design representation, generation and evaluation. Interaction between different design factors plays a significant role in these new digital models. The current digital models are identified according to their paradigmatic classes by Oxman (2006) as:

- CAD models
- Formation models
- Generative models
- Performance models
- Compound models[54]

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[48] Dino 2012, op. cit.

[49] Ibid.

[50] Sorguç, A. G. and S. A. Seluk (2013, May). Computational Models in Architecture: Understanding Multi-Dimensionality and Mapping. *Nexus Network Journal 15* (2), 349-362.

[51] Ibid.

[52] Oxman, R. (2006). Theory and Design in the First Digital Age. *Design Studies 27* (3), 229-265.

[53] Ibid.

[54] Ibid.

Within these classes, integrated compound models provide the most significant opportunities for digital design media. The models are based on integrated design process that combine formation, generation, evaluation and performance. Compound models are considered as the ultimate future objective of integrated design media, which aim to enable the interaction with any design module, data and information flow in multiple directions.[55] To this end, the compound models provide a wider perspective to the design team coming from different disciplines in an integrated manner.

Digital design models in PD lead architects to expect tools that connect design factors and building performance. In this manner, new computational design tools are introduced with a focus on improving design process efficiency with convenient information exchange between design tools and performance analysis tools. These tools allow users to control building geometry, space types, materials, daylight, thermal zones and so forth in 3D models which architects are already familiar with. In most cases, the selection of a computational program depends on its application, number of times it will be used, user experience, and hardware available to run it.[56] The ability of the tool is the most significant factor in this selection since the focus of each project differs and each program deals with a different application.

As integrated compound models, BIM-based tools have shown enormous developments, and provide effective and efficient design solutions and process in PA. Linking BIM and building performance becomes a developing area in research and practice. A number of simulation tools were modified to use BIM for data exchange capabilities, which contain building geometry information and other information of internal loads, occupancy, zone assignments, system configuration, and utilization schedules.[57] Since performative design assessment requires digital models that support the calculations and the needed parameters during design process,[58] the quality and type of data needed in different stages of building design process must be determined at the

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[55] Ibid.

[56] Harish, V. and A. Kumar (2016). A Review on Modeling and Simulation of Building Energy Systems. *Renewable and Sustainable Energy Reviews 56,* 1272-1292.

[57] Kim, J. B., W. Jeong, M. J. Clayton, J. S. Haberl, and W. Yan (2015). Developing a Physical BIM Library for Building Thermal Energy Simulation. *Automation in Construction 50*, 16-28.

[58] Hakkinen, T. and K. Belloni (2011). Barriers and Drivers for Sustainable Building. *Building Research & Information 39* (3), 239-255.

beginning. Data information needs to be described in order to provide the necessary information through open interfaces in different design phases and this information is emphasized for allowing architect to use it during the design and maintenance of buildings within integrated compound models.[59]

3.3.1. Design Simulation Process for Performative Design

The most accepted practice towards building performance is performance evaluation by simulation in building design.[60] Although the origin of building performance goes back to the early studies of energy and mass flow processes in the built environment,[61] its scope has been extended to the other fields. Currently, 'building simulation' covers a wide spectrum as it includes energy and mass flow, structural durability, aging, and even construction site simulation.[62] The simulation process aims at generating observable output states for analysis, and their mapping to suitable quantifications of performance indicators.[63] In this sense, building simulation is used as a tool which quantifies performance criteria that inform decisions.[64] Simulation process allows designers to have a better understanding of the consequences of design decisions, which increases the effectiveness of the design process as a whole. In this respect, design issues relating to continuous performance assessment within computational considerations during the overall design process revealed performance simulation tools for multi-disciplinary and multi-phase performance assessment functions.[65] Such performance-related considerations hamper the utilization of these performance simulation tools with design integration and communication.[66]

In the design process, the user needs and performance requirements constitute the

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[59] Ibid.

[60] Soebarto and Williamson 2001, op. cit.

[61] Augenbroe, G. and A. Malkawi (2004). *Advanced Building Simulation.* Spon Press. p4.

[62] Ibid.

[63] Ibid. p5.

[64] Hensen, J. L. M. and R. Lamberts (2011). *Building Performance Simulation for Design and Operation.* Spon Press.

[65] Gursel, I. (2010). *CLIP: Computational Support for Lifecycle Integral Building Performance Assessment.* TU Delft. p32.

[66] Ibid.

demand side of the building while the supply side consists of design solutions and the final constructed facility.[67] In order to fulfill the demands, design tools are required to provide solutions. It is important to design and evaluate (or simulate) the behavior or response of the building, and predict the anticipated performance criteria.[68] performance simulation capability in computational design approaches extends and includes manufacturing constraints, assembly logics and material characteristics in the definition of material and construction systems.[69] Furthermore, the versatile nature of simulation tools, which includes a wide range of aspects such as acoustics, structure, light and so forth, provides integrating feedback loops in order to evaluate building's behavior in a simulated environment, and thus becomes the generative drivers within the design process.[70]

The building's behavior under a certain usage scenario is modeled and observed through building simulation.[71] A piece of reality is reflected into a model, and a variety of experiments is studied in an experiment box as it can be presented in 3.1.[72] The simulation process generates a number of states to be observed in order to provide relevant information about the performance behavior. It is important to state that the experiment should reveal meaningful information according to the measure that comes from performance criterion and its quantification. Therefore, a deep understanding of the physical domain, the performance measure, and the experiment box is needed in order to study the experiment systematically.

Computational design approaches, when applied on PA, typically converge to simulation tools; however, BPS is not limited by the scope of these tools. Indeed, simulation covers a process that starts much earlier and extends towards the later design phases. This process basically consists of three main steps, which are:

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67 Becker 2008, op. cit.

68 Ibid.

69 Hensel and Menges 2008, op. cit. p56.

70 Ibid.

71 Hensen and Lamberts 2011, op. cit., p16.

72 Experiments refer to simulation runs while experiment box is used for the simulation tool according to Augenbroe. See: Ibid.

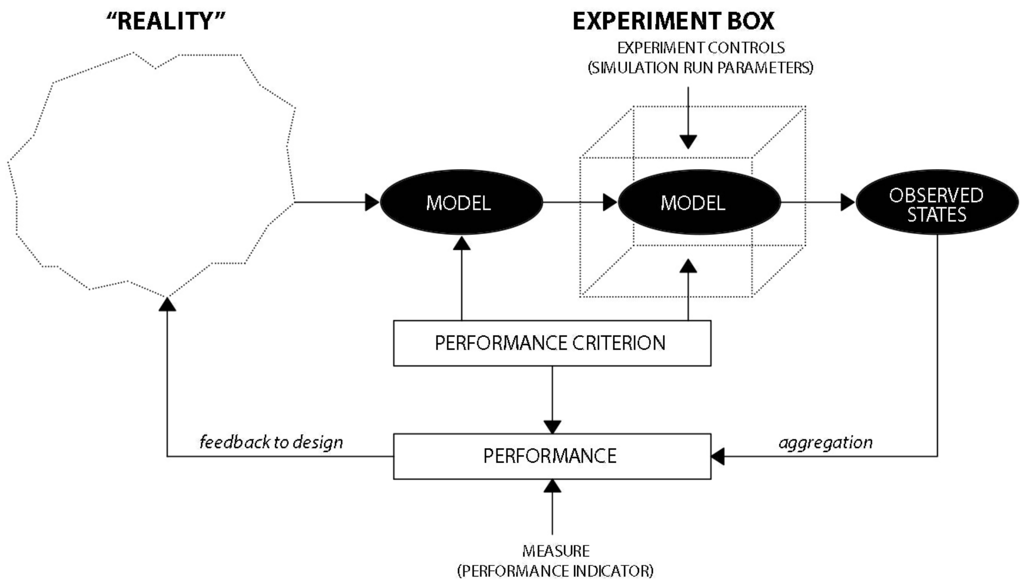

Figure 3.1: The diagram showing the required virtual experiment for performance testing.
Source: Hensen, J. L. M. and R. Lamberts (2011). *Building Performance Simulation for Design and Operation.* Spon Press. p17.

1. Determining the performance criteria.
2. Agreement about ways to measure, which are used for quantifying the required and fulfilled performance levels.
3. Making rational design decisions among the observed states.[73]

In order to perform a quick performance evaluation, design changes; which present the increasing performance improvement of a proposed building, are usually measured against single criteria such as reduced energy consumption and/or improved thermal comfort.[74] However, design decisions very seldom deal with a single performance criterion; indeed, satisfying many performance requirements at the same

[73] Ibid.

[74] Daniel, L., T. Williamson, and V. Soebarto (2017). Comfort-Based Performance Assessment Methodology for Low Energy Residential Buildings in Australia. *Building and Environment 111*, 169-179.

time is the inevitable consequence of PD. Therefore, the third step needs a significant attention due to the nature of multi-criteria decision making in the design process, which defines the demand-supply relation. At this point, an effective methodology is required in order to automate the design process and quickly reach an optimal design based on multiple performance criteria.[75][76] Optimization techniques come forward as an effective means to search for optimal design alternative(s) when multiple, conflicting performance criteria need to be satisfied.[77] A typical example is cost-effectiveness versus high-performance. In this case, a tradeoff between design objectives is to give way to a set of satisfactory solutions that maximizes the satisfaction of all formulated objectives. Since the focus is still on the process rather than the design result, performance is a continuous design parameter as a driving force.

Recently, the emphasis is not only on the performance simulation but also on the integration between the design and simulation processes. Computational design approaches support the analytical evaluation of environmental performance based upon simulating physical conditions, which also provides transformation and generation of a model.[78] PD has the potential of providing integrated evaluative simulation processes since it encourages design generation and design modification according to the performance data through computational tools, which is defined as the experiment box before. Furthermore, the term implies a method in which performance itself becomes the determinative factor.[79] PD emphasizes the performance of the design artifact, and becomes the ability to directly manipulate the design properties of a model according to performance analyses.[80] In this sense, it is possible to use performance simulations in order to directly inform, generate and modify the design model instead of the sequential analysis and modification method.

The combination of building designs and BPS has been used as a technique in design

[75] Lam, K. P. (2013). Sustainability Performance Simulation Tools Building Design Simulation Tools for Building Design Building Design. *Sustainable Built Environments*, 526-594.

[76] Shi 2010, op. cit., p516.

[77] Ibid.

[78] Oxman 2008, op. cit.

[79] Ibid.

[80] Ibid.

practice and research. This approach is called by many names, such as performance-based design (PBD), design by simulation, multi-disciplinary design optimization (MDO), generative design system (GDS), or goal-oriented system (GOS).[81] When PD is taken into account in the manner of performance simulation, its description is clarified among architects by the term "generative" or "computational", which means a computational/parametric 3D modeling environment.[82]

In this context, architectural design practices aim at integrating new demands in the design activity for minimizing environmental impacts, such as energy efficiency, waste, and resource management, and improving indoor conditions by means of thermal and optical comfort, air quality and so forth.[83] In line with this, computational tools have emerged in PA, which provide a holistic design approach combining different factors and emphasizing the interdisciplinarity in design teams from the architects' point of view.[84]

3.4. Design Synthesis in Performative Architecture

As George Broadbent defines the design process in 1969, it covers the entire sequence of design activities, which starts from the beginning of a project till its completion, that includes individual loops of briefing, analysis, and synthesis, as evaluation and decision sequences.[85] When performance is considered as an acting parameter for architectural design, analysis and evaluation processes become essential, and although all the technological developments in computer analysis have significant effects on PA, the developments of tools that provide design synthesis rather than only analysis manage to bridge the gap between different study fields, which are essential in per-

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[81] Touloupaki, E. and T. Theodosiou (2017, May). Performance Simulation Integrated in Parametric 3D Modeling as A Method for Early Stage Design Optimization - A Review. *Energies 10*(5), 6-37.

[82] Ibid.

[83] Ghaffarianhoseini, A., N. D. Dahlan, U. Berardi, A. Ghaffarianhoseini, N. Makaremi, and M. Ghaffarianhoseini (2013). Sustainable Energy Performances of Green Buildings: A Review of Current Theories, Implementations and Challenges. *Renewable and Sustainable Energy Reviews 25*, 117.

[84] Touloupaki and Theodosiou 2017, op. cit.

[85] Turrin 2013, op. cit., p60.

formative building designs.[86] Computational processes, in analytical and generative modes, have a potential for a high level of design synthesis. Research on computational design synthesis have gained acceleration for almost half a century.[87] Computational synthesis differs from traditional methods since it aims at capturing, emulating and utilizing design solutions more broadly. The complexity of PDs that can be synthesized has increased through recent advances in computation, and the power of computers provides a significant efficiency in design generation processes.[88] By contrast with analysis process that uses computational power to find significant performance parameters, computational design synthesis provides a model where the simplicity or complexity of the solutions is still left to the designer's tolerance.[89] In other words, the computational design synthesis still allows interpretations and evaluations made by human designers.[90]

The model of computational design synthesis can be divided into four major activities, which are; representation, generation, evaluation and guidance.[91] In some respect, computational synthesis activities are similar to the design activities that humans follow in their design process. *Representation* corresponds the mental model of the object, *generation* stands for the creation of the parts and the whole, *evaluation* is the analysis of the ways in which the design meets the goals and constraints, and *guidance* covers the feedback on improvements to the design for the next iteration.[92]

In design synthesis, design space is in an ordered structure in which each instance is a solution to a common design problem.[93] The solutions may be pursued through fully realized designs or more abstract visualizations. The main shift in computa-

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[86] Kolarevic 2010, op. cit. p249.

[87] Cagan, J., M. I. Campbell, S. Finger, and T. Tomiyama (2005). A Framework for Computational Design Synthesis: Model and Applications. *Journal of Computing and Information Science in Engineering 5* (3), 171.

[88] Ibid.

[89] Ibid.

[90] Wyatt, D. F., D. C. Wynn, J. P. Jarrett, and P. J. Clarkson (2011). Supporting Product Architecture Design Using Computational Design Synthesis with Network Structure Constraints. *Research in Engineering Design 23* (1), 1752.

[91] Cagan, Campbell, Finger, and Tomiyama 2005, op. cit.

[92] Ibid.

[93] Campbell, M. I., J. Cagan, and K. Kotovsky (2003). The A-Design Approach to Managing Automated Design Synthesis. *Research in Engineering Design 14* (1), 12-24.

tional design synthesis occurred in the representations formulated by the developer of the computational design method. Within visualized spaces, solutions that have similar configurations are organized proximately.[94] Therefore, in order to examine the space of solutions, little transformations are made to designs to arrive circumjacent solutions. By conducting numerous little modifications in design space, a wide range of solutions can be visited. In this sense, the computational representations are used for capturing the forms or attributes of the design space.[95] In general, a number of representational structures are embedded into a single representation. The representation structures that form the design space vary from underlying ordering media such as grids or zones to functional orders and relations that are often present implicitly in design representations.[96] The space does not have a limit and includes past, present, and future design states for creating, designing, or inventing in design problems.[97] In computational systems, the challenge is to effectively find the set of solution that best meets the demands of the design problem.[98]

PDs, therefore, can be represented throughtout the design synthesis process computationally, which defines the design space for different purposes. The representations provide a medium that enables a dialog between designers and other individuals, and integrate different data coming from external disciplines. The evaluation process is pursued within the same medium, and all the changes is conducted through computational representation tools. In this manner, the next sections will elaborate the computational representations used in PD process on the purpose of communication, analysis, modification and interoperability.

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[94] Cagan, Campbell, Finger, and Tomiyama 2005, op. cit.

[95] Ibid.

[96] Oxman, R. (1997). Design by Re-Representation: A Model of Visual Reasoning in Design. *Design Studies 18* (4), 329-347.

[97] Cagan, Campbell, Finger, and Tomiyama 2005, op. cit., p172.

[98] Ibid.

3.4.1. Representation for Communication

In order to propose a systematic assessment of building performance, a flexible and seamless communication that connects different domains and phases is required.[99] In architecture, communication is provided in visual mediums from the beginning to the end, including all visual representation techniques. The basis of visual and mental connection between designers can be considered as the design sketch since it brings a solid graphical response.[100] Schon suggests that the designer's concern is the graphical conversation with the design,[101] and all the visual representations starting from sketching allow designers to have conversation with design ideas in this manner. Factors affecting the design development can be represented as simple sketches in the early phases as it can be seen in figure 3.2, which direct the design process in the later phases.

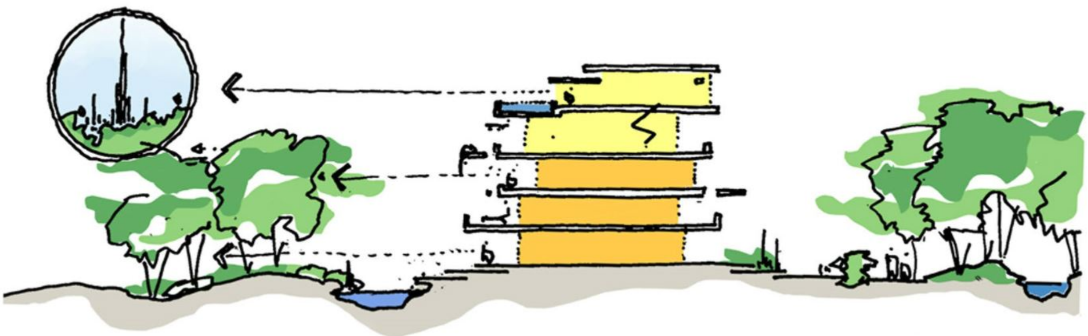

Figure 3.2: A design sketch that shows the performance aspects of the project Ashjar at Al Barari by 10 DESIGN, Dubai, United Arab Emirates.
Source: "Ashjar at Al Barari Dubai, United Arab Emirates." Web. 09 July 2018. <https://www.behance.net/gallery/21929163/ASHJAR-AT-AL-BARARI-DUBAI>

With the recent developments in computer technologies, design representations that architects and designers used for visualizing and communicating are in change as

[99] Gursel, Stouffs, and Sariyildiz 2007, op. cit., p379.

[100] Oxman 1997, op.cit.

[101] Schon, D. (1992). Designing as Reflective Conversation with the Materials of A Design Situation. *Knowledge-Based Systems 5* (1), 314.

well.[102] In the new computer-supported design activities, the concern is to ensure that the design process and collaborative design activity are not disrupted by computers.[103] In this manner, computer tools that aim at creating a continuous and seamless communication in order to strengthen the collaborative nature of design activity have to be guided by a better understanding on the ways in which the collaborators work and what obstacles they encounter in their work.[104]

It is important to emphasize that in contrast with the general opinion, representation for communication in computer medium have a wide range of techniques and alternatives. These representations should not be limited by communication through only realistic renderings in this sense since rendering tools tend to oversimplify the designs in general. However, the design morphology or the visual effects of designs are not the only aspects that should be visualized in the design process.[105] Thus, representations for communication in PA must include various sketches, diagrams, charts and orthographical drawings that constitutes several relationships, such as architect-architect, architect-client, architect-other disciplines and so forth.

3.4.2. Representation for Analysis

One of the most outstanding aspects of PA is its analysis-based aprpoach. It requires a fast and precise analysis of performance issues during the design process in order to go beyond a design based on just concept and estimation, which might not provide PD solutions.[106] After the architectural model creation in the design process, a simulation program is chosen in order to analyze one or several performance factors that the designer would like to consider. The analysis and assessment processes come later when the simulation data becomes readable and understandable by architects.

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[102] Scrivener, S. A. R. (2000). *Collaborative Design Proceedings of Codesigning 2000.* Springer.

[103] Gabriel, G. C. and M. L. Maher (2002). Coding and Modeling Communication in Architectural Collaborative Design. *Automation in Construction 11* (2), 199-211. p200.

[104] Ibid.

[105] Blaise, J. Y., F. D. Domenico, L. D. Luca, and I. Dudek (2004). Architectural Modeling and Information Interfacing: Learning from Three Case Studies. *26th International Conference on Information Technology Interfaces, 2004.*, 341-346 Vol.1.

[106] Shi 2010, op. cit.

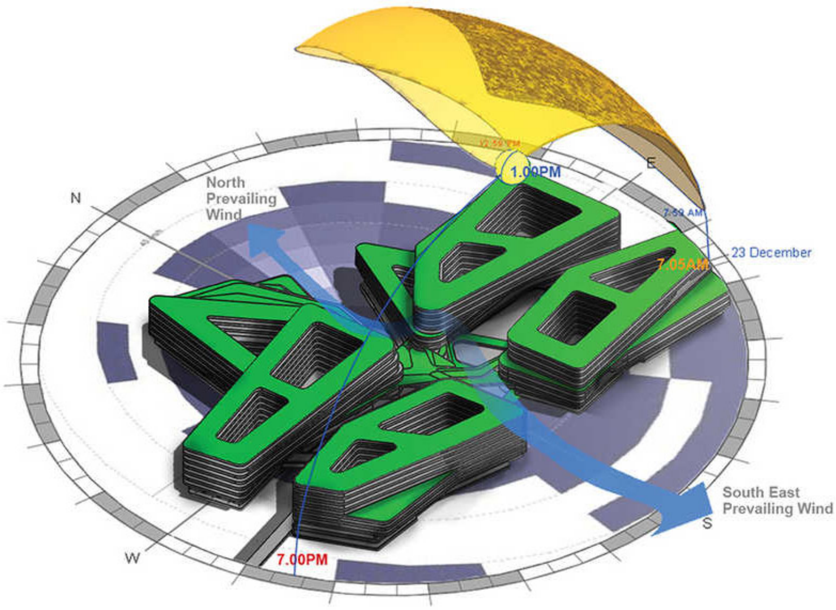

Figure 3.3: A representation of building form analysis that shows the effects of the performative factors for the project of Singapore University of Technology and Design designed by UNStudio, Singapore.
Source: "Organisation diagram." Web. 12 July 2018.
<https://www.dezeen.com/2015/06/03/unstudio-singapore-university-campus-buildings-dp-architects-sutd/>

Analysis and evaluation process, as a part of the design synthesis, reveals the worth and potential success of the design. Although the designer might benefit from the generation of design concepts, a level of design analysis must be included in the automated synthesis system that responses the concept generation.[107] The analysis and evaluation may be in the form of analytical expression for some design problems, however, simulation and evaluation is often included in most design problems.[108] Yet, combining simulation tools within computational synthesis has its own difficulties since simulation data is complicated due to its content, which contains a number of

[107] Cagan, Campbell, Finger, and Tomiyama 2005, op. cit.
[108] Ibid.

design measures that require balancing of multiple objectives.[109]

Computational PDs provide a complex process to architects, who consider multiple performance dimensions interrelated to each other, and cannot be considered in isolation within the process. For the analysis process within PD synthesis system, information within architectural models is considered as inputs while the results and deliverables become outputs.[110] At this point, computational tools aim at creating representations for visualizing information that is embedded into the architecture model and make them available for architects. Visual representations provide a number of perspectives that guide the collected data and analysis of information in order to make architectural choices according to the design goals (See: 3.3).[111] Analyzed data resulting from design goals provide consistent representations of architectural model within the same medium.

3.4.3. Representation for Modification

Computational representation of an architectural idea aims at identifying and formalizing a level of knowledge that is essential for transforming a model according to interactions of other representations and graphical medium.[112] In order to transform a specific knowledge into a representation, making unique modifications and changes in representations is necessary. However, this type of representations that modifies and changes the design model is not accustomed representation techniques such as drawings, since they are procedural and do not allow to make flexible manipulations unless they transformed into explicit forms of other representation. It is emphasized by Oxman in 1997 as following:

> In the development of explicit representations of form, humans are able to transform implicit knowledge to explicit representational structure. This

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[109] Ibid.

[110] Tang, A., J. Han, and P. Chen (2004). A Comparative Analysis of Architecture Frameworks. *11th Asia-Pacific Software Engineering Conference.*

[111] Ibid.

[112] Oxman 1997, op.cit.

appears to enable novelty through modification and change which transcend, contradict, or depart from the generic representation.[113]

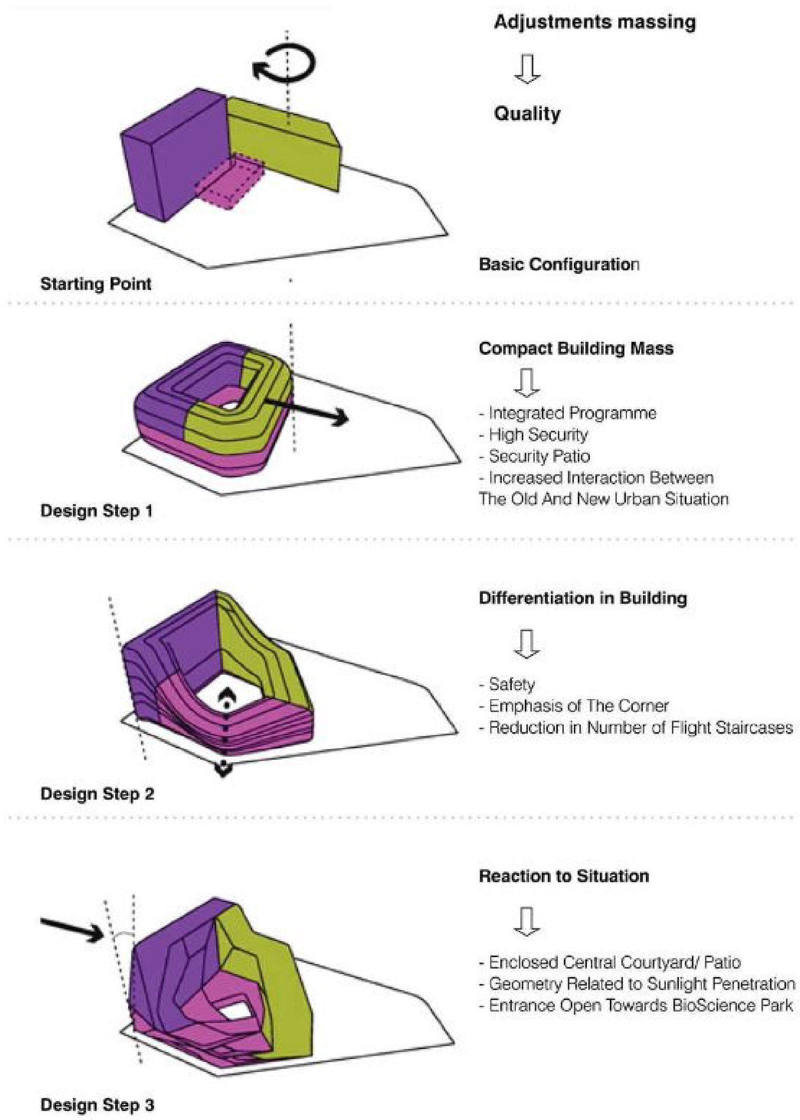

Figure 3.4: A visual representational model that shows the design modification process of the project Mirai House by UNStudio in Leiden, The Netherlands. Source: "Mirai House by UNStudio in Leiden, The Netherlands." Web. 09 July 2018. <https://www.unstudio.com/en/page/3386/mirai-house>

The transformation of implicit knowledge to a well-formed representational structure provides modification and change of designs within, or through, the representations.

[113] Ibid.

In each design activity, there must be various representations in order to encourage the manipulation of designs. For PA, a solid knowledge about the design requirements and their architectural correspondence is required in order to manipulate multiple representation and models produced through design activity (See:3.4). In computational PD, the modification process through representations follows a re-use activity of the previously existing representational content of a design solution.[114] The modification process occurs in the same medium in which all the knowledge, architectural model and its representations exist. In this sense, the design process turns into an activity which aims at formalizing the necessary knowledge and reasoning in representational model.

3.4.4. Representation for Interoperability

The architects, computational modelers, and engineers are working in close collaboration in PD process in order to create the most accurate and complex buildings. Therefore, it requires a network of interdisciplinary interrelations and focuses on the integral design due to the simultaneous integration of various and interdisciplinary aspects.[115] In order to solve a design problem, performance factors are simplified to simpler models in order to analyze and determine design purposes. In simple models, it would be the most ideal case to construct representations that can be examined through different disciplines within the same problem space since diverse approaches are needed in PA.[116]

The traditional building performance analysis process is conducted by an analysis expert who collects building information from 2D drawings and photos, and then creates an analysis model within a selected analysis program. However, due to arbitrary decisions and assumptions during the definition of the building's simulation, the results might not be reliable and reproducible.[117] Moreover, this process tends to

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[114] Ibid.

[115] Sariyildiz 2012, op. cit.

[116] Cagan, Campbell, Finger, and Tomiyama 2005, op. cit.

[117] Moon, H. J., M. S. Choi, S. K. Kim, and S. H. Ryu (2011). Case Studies for The Evaluation of Interoperability Between a BIM Based Architectural Model and Building Performance Analysis Programs. In *Building*

exclude architects from the design process since they do not have the ability to control performance simulations and the data commentated by the analysis expert.

In this respect, the main problem in performative architectural design is the lack of the ability to pass data between different mediums and applications, which is called as interoperability. Interoperability aims at integrating data in order to eliminate the manually copy data which is already existed in another medium.[118] Since the manual reproduction of partial design data does not support iteration that is required for finding solutions to complex problems during a design process, and leads to some level of inconsistency coming from errors occurred in manual copying, researchers focus on the ways in which different data and disciplines can be integrated within the same medium.[119]

The solution that is used as a common method is tool-to-tool exchange. Nevertheless, tool-to-tool exchanges are limited since each tool has its own visualization and review technique.[120] The exported data is available to the extent permitted by the exporting tool. Therefore, designers cannot implement design changes and modify the model since the information flows in one direction and does not allow to reciprocate between design alternatives.[121] Therefore, the need of interoperability in PD process is managed through multiple representations of a project within the model or tool levels as it is seen in the figure 3.5. A seamless exchange of data should be embraced and duplicate data generation need to be eliminated in order to allow bidirectional update of information coming from the architectural model.[122] The interoperability problem is not solved only by translating an architectural model to another format, indeed, it can be settled by modifying and extending the model information in order to represent the different uses of the design.

Simulation 2011: Sydney, Australia. November 14-16 2011. Proceedings of the 12th Conference of the International Building Performance Simulation Association. IBPSA Australasia and AIRAH.

[118] Eastman, C., P. Teicholz, R. Sacks, and K. Liston (2011). *BIM Handbook A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers, and Contractors.* Wiley. p100-105.

[119] Ibid.

[120] Ibid.

[121] Ibid.

[122] Moon, Choi, Kim, and Ryu 2011, op. cit.

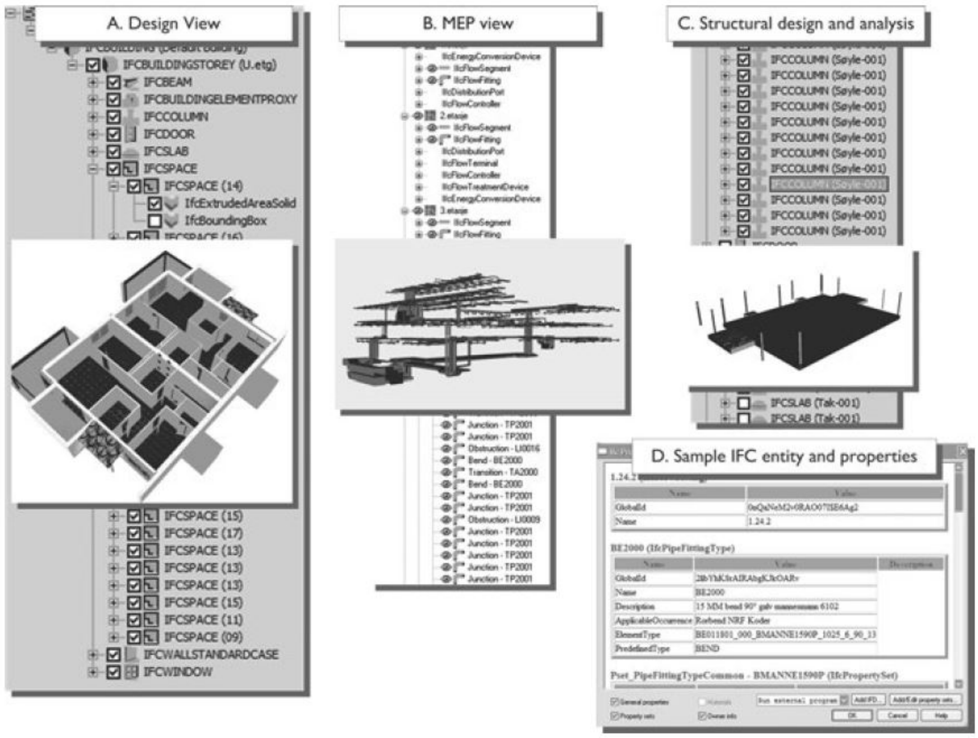

Figure 3.5: The figure shows three examples of specific domain uses from a project, which are; an architectural view, a mechanical system view, and a structural view. It also shows a sample object or entity and sample properties and attributes within BIM library.

Source: Eastman, C., P. Teicholz, R. Sacks, and K. Liston (2011). *BIM handbook a guide to building information modeling for owners, managers, designers, engineers, and contractors.* Wiley. p115.

CHAPTER 4

PERFORMATIVE DESIGN IN ARCHITECTURAL PRACTICE

The increasing awareness of the notion of performance introduces new design strategies regarding building geometry, material, function, structure, aesthetics and energy efficiency. Architects started to consider building performance as a guiding factor through the design process. To this end, PD approach aims at translating and integrating performance requirements into a building design. Up to this point, a theoretical study is pursued in order to underline the utilization of building performance in architecture. However, the current architectural practices constitute a significant part of this research and they also need to be examined at the same time for combining architectural theory and practice. In this respect, Chapter IV presents and exemplifies PD processes within architectural practices by means of case study methodology and personal communication via semi-structured interviews. Data on these practices will be collected through these interviews carried out by the author. The semi-structured interview method for data collection was selected as the main research element since it presents a clear set of instructions for interviewers and provides reliable and comparable qualitative data.[1] It is important to express that this chapter presents just one of the multiple possible results which may be interpreted in various ways due to the nature of this research methodology. Architects contribute to the case study based primarily on their own experience in the practices, and the results are categorized by the author. In this chapter, current conditions and obstacles to PD in architectural practice are presented.

[1] Cohen, D and B. Crabtree. (2006, Jul) "Semi-structured Interviews." RWJF - Qualitative Research Guidelines Project | Constant Comparative Method | Constant Comparative Method - Grounded Theory. Accessed August 15, 2018. http://www.qualres.org/HomeSemi-3629.html.

4.1. The Features of the Selected Architectural Offices and the Interviews

In order to gain a more in-depth insight into architectural practices implementing performative concepts into architectural design, several architectural design offices were chosen. The selection of the architectural practices was according to their participation in projects that are complex and include several performance factors w,th,n the design process. However, these practices do not aim at any sustainability or performative design considerations, and therefore, they present a general case for architectural practice. Prior to selection, a number of architectural practices were shortlisted by the author. Following, a total number of 9 practices were selected by expert opinion and their architectural design projects in their portfolios. The practices provide an equal distribution of sizes to ensure that they use similar design methods, which is related to the means in terms of organization and available in-house capabilities. In the selected offices, four offices had 10-20 employees and five offices had 20-40 employees, who were working in the offices at the time of the interviews.

Table 4.1: The features of the selected Architectural Offices.

Architect	Age Range	Office Location	Employees	Project Location	Project Year
1	30 - 40	Ankara	20 - 40	Istanbul	2013
2	30 - 40	Ankara	20 - 40	Ankara	2012
3	30 - 40	Ankara	20 - 40	Istanbul	2014
4	30 - 40	Ankara	10 - 20	Ankara	2006
5	40 - 50	Istanbul	10 - 20	Istanbul	2014
6	40 - 50	Istanbul	10 - 20	Istanbul	2015
7	40 - 50	Istanbul	10 - 20	Kıbrıs	2017
8	30 - 40	Ankara	20 - 40	Ankara	2016
9	30 - 40	Ankara	20 - 40	Ankara	2014

9 face-to-face interviews were conducted from April 2018 to June 2018 with the

selected architectural practices. All interviews were conducted at the architectural design offices, which were located in the two biggest cities of Turkey; Ankara and Istanbul. All the interviewees, five women and four men, were within the similar age group and had experience in projects which they participated from conceptual phases to its construction, and was responsible for contact with external consultants.

As the first step, it was asked to choose a project which is representative of the performative design practices at the office; however, architects were free to mention other projects if they would like to in order to make it possible to explore some responses in greater depth during the interviews. In table 4.1, an overview of the selected offices and projects is presented.

Before the actual interview took place, the interviewees had been informed about the questionnaire. The interviews usually lasted from 1-1,5 hours. Interviews were held in Turkish and tape recorded. The interview questions were set up as a basic guide to all interviews as it is seen in the table A.1, however, architects were free to express other thoughts on PA and their experience.

4.2. The Architects' Perspective on Performance

When asked about the ways in which building performance is implemented in the architectural practices, a number of key concepts were identified. All architects seemed to be aware of the different design concepts regarding building performance, from sustainability aspects to building systems and technologies. However, all concepts were described over examples and previous experience rather than giving certain definitions. These concepts, in the order of the frequency of the responses as presented in figure4.1, were energy, daylight, façade, environment, certification systems, mechanical systems, structural systems, economic, social, solar systems, materials and functionality.

The concept of energy performance was identified as the key factor in PD by all of the interviewees (n=9). The main motivation for prioritizing energy, according to four interviewees, was reducing energy consumption during the lifetime of the building, and in parallel to that, reducing the costs associated with energy use. Moreover, all

Table 4.2: The Semi-structured Interview Guide.

Performative design in relation to design practices	• In what aspects do you implement building performance in your projects? What are the relationships between these aspects?
Architects' Competences on Building Performance	• What basic information / knowledge should an architect have to be able to conduct a PD process? • Are the performative decisions taken based on formal / quantitative analysis and evaluation results (i.e. simulations) or are they intuitive decisions?
Client demands	• What performative factors do the owners / clients require at the beginning of the project? • Are the certificate programs (e.g. LEED, BREEAM) effective in the implementation of PD processes? • What are the differences between the projects requirements for domestic and internationally based projects?
Design Process	• How do performance factors affect design process? In which design phases are these factors considered? • Which digital design tools do you use during the design process? Are these tools able to conduct performance analysis and evaluation? • Do you think BIM tools are effective on performative architectural designs? If so, how?
Design Team	• Is performance analysis / evaluation carried out in-house by your firm? How often and on which topics do you need consultancy in the design process? • What are the communication methods used between the architects and other disciplines throughout the design process? • What is the responsibilities of involved parties in performance assessment during design? • How is the information transfer achieved between architects and other involved parties?
Conditions and Barriers	• How is a design project in which performance is prioritized different from other projects carried out by your office? • What are the most determinant barriers against conducting a performative building design?

interviewees underlined the central role of energy performance in all other concepts provided as a response to this question. This relationship was most evident in certification systems and its mandate on reduced energy use. Moreover, façade design for effective daylighting was stated as a key factor for energy performance, in that it reduces the need to artificial lighting and therefore energy use.

The knowledge on solar control and mechanical systems came forward after the energy performance. Five architects stated that the building needed mechanical support to supply a certain indoor comfort level. When the architect chose to use technological systems for building performance, economic aspects became crucial for both architect and client. In this manner, half of the architects underlined the importance of economic considerations by means of selected materials, construction techniques, energy usage, and so forth.

When asked about the relationships between different performance factors, a disconnect between such factors was identified as a result of the responses. Four respondents stated that one single performance aspect (i.e. energy performance, certification) in each design project played a central role, and other performance aspects were considered secondary to that. In this respect, the respondents admitted that other performative aspects run the risk of being overshadowed by primarily focusing on only one aspect. Integrated design approaches were merely mentioned by only two architects relating performance to social and functional aspects of the building design as well.

4.3. Architects' Knowledge and Competencies on Building Performance

The architects were asked what the competences they need to have to be able to successfully conduct a PD process. The majority of the respondents agreed upon the idea of that the architect's responsibility includes ensuring building performance. Therefore, they stated that an architect should have at least basic knowledge on technical aspects of designing as well during the design activity.

5 interviewees stated that they have basic knowledge on the existing technologies on solar control and HVAC systems and their application in buildings, based on their architectural practices and previous experience. However, all respondents admitted

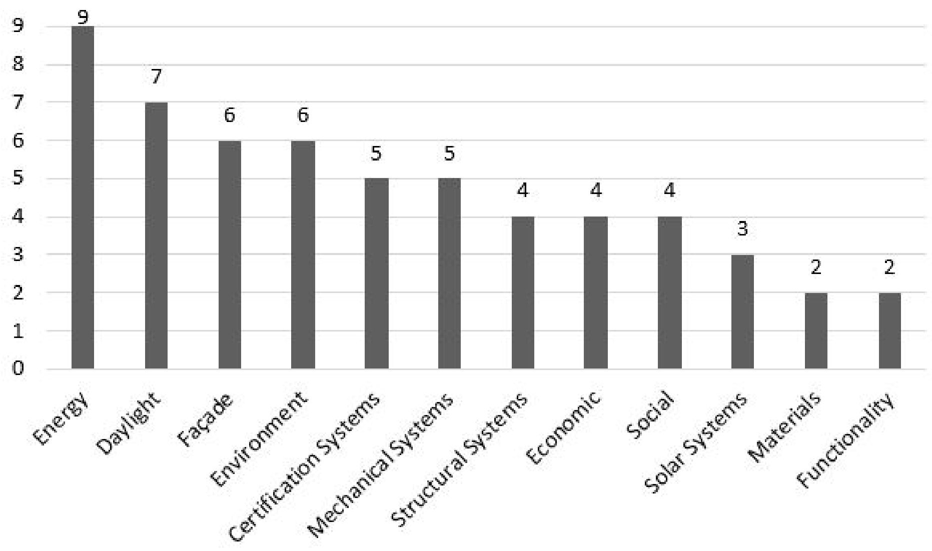

Figure 4.1: Mentioned themes in the interviewed architects' definition of building performance.

that more advanced technologies require the active interdisciplinary involvement of consultants and engineers, based on the technical expertise they provide.

The interviewed architects mentioned 7 different bioclimatic factors (i.e. sun, daylight, ventilation, wind, water, landscaping and view.) which they look out for in design process (See: Figure 4.2). These factors are changeable according to the client demands, project type and features of the site. Sun and daylight have a significant role in this consideration for the majority of the offices, and ventilation follows these factors afterwards. Other factors were ignored or slightly discussed in performative projects, and each practice introduced a different approach for implementing these factors to the projects.

The majority of the participants stated that intuitive methods of building performance are most typically applied in their practices. When asked about the performative concepts that are most commonly applied, the architects identified solar control and daylight as most central concepts. They explained that passive solar control techniques were used intuitively in order to decrease direct solar radiation onto the glass façades. This is mainly for the purposes of maintaining thermal and visual comfort and controlling glare. Building orientation and site use, in most cases, was mentioned as a key design criterion that heavily influences thermal and daylighting performance.

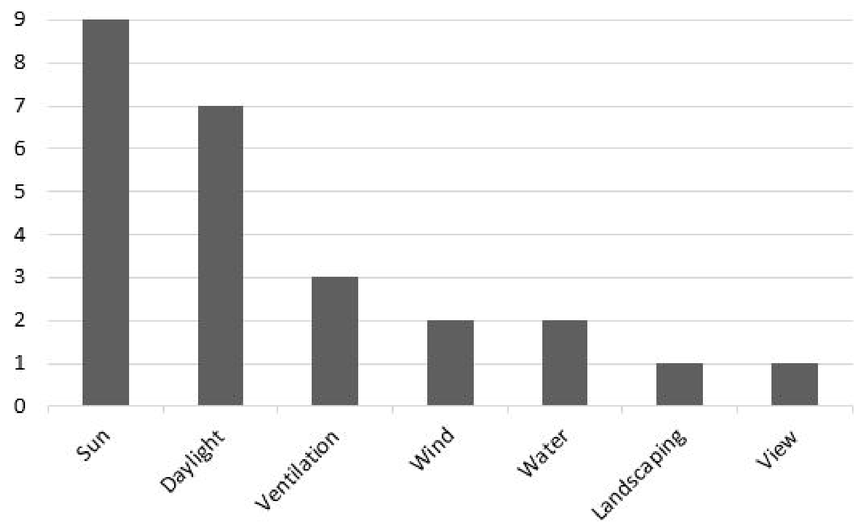

Figure 4.2: Bioclimatic factors taken into consideration by offices.

Primary architectural design decisions such as site use, spatial organization, façade design have a direct influence on orientation. Similarly, since direct sunlight may cause unwanted glaring, the application of shading devices and surrounding vegetation were used in order to allow diffused sunlight to enter the space for visual comfort without glare.

Natural ventilation is taken into account when the project scale is relatively small, such as residential buildings. This is due to the difficulties of assessing the effect of natural ventilation, and the lack of technical expertise and advanced digital tools to qualitatively inform and support design decisions. Three architects explained that they use passive ventilation by appropriate placement of openings according to the direction of wind. Ventilation was used for reducing energy cost and excess moisture present within the space. When the project scale is relatively bigger, especially in high-rise buildings, wind force became crucial in the design process. However, the analysis and evaluation process was pursued by consultants and engineers in order to calculate wind loads. In these cases, architects were generally not involved into the process, which they were only allowed to examine the consultants' and engineers' reports after the evaluation finished.

The basic knowledge on performance was generally concentrated on solar control, daylight and ventilation. Architects stated that they were able to control these factors by themselves without the support of external experts. However, these performative decisions are intuitive and based on rules of thumb in general. The knowledge applied in design projects are based on the previous experience of architects and projects designed in a similar manner. The topics that architects felt confident about can be listed as following;

- Building orientation.
- Spatial zoning according to orientation.
- Shading Systems.
- Initial decisions on the inclusion of renewable technologies (e.g. solar PV panels.).
- Space requirements to install mechanical systems in buildings (i.e. the size of the technical room, the installation of the ductwork etc.).

Although most of the interviewed architects were aware of the passive systems, they also admitted that they heavily rely on mechanical systems, when their knowledge on passive systems are not sufficient. Interviewed architects stated that they were able to estimate equipment sizing; however, they remained incapable when it was necessary to provide rather new and advanced technological solutions on mechanical and electrical systems. They expressed the need for extended knowledge or consultancy on the following topics;

- Quantitative performance data analysis and evaluation.
- Using performance simulation tools.
- The correct use of advanced electrical and mechanical systems in buildings.

Almost all the interviewees dwelled on the importance of the effective use of design tools that support PA. Although they felt certain about the potentials and advantages of design and performance evaluation tools, they stated that these tools were not fully explored of used by the design offices yet. Most of the employers aimed at maintaining the continuity of relatively fast but intuitive design processes, which ended up with the lack of encouragement on exploring new design tools and features. Section 4.5.2 will provide the current situation of the design tools usage, and the perspectives of architects towards them.

4.4. Client Demands

In almost all cases in the interviews, the demand for performative buildings came from the client, who assigned the architect to design sustainable, energy-efficient building. In only a few cases, it was the architect who had a focus on sustainability without any external pressure. However, most of the interviewees stated that the client generally needed to be convinced by the architect about the advantages and disadvantages of the suggested integrated performative solutions, both regarding the active and passive approaches. This negotiation process, as was stated by the interviewees, was driven by financial advantages of the proposed solutions. What was problematic in most cases was the fact that the clients approached performance-related issues with a result-oriented approach in general. Therefore, long term benefits including operational costs or lifecycle performance of buildings were not as predominant as loss account statements at the moment of design process.

Two architects stated that the clients' profile and perspective was the most influential factor in performative buildings. When the client had certain demands on sustainability and energy efficiency, there is much increased motivation for architects to find solutions for performance-related problems since the need for convincing the client was not necessary anymore. Besides, when the client was knowledgeable about performative systems and sustainable design approaches, the project budget is determined accordingly, which prevented conflicts and disagreements that might be occurred in the upcoming design phases.

When the underlined factor became the project budget, a number of the interviewed architects mentioned the cases in which the clients undertook the operation of the project as well. These are especially the cases with government procurements, wherein operational performance and costs were prioritized over design. Government regulations became determinant on the PD process when the client is government, as client requirements might impose the use of sustainable systems in these cases.

When asked about the certificate systems and their effectiveness on performative building designs, most architects stated that these systems were generally used as marketing strategies rather than environmental regulations. The main incentive in this type of projects was to use the ‘sustainable’ label in the market and the aim was to provide an increase on sales. Therefore, the architects answered that the certificates were considered as a part of greenwashing strategies if all the performative requirements were only coming from them. However, the interviewees stated that if the client would like to have an energy certificate, the financial resources were distributed according to the performative necessities which might be an advantageous feature of aiming certificate systems.

Most of the architects stated that the national or international demands did not show a significant difference in performative projects. They explicitly emphasized the importance of the client and its perspective towards sustainability. All other factors and problems might be perceived secondary if the awareness and knowledge of the client is sufficient.

All interviewed architects found it important to come to a mutual agreement with the client. Indeed, one practice developed a checklist to examine with the client before the project started. The list had several subcategories including design process, certificate systems, building performance, consultancies, and so forth. The aim was to set the relationship between architects and clients early on, along with the relationship between architects and constants. The architect underlined how useful to have such checklist to prevent any disagreement that might occur afterwards.

> *TQ1:* A very precise contract is signed with the client in order to prevent any interpretation. That means that she/he needed to demand exactly what the project involved. (Architect #5)

4.5. Design Process

4.5.1. Early Consideration

When all 9 interviews are compared with their own specifications, conditions, participants and design processes, the early consideration of performative problems and solutions from the early design phases comes forward.

> *TQ2:* We consider performance criteria especially in the early design

> phases. A high number of modifications are conducted during these phases. (Architect #9)

When the architects were at the center of PDs, they usually preferred passive solutions which should be considered at the early phases. However, most cases showed that passive systems could not be used effectively in complex performative buildings since the architects mostly relied on intuitive decisions and previous experience. To this end, performance was delegated to active technologies and additional technological systems were considered for performance-related problems. The passive systems were not on focus anymore and the architects tended to delegate the design and application of performative building technologies to experts. Since the additional systems were implemented in detailed design phases, early consideration of performative solutions and integrated design strategies were not possible in these cases.

When the client had a specific request about building performance or asked for a certificate, performative solutions started to be considered at the early design phases. As one of the interviewed architects stated, the initial ideas on basic performative decisions, such as daylight, orientation, materials, recycling, reuse and so forth, came into focus since the client required to see the development of performative aspects of the project at each phase, and these decisions were presented from the beginning to the end. At this point, financial opportunities were underlined on more time by the architects. When the client had a request on sustainability, the project budget arranged according to that and it became possible to consider building performance are the early design phases.

4.5.2. Design & EvaluationTools

On the question that concerned the type of design tools used in the PD process, architects explained that digital tools were prominent in different phases of design. Although architects still preferred hand sketches and physical mock-ups during early phases of design, 2D and 3D drawing tools are widely used in every design phase as it is presented in the figure 4.3. The most commonly used drawing and modelling tools were Google SketchUp, AutoCAD, Revit, 3DsMax, Rhinoceros, Grasshopper and Lumion.

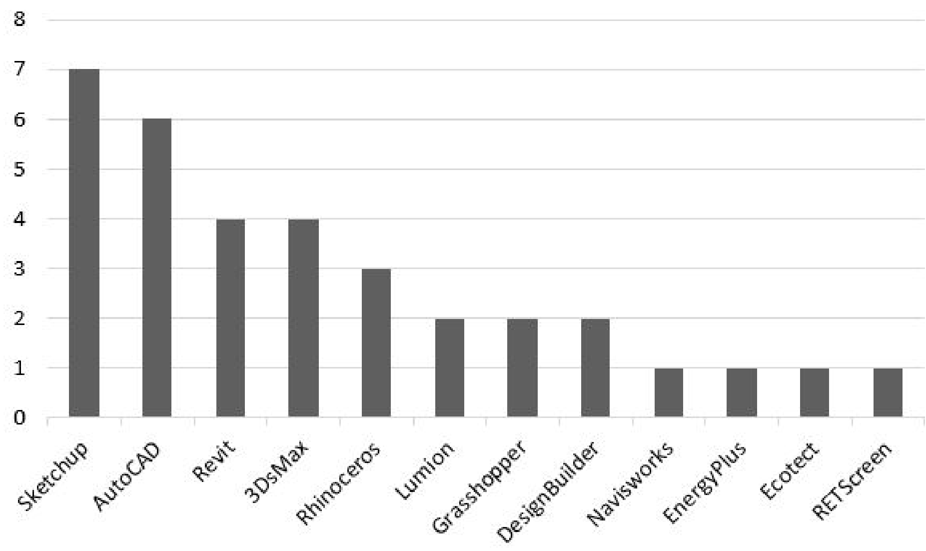

Figure 4.3: The distribution of the design tools used by the interviewed architects.

When the architects were asked to name the tools which were used by themselves or by the involved engineers for performance simulation, the majority of the architects stated that they were not familiar with any names of these tools. Only two practices could name some performance analysis or project review tools, such as DesignBuilder, Navisworks, EnergyPlus, Ecotect and RETScreen. These tools are mostly used by external experts and architects were exposed to only analysis results in periodic reports. Only two architects were using basic simulation tools and one architect was capable of using advanced BPS tools while all the others assigned engineers and consultants for pursuing performance simulations. On the other hand, all architects were confident about their skills for manually using rules of thumb in order to achieve sustainable or PA. The architects stated that they were already applying these design strategies intuitively even in relatively bigger and complex projects without facing any problem. At this point, they also mentioned that none of the consultancies they received had used rules of thumb in their reports and solution sets. The design methods used during PD processes among the interviewed practices are presented in the figure 4.4

Two architects mentioned that they used basic design tools for taking simple performative decisions. In this respect, almost all the interviewed architects stated that they

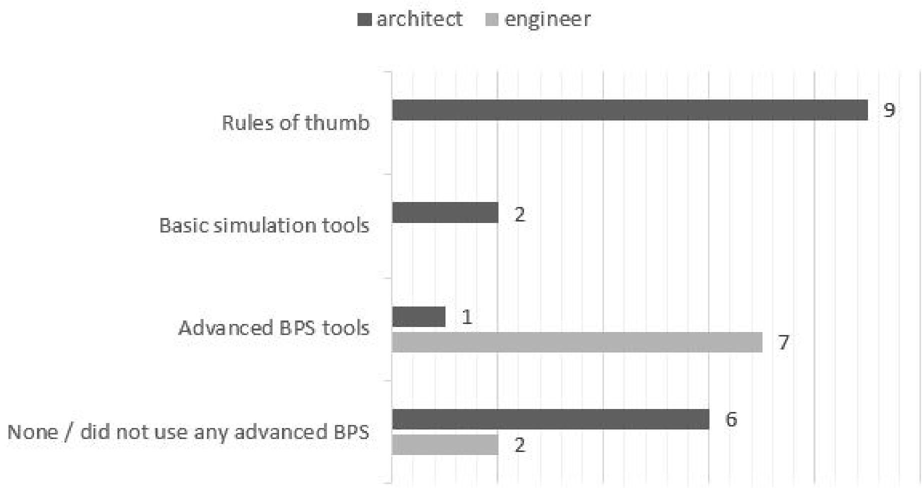

Figure 4.4: The use of design methods (Intuitive/computational) in the PD process.

used Google SketchUp for sun and shadow analysis, but they also underlined that the process did not give quantitative results and the evaluation was done afterwards intuitively by architects. On the other hand, the selection criteria of design and evaluation tools were not expressed clearly by the interviewees. Half of architects emphasized the user-friendliness of the tools as a selection criterion. Yet, the most determinant factor in the selection of the design tools was the abilities of the architects working at the offices. One architect pointed out to the problematic consequences of concentrating all the performative knowledge and responsibilities on one single person. In this case, the key role that this person plays in the process might danger performative projects when this person leaves the office. The projects might stop or receiving external supports might be obligatory. To prevent this potential danger, the tools and performative knowledge should be given to the design team rather than concentrating only one person.

In 7 practices, advanced performance simulations were outsourced to external consultants. In all these cases, the participants stated that the architects' design drawings (2D or 3D) are shared with the consultants, to be used in analyses. Architects were presented the reports prepared by those consultants only after the analyses were completed. Consequently, architects did not have the chance to contribute to the analysis and evaluation/simulation process while consultants were working on the projects. Consequently, external consultants were not able to receive architects' opinions while architects only obtained the end results of the simulations. To this end, architects mentioned an interdisciplinary fragmentation during PD projects pursued together with external consultancies.

When performance analysis is outsourced to consultants, the solutions suggested were typically presented and negotiated over data reports in the interviewed practices. However, the lack of visual/model-based interaction between architects and consultants was considered as a barrier by almost all interviewees against effective communication and collaboration. It was true for a shared building model (i.e. BIM) as well, which includes all involved parties. Even in this case, the models, analyses and evaluations were pursued through different mediums and combined in a BIM model at the end. As a consequence, these architects were not able to fully and effectively get involved, change and control the performance assessment process as well. One architect stated his/her concerns by saying that:

> *TQ3:* The involvement of the engineers is important for the process. They should also work on Revit or BIM-based programs so that we can move on. We had some troubled projects. There are some projects that only the architectural drawings are on Revit and the other disciplines are sending files in just 2D. [...] so that these drawings are needed to be remodeled. This cause a serious waste of time to me and the design team. (Architect #1)

BIM was used by four architectural design offices at the time when the interviews were conducted. Architects stated that BIM was critical especially when it was necessary to make modifications according to suggestions given by consultants. In this case, design revisions could be made rapidly. Moreover, it was pointed out by one interviewee to the increased control achieved by the involved parties due to the use of a shared BIM model. Therefore, it was stated that BIM was preferred over rather than traditional CAD systems by an interviewee.

> *TQ4:* The beginning of the project takes longer. Later on, of course I think it is more advantageous for revisions or better standards and submission quality. (Architect #3)

Nevertheless, the usage of BIM did not cover performative aspects of design in their practices. Only one office stated that the architects used performance simulation capabilities integrated into BIM (i.e. Autodesk Revit and Insight) in the design process as it is seen in the figure 4.5.

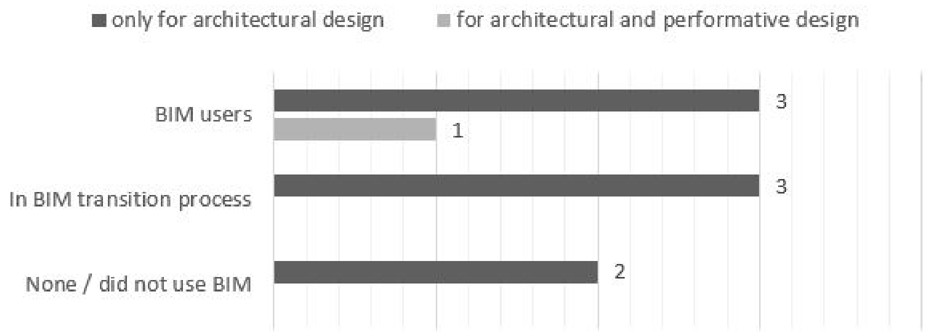

Figure 4.5: The use of BIM at the architectural design offices.

Three architects mentioned that they were in transition process to adopt BIM in design processes. However, all three stated their hesitancy to transition to a BIM-based design process immediately, due to the amount of time required, the lack of existing know-how that can guide the transition process, and the lack of trained architectural design staff that can use BIM-based design tools. Although the architects were aware of all these obstacles and difficulties, they were still willing to adopt BIM in the near future.

4.6. Design Team

4.6.1. Interdisciplinarity

In order to meet the necessities of designing a performative building, all interviewed architects often collaborated with engineers and consultants to determine performative strategies for the design. The involved engineers were generally mechanical and electrical systems engineers, structural engineers and energy consultants. Six architects stated that they came together with the engineers at early design phases in order to determine the technical systems to be applied into the building and how the most suitable performance factors for the building could be achieved. It was stated by these architects that the suggested technical systems required comprehensive knowledge and it was for this reason why architects needed collaboration with engineers in design process. Only three architects stated that they were able to control and apply technical systems by themselves based on their limited knowledge for relatively smaller project designs. On the other hand, the architects did not rely on their knowledge since the project and the required technical systems could exhibit a high level of complexity when the project became multifunctional and the scale increased.

> *TQ5:* If it is a project which our knowledge is sufficient, of course we conduct the project within our team. This becomes convenience for that project. However, there are some projects or scales that exceed our knowledge. In those projects, it is certainly required to have a consultant. (Architect #5)

> *TQ6:* When the architects become insufficient in the technical manner, we come together with the engineers and ask about the meaning of the results and the precautions that shape the projects. (Architect #9)

Two architects explained that they did not find it necessary to have the extensive knowledge on technical systems since the accustomed design process already provided the required knowledge from additional supports. When asked their opinion on the opportunities of design and evaluation tools, these architects did not consider the use BPS tools in the design process as the architects' responsibility. They found BPS tools difficult to understand and use, and thought that an architect should focus on the design itself rather than the technical aspect of it. In this respect, two other architects stated that they found it beneficial to have as many consultants as possible in order to strengthen a project's performative aspects.

In the majority of cases, the architects underlined the role of setting the contractual obligations with the consultancies clearly before starting a building design. The agreement between architectural practices and consultant companies was found as the most significant factor in interdisciplinary design processes. Architects highlighted the importance of their active involvement in the consultants' and engineers' ideas, suggestions and changes. Therefore, the requirement of determining all the terms and conditions at the beginning before the design activity was underlined by all the architects that received external consultancies.

4.6.2. Design Integration

In PD approach, the interviewees were aware of the interdisciplinary gap between the architect and the engineer, which could risk integrated design strategies. Seven architects stated that the design was conducted in an integrated way when the decisions depended on factors such as building orientation, spatial zoning, solar exposure and so forth, since the architect was in charge of controlling the whole system in those cases. However, when it was required to have consultancy for more technical decisions, the majority of architects mentioned the significance of receiving consultancies at the early design phases to promote integrated design strategies.

The necessity of the engineering support made the communication between the involved parties essential throughout the design process. Architects who worked with external consultancies stated that all engineers, consultants and architects should be familiar with the design process and come together through meeting (most preferred physical) while taking critical decisions. Therefore, the interviewees supported the key role of external experts, but they found it necessary to include them to the design process from the very beginning of the project. They emphasized that a high level of communication was needed in each phase of PDs. In most cases, the communication between the architect and the engineer were carried out through meetings and email correspondence. In addition, consultants and engineers provided periodic reports about their works to the architect, which were technical and data documents without visual aids generally. In all cases, the necessity of direct and quick communication was emphasized by the architects in order to perform integrated design strategies.

The frequency of meetings with the consultants and engineers was considered as determinant as representative of the level of design integration in most of the cases. In terms of the performative aspects, architects stated that close collaboration promoted more integrated designs, which might be explained as the number of meetings, the number of employees dedicated to collaboration, periodic reports and explanatory documents. To this end, computational tools used in design process and models shared between the involved parties were emphasized by all architects as presentation and communication channels throughout the design process.

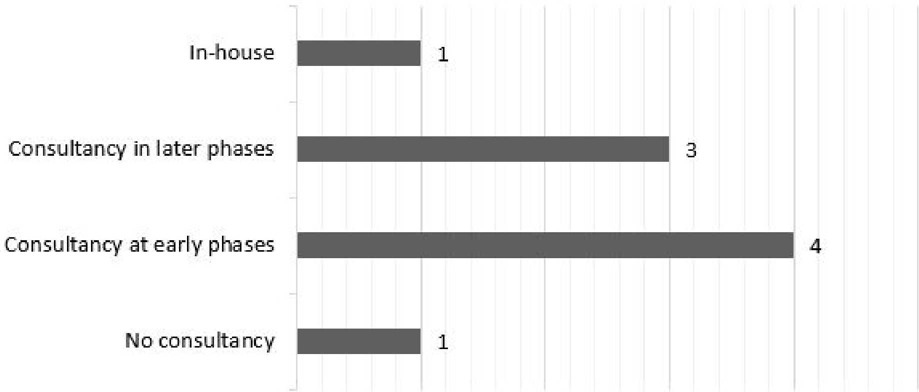

Figure 4.6: Performance consideration of the interviewed architectural offices.

In line with the collaboration issue, two architects emphasized the added value of sharing the same physical work environment with different disciplines. They stated that physical accessibility reduced the time spent for communication, arranging periodic meetings, preparing detailed reports including data extraction, conversion, transfer, interpretation, visualization and so forth. One architect also underlined that it would be more effective and fast if they were able to directly communicate and express design ideas and solutions immediately in PD process.

Digital tools were also critical in integrated design strategies according to all architects. The offices that used BIM tools mentioned the advantages these tools provided in design collaboration. These advantages include less time required for the design revisions, interdisciplinary knowledge and various architectural representation modes captured within the same medium, and the seamless integration with analysis tools in the BIM environment. However, it is stated that the lack of widespread use of BIM tools was an obstacle against its efficient use for performative data integration and tool interoperability. As one architect stated, if one of the involved parties, architect or engineer, is not using BIM tools in the design process, it is not possible to mention the integration and added benefit in design.

Two architects mentioned that in some cases, the design team had to recreate their digital model since the involved engineers did not used BIM tools and request CAD models instead of BIM. In line with this, one architect pointed out the lack of incentives for innovation in a notoriously traditional industry such as architecture and engineering as the reason why they did not consider using BIM tools in their practice. This situation hampers the use of BIM for collaboration according to the architect.

> *TQ7:* It is a transition phase of the world. But let's consider that an architectural design office or all the architecture community adopt BIM, so what happens? Let us say that we draw BIM, then the engineers need to use it. Let us say that the engineers use it, the consultancies need to use as well. Let us say they also use it, the contractor needs to use it. [...] Now if it is not used like this, there is no sense if an architectural office work with BIM. (Architect #7)

When the focus was on integrated design, participants stated that architects' central role in the PD process is the key for design integration. They underlined the significance of design synthesis from an architectural point of view for understanding and interpreting the performative data coming from consultants and engineers.

4.7. Bariers and Conditions of Performative Design Practice

A majority of architects interviewed for the research stated that the main obstacle to PA was the lack of client interest. Architects experienced that the clients were in doubt on PD approaches due to required time and financial resources. All architects conducting performative projects stated that it required relatively longer time in compared to architectural design projects without performative concerns because of the interdisciplinarity. Therefore, these architects stated that they needed to convince clients in at least one part of the project about a performance-related solution and its benefit for the overall project. Architects basically mentioned the main obstacles in three different categories, which are financial constraints, marketing constraints and architects' education.

4.7.1. Financial Constraints

All the interviewees explicitly emphasized the insufficient financial resources as the main obstacle to PD. Architects who conducted PD process with external supports underlined the necessary additional budget for receiving consultancy during the design process. They mentioned that especially during the early phases, they needed consultancies while taking major design decisions. Besides, two architects explained that implementing performative technologies and materials are too expensive and architects had trouble on finding economic solutions when the client did not tend to budget for these solutions.

One third of the architects stated that clients aimed at making profit as quickly as possible. In these cases, architects tried to convince clients to pursue PD strategies by calculating long term profits. However, performance aspects are generally left aside by the clients even when they saw the results. Two architects mentioned that the short-term benefit culture affected the perspective towards building performance the most, since the clients tended to consider immediate gains and long term plans were found financially risky by them.

One architect also mentioned that it requires a serious amount of money to supply the necessary computer power in order to run PD and evaluation tools. In addition, licenses of these programs and the necessary training given to architects for teaching how to use these tools also require a certain amount of money before the project started. Therefore, apart from the client interest, architectural practices abstained from PD due to the expensive transition process.

4.7.2. Marketing Constraints

Two architects stated that performance aspects of the designed buildings were highlighted to be visible since the clients who wanted to have a performative building asked to. As a consequence, these architects needed to provide certificate programs because intuitive and non-quantitative solutions were not seemed efficient for the clients. In this case, practices led to adopt design strategies supported by consultancies and certificates in order to manifest the performative aspects. Architects also stated that a client who would like to attend a performance certificate program is advantageous since in certified projects, the budget is calculated according to PD requirements from the beginning.

An architect explained that if an architectural practice promotes certain performative aspects (e.g. maximizing daylight, providing solar energy, using sustainable materials etc.), this practice becomes notable and recognized in the market with that aspect. The interviewed architect expressed that having a target, a performative theme in designs, whether certified or not, creates its own demand group and increases the sales and the preferability of the projects.

4.7.3. Education of Architects

A majority of the interviewed architects pointed out to the segregation between architectural education and architectural practice. Half of the architects stated that architectural education is mainly theory-oriented and PD knowledge is required to be acquired in professional life. To this end, each practice that aims at pursuing performative projects suggested their own ways in order to train the architects.

> *TQ8:* The sources that can be found out of school are very limited. There are the Chamber of Architects or the trainings in the market. [...] The education needs to be given consciously and the ones out of school are not sufficient. They do not consider the problems that can be confronted in the market. (Architect #1)

All the interviewed architects mentioned the lack of performative focus within architectural practice. To create awareness, three practices arranged trainings and meetings with invited speakers, engineers or architects, who are working on performative projects. Two other practices stated that attending fairs, site trips, expos, presentations of other offices provides sufficient benefit to pursue PDs. Similarly, one architect expressed that certificate programs also provide an opportunity for PA since the content of these programs allows to reach various useful information in PD. All these attempts were considered by architects as a movement towards performative buildings for creating their own field of study in the current architectural practice.

CHAPTER 5

DISCUSSION

In this chapter, the results of the case studies are discussed in order to propose an assessment on PD approaches in architectural practices. The selected case studies showed that the interest in PDs was on focus especially in the last decade. To this end, an increasing awareness and available technologies and tools became effective in that architects and clients adopted such performative approaches in their designs.

According to the interviews, the design priorities are different due to the general perspective towards architectural design in the architectural practices in Turkey. As it can be seen during the interviews, architects cannot consider performance aspects deeply in most cases since they are given a very limited time for fulfilling architectural requirements and a very low project budget which cannot maintain interdisciplinary design processes. Therefore, architects improved themselves on time management and financial resource arrangement while advanced building performance factors have to be considered secondary.

As a result of the semi-structured interviews, three main themes were identified regarding performance-based design practices. These themes were sustainability, performance and systems. All architects touched on the subject of energy while explaining performance aspects which they considered during their projects. Energy efficiency in building performance was considered together with economic sustainability and certification systems as a significant factor. Besides, a majority of interviewed architects underlined the importance of daylight control during PD process and explained the ways in which building façade affects daylight control strategies and provides energy efficiency at the end.

Nevertheless, the relationship between performance concepts were not very clearly discovered by the architects. Building performance concepts were generally explained over previous projects or experience by the interviewees. Although performative strategies –mostly based on first principles– were adopted to a certain extent by all of the interviewees in various degrees, a conscious conceptualization of the definition of performance and the ways in which it can be used in design were rather vague in all cases except for two. This was evident in the interviews; only two architects could name performance objectives, targeted PD solutions and building systems with architectural concerns in the design brief of the projects. However, it was also identified in the interviews that certificate systems can improve awareness towards performative concepts and their implementation in architectural design. This is because certificate systems usually necessitate a clear understanding towards PA as they present a systematical framework on building performance. Except this, architects seemed rather ambiguous in performance-related concepts and their categories.

The current conditions and obstacles to PA can be categorized as internal factors and external factors. Internal factors consist of all parties involved directly to the design process, their competences, and tools which are mainly related to the architectural design office and the architects. Consultants and additional supports are considered within internal factors since they are also effective on the design process and involve into the design team. On the other hand, external factors are basically composed of all factors that are independent of the architectural practice, which include client demands and market related situations which affect the design process. The discussion is pursued according to these categories in the following sections.

5.1. Internal Factors

5.1.1. Competences of the Design Team

The lack of knowledge and skills on existing efficient performative strategies is identified as the main barrier to PA according to this research. All interviewed architects demonstrated some degree of confidence in their ability to access and use knowledge in PDs, however, a majority of them remained vague when a specific issue of PD was addressed. The importance of architects' skills and knowledge was underlined in all interviews in order to conduct integrated PDs, without being exposed to advanced complex technical information coming from external consultants. The requirement of identifying project objectives was seen as a critical topic for achieving project goals regarding cost, time and performative strategies. However, when advanced PD problems occur, the interviewed architects delegate the problem solving part to other experts.

Mostly, the interviewed architects are able to manage most basic architectural design decisions regarding daylight control, orientation, site use and solar exposure strategies in PD projects. These decisions are taken based on rules of thumb among these architects in general. The rules of thumb provide the necessary information at basic levels to architects in order to orient the project in the right direction at early phases. However, since they are not familiar with the advanced computational methods (e.g. BPS tools) to assess the effects of performance decisions due to the required time for running advanced simulations, only basic visual evaluation (i.e. shadow analysis) is conducted by the interviewees. This method, however, proves to be not very precise. The most significant cause for this unfamiliarity is the weak knowledge transfer from educational / theoretical settings into design practices. This problem can be traced back to the architectural studio education in universities, wherein awareness and skills on PD principles are only arbitrarily applied.

Yet, design application of performative principles is not a part of the curriculum at the moment. Knowledge acquisition is only possible through project-based knowledge transfer. In this respect, interviewed architects are bound at the limit of previous projects, which does not allow extending the knowledge and discovering recent developments. The gaps between theoretical knowledge and practical implementations seen during the interviews might be bridged when architects are able to comprehend the overall PD processes including advanced PD decisions.

5.1.2. Share of Responsibilities

During PD practices, an effective and seamless cooperation of the involved partied is needed. Although the relationship between the stakeholders in the PD activity is complex and multi-directional, a limited number of design actors were identified during the interviews as; the client, who supplied financial resources to the design team, the architects, who carried out the project with architectural and performative concerns, the engineers, who lent technical support to the architectural design processes either through consultancy or as part of the design team, and the regulatory authorities, who provided frameworks and regulation to follow throughout the design process.

According to the interviewed architectural practice that implemented integrated design processes, the seamless collaboration of qualified architects and engineers to the PD process was seen as critical and necessary for achieving well performing buildings. In line with this, sufficient experience, quality education and awareness of PD strategies were required in decision making process to suggest feasible solutions regarding to the project budget and architectural priorities. However, the interviewees mentioned that they experienced a huge divide between engineers and themselves and difficulties they experienced in communication and collaboration because of different background knowledge towards performance. Strikingly, although it is widely acknowledged that performance is primarily the architects' responsibility, almost half of the respondents tended to receive external support for performance-related decisions. Accustomed PD practices disburdened the architects' responsibility without considering design integration. Although the interviewed architects seemed to be aware of the consequences, they preferred to adopt this system since it requires less time and the budget is arranged by the client, even though it causes a conflict between the perceived roles of architects regarding the architectural performance and the practices.

5.1.2.1. Involvement of other Disciplines

The interviewees indicated that performance factors should be considered from the beginning of the design process for integrated PDs. Performance integration at early design phases could be achieved in two ways: manually using rules of thumb that architects are already familiar with, or using computational methods (i.e. simulation tools). However, in case of high technical complexity, most practices considered to hire additional engineers and consultants to provide necessary advanced knowledge to PD process, in spite of the additional costs of such employees.

When it is necessary to include engineering consultancy in the design process, architects mentioned the risks of late involvement of the additional project parties to the PD process. Since higher number of project participants and interdisciplinary aspects of projects are valid for almost all performative buildings, determining the integration of these parties along with the environmental issues into the early design phases becomes essential for conducting integrated PD process. Early involvement embraces the familiarity of external experts to the project and increases the efficient cooperation and use of information needed in PA.

PD is disturbed not only the late involvement of external parties, but also because of the management and communication related problems within practices. Integrated design is not effectively pursued with interdisciplinary design teams. The lack of collaboration between involved parties within architectural practices diminishes the practice's capacity in PD, since there is not a holistic view towards building performance. It is one of the barriers to adopt integrating PD strategies since it is difficult to maintain interdisciplinary design teams and provide the necessary information flow during building design process. Therefore, systematic information sharing is essential in PA, which becomes possible thanks to the recently introduced computational design programs explained in the next section.

5.1.3. The Use of Computational Tools

PD needs integrated methods which enable to share design information and conduct integrated calculations, optimizations and simulations to compare design alternatives easily with least extra time. In Chapter 3, the state of the art in computation-supported PD is identified as the seamless use of simulation tools, made possible through BIM-based models that are shared between the involved parties in order to provide continuous information transfer and design control over performative decisions. Other approaches included generative models that can facilitate the automated generation of design alternatives that can give way to performance optimization.

In the interviews, the lack of architects' knowledge and skills to use simulation tools or understand the complex simulation results becomes the main obstacle in PD. Mostly, the interviewed architects stated that the simulation tools are very complex and difficult to use. As a result, they preferred to receive consultancies when advanced simulations are required. Consequently, this accustomed design approach led design teams to continue getting help from additional experts and engineers instead of improving their knowledge on BPS tools due to the high cost of providing BPS tools and the required hardware to run these tools, along with the necessary training time for the architects.

In interdisciplinary PD approaches, the importance of tool interoperability was underlined since communication between design actors gained crucial role for efficient time and cost management. This challenge is mainly addressed by the use of BIM in design process. The interviewed architects stated that BIM-based tools have great potentials in interdisciplinary design processes since they provide a shared model that potentially integrates all involved parties. BIM tools, as discussed in Chapter 3, are effective in PD as well since it is possible to collect, share and use environmental information during design, construction and operation of the building.[1] Similarly, during the interviews, all architects who used BIM-based tools expressed that information transfer is relatively faster and making revisions on projects is easier in compared with traditional CAD systems. However, it was stated by the interviewees that the lack of use of BIM-based tools in the design project actors was an obstacle against its efficient use for performative data integration and tool interoperability. Some practices mentioned that the design team had to remodel the design in a different CAD tool, since other involved partied did not use BIM tools. In this case, it is not possible to promote design integration and added benefits if one of two parties does not use BIM in design process.

The use of tools is not only crucial in design phases, but also in operational stages of buildings other construction assets as well. Two architects stated that decision support tools are useful when the client has operational rights of the building as well. One architect stated that BIM-based tools were also used after the architectural design finished, since they are capable of evaluating the value, risks, performance and

[1] Hakkinen and Belloni 2011, op. cit.

conditions, maintenance and life cycle operations of buildings.[2] Since the extend and potentials of BIM systems increase day after day, a majority of the offices begins transition process in order to adopt BIM tools in practice.

5.2. External Factors

5.2.1. The Architect - Client Relationship

The demand and the willingness of clients eventually determine the development of PA. Clients can be in different positions in design process. The client selects the design team and influences the ways in which they explore PD alternatives during design process. It is expected to understand the client's budget, functional requirement and corporate responsibility values. However, most clients were interested in the end result and considered the design process with a result-oriented perspective. When the client prioritizes end profit, immediate return is preferred to long-term profits. One interviewees stated that:

> *TQ9:* The most important thing is to be able to find proper communication methods. In order to succeed the project, we are trying to explain the long-term results of the investments. (Architect #9)

Operational costs or lifecycle performance of buildings were not predominant in the building design process at the moment according to the interviewed practices. Design practices only focus on the design activity itself. However, there are other project delivery models, such as design-build or design-build-operate. The incentives for lifecycle performance can be more important in those cases due to the sustained interest of the practice in the building lifecycle. In this respect, the PD advantages regarding long-term profits are promoted to clients to implement PD strategies in the design process. Architectural offices tend to adopt integrated PDs since the client is also satisfied with process-oriented strategies considering the integration of performative technologies or the architectural quality of the building.

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[2] Vanier, D. J. D. (2001). Why Industry Needs Asset Management Tools. *Journal of Computing in Civil Engineering 15* (1), 35-43.

5.2.2. Market Demand and Finance

One of the most determinant factors regarding the drawbacks in PA is the lack of incentive from the demand side and the low level of expectancy for high-performance buildings in the industry according to the interviews. Higher investment costs of PD and the risks of unforeseen cost are the most commonly addressed barriers. Clients are concerned about the unfamiliar performative techniques, the lack of previous experience, additional testing and inspection in construction, lack of manufacturer and supplier support, and lack of performance information, and thus, they demand traditional building designs rather than performative buildings. The neglected new technologies because of the risks they have also endanger well-developed and tested PD technologies since the perspective towards them is doubtful. In this respects, an interviewed architect stated the necessity of sharing information about good PD practices to let other practices benefit and learning from the experience. Knowledge management and sharing become essential determinants for new technologies and strategies in large architectural practices.

> *TQ10:* We are generally, even when we know how to conduct a work, trying to work with someone who is in this sector. We consider with whom we can work in order to enrich the design. [...] In spite of the fact that we are able to pursue most of the things in-house, we are trying to work wtih as many people as possible in order to let the sector grow together. (Architect #9)

Financial resources become critical when it is decided to conduct a performative project. PD approaches require additional financial support due to several reasons. Firstly, since the design process is conducted as an interdisciplinary activity, consultancy is needed from the beginning to end for most of the architectural offices. Secondly, taking certificates of PD tools, supplying the necessary computer power to run these programs, and the training given to architects for teaching how to use these tools necessitate a certain amount of money even before the project begins. Thirdly, many architects state the high cost associated with performative building systems and components. In line with this, the architects stated that the additional time required to embed PD principles in design processes which might occur in PD processes also increases the project budget for the client.

In order to adopt PDs, clients' understanding towards new performative strategies needs to be changed. As it is explained in Chapter 2, even though such aspects of PD like energy-efficiency and low environmental impacts are not directly visible, the potentials of PA are promoted in the market in some levels. It is expressed during the interviews that improved energy-efficiency and corresponding lower operational costs has become an issue which affects the attractiveness and market value of the buildings. To this end, certificate programs increasingly provide significant opportunities since they rate environmental impacts of buildings and label them in the market.

The lack of government initiatives and municipal authorities' support is another main problem in PA. Since such support and/or requirement to have a performative building is limited, especially in the cases which the client was not responsible of building operation, the focus is only on the use of financial resources most efficiently. To this end, architects have to aim at minimizing project costs in spite of the risk of ignoring building performance. At this point, the state and municipal organizations have crucial roles since they own and develop public buildings and might affect the development of PDs significantly if they decide to promote PD strategies. The perspective towards PA might change if such strategies are promoted not only for public buildings, but also for the whole building stock by providing good example of the effects of PA as one of the interviewed architects stated:

> *TQ11:* ...let us say for not losing that market. When it is started to be a condition in biddings, the rest also comes. And if you cannot fulfill that standard, you become prehistory. [...] It may be even resulted that you pulled out of the market. (Architect #3)

On the other hand, as it is underlined in Chapter 2 & 3, evaluating building performance is a complex process which might be used accidentally, incorrectly or even deceptively. One of the interviewed architects mentioned the difference between well conducted PDs and "greenwashed projects". The cultural fashion or technological developments may change along with the meaning and value of a specific indicator in the market. Therefore, performative projects must be pursued by not only considering the cultural factors, but also the PD necessities in an integrated way along with the architectural requirements.

The case studies show that the current condition of PD has multiple potentials and barriers which create complex interrelations between design parties and change design processes in different ways. Based on the semi-structured interviews and discussion, the following points can be emphasized:

- The current architectural practices in Turkey do not allow to adopt PD strategies during architectural design process due to the limited time and cost.
- Architects are forced to consider performative factors as secondary to be able to give necessary attention and time to other architectural requirements and demands.
- The gap between architectural educational / theoretical settings and design practice causes an unfamiliarity to PA and hampers integrated PD strategies.
- Clients' perspective is very effective on building designs and can change the overall design process in PA.
- Complex PD strategies require interdisciplinary design teams and the use of advanced BPS tools in design processes.
- Communication and negotiation between the involved parties is one of the most determinant factors in PA.
- BIM-based tools have significant potentials since they provide continuous information transfer and design control over performative decisions through a model shared between the involved parties.
- Each PD artifact becomes a learning tools and the market gets used to performative buildings and integrated design strategies.

It is necessary to underline the fact that these results show the current state of PA and the perspectives of the architects according to the selected practices interviewed by the author. It is possible to pursue different discussions and the points above just present one set of the conclusions. In this research, the case studies show that integrated design processes are partially possible in PA when different meanings of performance are considered by the desgin team. To this end, identification of functional and architectural requirements along with the performance and sustainability objectives is necessary as a beginning. According to the identified requirements and objectives, the decisions are taken and the solutions are applied from the beginning of the conceptual design phases. Advanced analyses and models are pursued after the conceptual design ideas are set, and revised improved architectural designs are presented at the end. For these reasons, in-house capacities of a practice become crucial in terms of managing interdisiplinarity of the design team, computational design methods and capabilities, and performance-based solutions in order to go even beyond the integrated design strategies to conduct fully holistic design processes within architectural practices.

CHAPTER 6

CONCLUSION

Within the scope of this research, first and foremost it is aimed to explore and conceptualize the PD in architectural practices. The concepts of building performance are explored in architectural design by means of computational design tools and methods. Performance criteria, both quantifiable and non-quantifiable, are explored in architectural design. Hard performance criteria correspond to the ones that are quantifiable in nature and enable to conduct objective assessments through the design process. Material, structure and energy related performance factors are covered within hard criteria. On the other hand, the factors depending on individual perceptions are in soft performance criteria, as these factors are difficult to qualify and often difficult to assess, such as visual perception, spatial qualities, functional use etc. After this investigation, this research focuses on performance integration methods in building design by means of supporting technologies and certification systems. Although the development and utilization of these technologies and systems are very effective and provide significant opportunities for performance integration, mostly hard performance criteria are on focus within these approaches. Therefore, performance integration in conceptual design stages is emphasized since it provides the most holistic design processes including different disciplines.

In performance integration, the computational design approaches provide a comprehensive perspective among various knowledge disciplines and involved parties. These approaches focus on a wide range of design goals, whether architectural and performative. The contribution of computational approaches leads to modelling and collaboration for visualization, analysis and evaluation of building performance, realization, construction and operational services within PA. To this end, this research aims at exploring the computational methods which are used in PD processes and the ways in which these methods can be used in architectural design. PD by means of computational tools offers unique opportunities in architectural design, which provide a more integrated and precise design decisions.

Through the use of computational tools in PD, explicit computational models can be used for the representation, sharing, evaluation and visualization of design knowledge. In this respect, integrated compound models, which combine different models and disciplines within the same medium, provide significant opportunities in the development of PD strategies.[1] These models include formation, generation, evaluation and performance and provide interaction and data and information flow in multiple directions. Design synthesis process in PA is redefined since architectural representations in PD acquire new purposes, such as communication, analysis, modification and interoperability. The ability to represent and evaluate PD considerations is critical to their long-term success, adoption and incorporation of these performance considerations into the design process. To this end, complex PD processes can be synthesized through computational methods and visual representations provide significant efficiencies within design processes.

Although the importance of computational design is emphasized by many scholars, this research also focuses upon integrated design strategies along with the potentials of computational design throughout the design process including early phases in PA. A high number of factors affect PD practices, which include architects' competences, client demands, design tools, involved parties from other disciplines, project budget, construction market and so forth. In this respect, architect's responsibility and control over the design process becomes crucial in order to achieve holistic design solutions. Actors from other disciplines are necessary for PA, yet, the ways in which they contribute to the design process need to be considered from the early phases. In this respect, computational approaches have the potential to provide the essential communication between the involved parties, and enable the transfer of design information and pursue integrated analysis processes (calculations, evaluations and simulations) to compare design alternatives within the design process.

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[1] Oxman 2006, op. cit.

The perspective of the clients is another determinant factor in performative practices. There is added responsibility on the architects to convince clients about PD advantages regarding long-term profits, and promote PD strategies for the design process. The familiarity of performative techniques is significant in the promotion of PA. To this end, the government initiatives and support are also significant for encouraging PD strategies in architectural practices. Integrated PD strategies combine the demands of the market and the clients, along with the architectural requirements and performance criteria.

Since computational PD and its implementation is relatively new in architectural design, each new PD has the potential of becoming a learning tool for the architects, engineers and other design actors. The ability to design performative buildings can be possible with, first, the necessary background knowledge on building performance, and second, with the understanding of the current conditions and barriers in the practices and compare them with the previous examples. It is beyond doubt that PD attracts continuously more attention from both professionals and academia as an integrated approach able to bridge the gap among architects and engineers. Computational design approaches are considered as valuable methods to explore PD potentials and enhance the process of architectural synthesis in PA. An interdisciplinary design process can be achieved, which all parties involve and control the design when necessary without causing a disintegration.

As a conclusion, PD approaches becomes crucial in architecture to provide the architectural requirements within the consideration of the overall building performance. If the use of different computational design approaches and methods with a design team consisting of qualified members including architects and engineers, the awareness of people on the potentials of PA will increase and such integrated performative design strategies will be achieved in professional design and architecture.

APPENDIX A

THE SEMI-STRUCTURED INTERVIEW GUIDE.

Performative design in relation to design practices	• In what aspects do you implement building performance in your projects? What are the relationships between these aspects?
Architects' Competences on Building Performance	• What basic information / knowledge should an architect have to be able to conduct a PD process? • Are the performative decisions taken based on formal / quantitative analysis and evaluation results (i.e. simulations) or are they intuitive decisions?
Client demands	• What performative factors do the owners / clients require at the beginning of the project? • Are the certificate programs (e.g. LEED, BREEAM) effective in the implementation of PD processes? • What are the differences between the projects requirements for domestic and internationally based projects?
Design Process	• How do performance factors affect design process? In which design phases are these factors considered? • Which digital design tools do you use during the design process? Are these tools able to conduct performance analysis and evaluation? • Do you think BIM tools are effective on performative architectural designs? If so, how?
Design Team	• Is performance analysis / evaluation carried out in-house by your firm? How often and on which topics do you need consultancy in the design process? • What are the communication methods used between the architects and other disciplines throughout the design process? • What is the responsibilities of involved parties in performance assessment during design? • How is the information transfer achieved between architects and other involved parties?
Conditions and Barriers	• How is a design project in which performance is prioritized different from other projects carried out by your office? • What are the most determinant barriers against conducting a performative building design?

APPENDIX B

THE TRANSLATIONS OF THE SEMI-STRUCTURED INTERVIEW QUOTATIONS.

TQ1: A very precise contract is signed with the client in order to prevent any interpretation. That means that she/he needed to demand exactly what the project involved. (Architect #5)
TQ1: Müteahhit ile çok sıkı sözleşme yapıldı. Yani hiçbir şekilde yorum yapmaması için. Yani o şartnamede o projede ne varsa onu uygulayacaktı. (Mimar #5)

TQ2: We consider performance criteria especially in the early design phases. A high number of modifications are conducted during these phases. (Architect #9)
TQ2: En çok performance kriterlerini düşündüğümüz aşama erken tasarım aşamaları. En çok modifikasyon bu aşamalarda oluyor. (Mimar #9)

TQ3: The involvement of the engineers is important for the process. They also should work on Revit or BIM-based programs so that we can move on. We had some troubled projects. There are some projects that only the architectural drawings are on Revit and the other disciplines are sending files in just 2D. [...] so that these drawings are needed to be remodeled. This cause a serious waste of time to me and the design team. (Architect #1)
TQ3: Mühendislerin bu sürece dahil olabilmesi önemli. Onlar da Revit ya da BIM tabanlı programlar çalışmaları lazım ki biz ilerleyebilelim. Öyle sıkıntılı projelerimiz oldu. Biz sadece mimari olarak Revit'te çalıştığımız ve diğer tüm disiplinlerin 2D olarak attığı şeyler de oluyor. [...] dolayısıyla atılan çizimlerin bir daha modellenmesi gerekiyor. Bu da bana ve ekibe ciddi bir zaman kaybı oluşturuyor. (Mimar #1)

TQ4: The beginning of the project takes longer. Later on, of course I think it is more advantageous for revisions or better standards and submission quality. (Architect #3)
TQ4: Başlangıç aşaması daha uzun sürüyor. Daha sonra tabi ki revizyon için, teslimlerin standartlarının daha üst kalitede olması için daha avantajlı oluyor diye düşünüyorum. (Mimar #3)

TQ5: If it is a project which our knowledge is sufficient, of course we conduct the project within our team. This becomes convenience for that project. However, there are some projects or scales that exceed our knowledge. In those projects, it is certainly required to have a consultant. (Architect #5)
TQ5: Eğer bilgilerimizin yettiği ölçekte bir proje ise tabi ki onu ekip içinde yaparız. O o proje için bir kolaylık olur. Ama bazı projeler bazı ölçekler vardır ki o bizim o bilgilerimizi aşar. O projelerde zaten mutlak suretle bir danışman olması gerekir. (Mimar #5)

TQ6: When the architects become insufficient in the technical manner, we come together with the engineers and ask about the meaning of the results and the precautions that shape the projects. (Architect #9)
TQ6: Mimarların teknik anlamda yetersiz kaldığı noktalarda yine mühendisler ile bir araya gelinip bunun anlamı nedir ne gibi bir önlem almamız gerekir diye birlikte şekillendiriyoruz. (Mimar #9)

TQ7: It is a transition phase of the world. But let's consider that an architectural design office or all the architecture community adopt BIM, so what happens? Let us say that we draw BIM, then the engineers need to use it. Let us say that the engineers use it, the consultancies need to use as well. Let us say they also use it, the contractor needs to use it. [...] Now if it is not used like this, there is no sense if an architectural office work with BIM. (Architect #5)
TQ7: Dünyanın bir geçiş aşaması bu. Ama bu bir mimarlık ofisini ya da bütün mimarlık camiası desek ki BIM'e geçti, ne oldu? Diyelim ki biz BIM çizdik, mühendislerin

de kullanıyor olması lazım. Peki mühendisler de kullandı, danışmanların da kullanması lazım. Danışmanlar da kullandı, müteahhitin de kullanması lazım. [...] Şimdi bu eğer böyle kullanılmazsa mimarlık ofisinin çalışmasının bir anlamı yok yani. (Mimar #5)

TQ8: The sources that can be found out of school are very limited. There are the Chamber of Architects or the trainings in the market. [...] The education needs to be given consciously and the ones out of school are not sufficient. They do not consider the problems that can be confronted in the market. (Architect #1)
TQ8: Okul dışında dışarıda bulunabilecek kaynaklar sınırlı. Mimarlar odası ya da piyasada verilen eğitimler var. [...] Bu eğitimin bilinçli verilmesi gerekiyor ve dışarıda verilen bu anlamda yeterli değil. Piyasada karşılaşılabilecek sorunlara hiç değinilmiyor. (Mimar #1)

TQ9: The most important thing is to be able to find proper communication methods. In order to succeed the project, we are trying to explain the long-term results of the investments. (Architect #9)
TQ9: En önemlisi doğru iletişim kanallarını bulabilmek. Projenin başarıya ulaşması için uzun vadeli yatırımların sonuçlarını anlatmaya çalışıyoruz. (Mimar #9)

TQ10: We are generally, even when we know how to conduct a work, trying to work with someone who is in this sector. We consider with whom we can work in order to enrich the design. [...] In spite of the fact that we are able to pursue most of the things in-house, we are trying to work wtih as many people as possible in order to let the sector grow together. (Architect #9)
TQ10: Biz genelde kendi bildiğimiz bir şey de olsa sektörden birileri ile iş yapmaya çalışıyoruz. Kimlerle beraber yapsak da daha zengin bir şey olsa diye. [...] Biz hani çoğu şeyi içerde yapabildiğimiz halde olabildiğince herkesle beraber bir şey yapmaya çalışıyoruz ki sektör beraber büyüsün. (Mimar #9)

TQ11: ...let us say for not losing that market. When it is started to be a condition in biddings, the rest also comes. And if you cannot fulfill that standard, you become prehistory. [...] It may be even resulted that you pulled out of the market. (Architect #3)

TQ11: ...o pazarı kaybetmemek için gibi diyelim. Bir kere artık ihalelerde şart olarak kullanılmaya başlandığında, devamı da geliyor. Ve o standardı yakalayamazsanız da tarih öncesi kalıyorsunuz. [...] O pazardan çekilmeye kadar gidiyor bunun sonuçları. (Mimar #3)

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