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RE-UNDERSTANDING MULTIDISCIPLINARY BUILDING DESIGN PROCESSES TOWARDS THE CONCEPT OF SUSTAINABILITY: A MULTI-LAYERED DESIGN APPROACH

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

ÖZGE SELEN DURAN

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
BUILDING SCIENCE IN ARCHITECTURE

JULY 2022

Approval of the thesis:

RE-UNDERSTANDING MULTIDISCIPLINARY BUILDING DESIGN PROCESSES TOWARDS THE CONCEPT OF SUSTAINABILITY: A MULTI-LAYERED DESIGN APPROACH

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ABSTRACT

RE-UNDERSTANDING MULTIDISCIPLINARY BUILDING DESIGN PROCESSES TOWARDS THE CONCEPT OF SUSTAINABILITY: A MULTI-LAYERED DESIGN APPROACH

Duran, Özge Selen
Doctor of Philosophy, Building Science in Architecture
Supervisor: Prof. Dr. Celal Abdi Güzer

July 2022, 245 pages

Sustainability has been one of the most researched and discussed issues within the realm of architecture as a discipline and also within the building design as a practice. However, the focal point in the majority of existing studies concentrate primarily on the design development and building performances based on the components of the design, where pre-design and post-design phases as well as multidimensional contribution of different actors are excluded. Therefore, perceiving and evaluating the entire processes and all the actors involved in these processes from a broader new perspective would provide more comprehensive achievements of sustainability. In addition to these concerns, the design process itself should have been carried out in a more sustainable manner, improving the design communication, collaboration and correspondences of multidisciplinary teams in complex building design projects.

A wider understanding of sustainability is required for the achievement and more effective utilization of multidisciplinary building design developments and their relevant lifecycles. Such a multi-layered understanding of sustainability is required not only due to the integration of multidisciplinary contribution through a broader lifecycle, but also to the integration of additional dimensions to the sustainable building design development execution processes. This multidimensional approach would inevitably serve a multi-layered structure as enabling multiple data entries and follow-ups by various users with their individual priorities or concerns through the entire sustainable lifecycles for many different possible scenarios.

Keywords: Sustainable Building Design, Lifecycle, Building Design Processes, Multi-layered Design Approach

ÖZ

BİNA TASARIMLARINDA ÇOK DİSİPLİNLİ PROJE SÜREÇLERİNİ SÜRDÜRÜLEBİLİRLİK KONSEPTİNE DOĞRU YENİDEN ANLAMA: ÇOK KATMANLI BİR TASARIM YAKLAŞIMI

Duran, Özge Selen
Doktora, Yapı Bilimleri, Mimarlık
Tez Yöneticisi: Prof. Dr. Celal Abdi Güzer

Temmuz 2022, 245 sayfa

Sürdürülebilirlik, hem bir disiplin olarak mimari tasarım ortamında, hem de bir pratik olarak yapı ve üretim alanında oldukça yoğun araştırılan ve tartışılan bir konudur. Buna karşın sürdürülebilir tasarımlarla ilgili tartışmaların ana odak noktası tasarım geliştirme sürecine ve yapı bileşenleri temelinde yapıların performanslarına odaklanmakta, tasarım öncesi ve sonrası süreçler ile farklı aktörlerin sürece yönelik çok boyutlu etkileri yeterince göz önüne alınmamaktadır. Bu nedenle, tüm süreci ve içerisinde yer alan farklı aktörlerin bu süreçler üzerindeki çok boyutlu katkılarını daha geniş bir perspektiften anlamak ve değerlendirmek, daha kapsamlı bir sürdürülebilirlik kavramının elde edilmesini sağlayacaktır.   Bu amaçlara ilave olarak, özellikle karmaşık yapıların tasarımında yer alan farklı disiplinlerden ekiplerin tasarım iletişimini, iş birliğini ve iletişimlerini geliştirmek için, tasarım sürecinin kendisi de daha sürdürülebilir bir yaklaşım ile ele alınmalıdır.

Çok disiplinli yapı tasarım geliştirme süreçlerinin ve ilgili yaşam döngülerinin sağlanabilmesi ve daha verimli olabilmesi için bu anlamda kapsamlı bir

sürdürülebilirlik anlayışı gereklidir. Bu çok katmanlı sürdürülebilirlik anlayışı sadece daha geniş zeminli bir yaşam döngüsünde farklı disiplinlerden katılımın entegrasyonu için değil, aynı zamanda sürdürülebilir yapı tasarım geliştirme ve uygulama çalışmalarının entegrasyonu için de ihtiyaç duyulmaktadır. Çok boyutlu bu anlayış kaçınılmaz bir şekilde farklı kullanıcıların, olası tüm senaryolar için, sürdürülebilir yaşam döngüsünün bütününde, kendi öncelik ve değerleri çerçevesinde çoklu veri girişleri ve takipler yapabilmelerini de sağlayacak çok katmanlı bir yaklaşım sunmuş olacaktır.

Anahtar Kelimeler: Sürdürülebilir Bina Tasarımı, Yaşam Döngüsü, Yapı Tasarım Süreçleri, Çok Katmanlı Tasarım Yaklaşımı

To My Beloved Family

ACKNOWLEDGEMENTS

As a priority I would like to express my deepest gratitude to my supervisor Prof. Dr. Celal Abdi Güzer for his guidance, advice, criticism, encouragements and insight throughout the research. This study's comprehensive content and approach would not be completed without his open-minded, profound and collected suggestions and critics, together with the practical approach and contributive encouragements.

I would also like to thank to my very valuable thesis committee members, Prof Dr. İrem Dikmen Toker and Prof. Dr. Talat Birgönül who guided me throughout this long research with patience and continuous support as well as their belief in me on my enthusiasm to contribute to the discipline with my intended research approach; and Prof Dr. Nuray Bayraktar and Prof. Dr. Nur Çağlar for their valuable suggestions and comments.

I wish to express my sincere and special thanks to the Chair of Metu, Architecture Department, Prof. Dr. Cana Bilsel for her support and understanding throughout my PhD research study period. Also, I would like to thank to Bilkent University Department of Architecture all of my colleagues for all their supports and motivative encouragements throughout the finalization of this thesis study.

The technical assistance of Elif Gamze Dedeler is also gratefully acknowledged.

Lastly but not the least, I am very grateful to my family, particularly my spouse, Murat Duran and my daughter, Selen Su Duran, together with my parents for their constant support, patience, understanding through this lengthy PhD journey.

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CHAPTER 1

INTRODUCTION

1.1 Problem Definition

Sustainability has been one of the most researched and discussed issues in both architecture as a discipline and building design as a practice. The concept dates to 18th century, but it was in 1987, in the publication 'Our Common Future' (WCED,1987) an official definition was introduced and agreed, stating that sustainability should be defined as meeting the basic needs of all people and extending to all the opportunity to satisfy their aspirations for a better life without compromising future generations' ability to meet their own needs. Thereafter, various research and new approaches to enhance sustainability have been conducted. However, it was mostly in the recent years that the term gained attention and a level of prominence (Caradonna, 2014). Furthermore, rapid technological and economic advances over the last two centuries combined with population increase and extensive exploitation of nonrenewable natural resources, have fostered the relatively recent re-emergence of the sustainability concept (Chen and Chambers 1999; Horvath and Matthews 2004, as cited by Chon et al, 2009). Consequently, sustainability has gone from a marginal ecological idea to mainstream movement in a remarkably short period of time (Caradonna, 2014). Moreover, a major shift has been observed in the concept of sustainability over the same last two decades, from the focus on environmental issues like resource efficiency, to the broader social and economic issues like social equity and poverty reduction (Berardi, 2013a; cited by Goel, 2019). Therefore, many different studies, discussions and proposals have been conducted to question how to improve the achievement of sustainable designs as an output of today's complex building design processes.

Despite the vast majority of research focusing and studying on factors or impacts directly effecting building performances for the achievement of sustainability, there have been not many research focusing and emphasizing that; the building design development process should have been perceived as a total lifecycle, which begins with the very early decision-making processes and ends with the latest decisions even including the waste management after demolition. Building design is claimed to be one of the most effective factors for consuming the resources and producing various types of waste and therefore, it still needs improvement in order to be sustainable in terms of both its processes as well its outcomes. According to Sassi (2006), 'buildings, their construction, use and disposal have a significant impact on the natural environment and social fabric of our society'. Consequently, the impact of built environment on a sustainable world is also inevitably dominant. Thus, sustainability achievement considerations and sensitivity in building design industry must have specific efforts, first to minimize their negative impacts like carbon footprints, excessive use of resources and energy consumptions, and second to make positive contributions for multiple domains social, cultural, physical, environmental and contextual, to the communities by providing efficient improved solutions to enhance psychological physical and global well-beings (Sassi, 2006).

In general, however, the focus and contribution of these sustainability studies have been on the performances of those building design developments, revealing the prioritization of technical features, constraints and specifications required to achieve sustainability as an outcome. Furthermore, the majority of these research and studies place significant emphasis on efficiency, innovation and high technology as the solutions of environmental problems (Yalçın & Acar, 2017). Various streams of sustainability thought, or "typologies of environmental logic" have been identified in the architecture literature and can be distinguished according to the level of emphasis placed on technology; culture and values; aesthetics or health and social considerations (Guy and Farmer, 2001). However, most of these attempts underestimate and even overlook the relevance and the significance of sustainable design processes. Hence these design processes, which need to be sustainable for the continuation of a sustainable building design development strategy, continue to generate most of the waste and are not sustainable at all. In relation to these concerns and research on promoting sustainability in existing built environments, the necessity for the improvement of processes by which building design developments have been executed and outputs have been reached consequently, has been raised in some research. As stated by Rekola et al (2012), processes must be facilitated while outcomes have to be controlled (Volker & Prins, 2005), demonstrating that the two are strongly interdependent and inseparable. This approach on improving building design development processes and projects to achieve sustainability as a broader output; requires an approach and a thorough understanding of integrated project design, since the entire lifecycle of building design development processes must be integrated to be optimized and thus become significantly more efficient. Keeping in mind that the existing built environments are primarily the consequences and direct results of various interdependent impacts of actors, factors, exchanges, priorities or concerns, that are acting synchronously, sequentially or iteratively within the overall development process of each design built on them, not only the outputs but also the processes leading to these outputs should also be improved and sustained to achieve more efficient building design developments. Consistent with the increase in the complexity and multi-disciplinary requirements of building designs, the studies focusing on developing these integrated project designs have mainly concentrated on the efficiency and the performance of the outputs, but not on the priorities of all participants, or constraints of structure or even the management of tasks or exchanges held. In addition, they have primarily disregarded or undervalued the importance and the improvement of the overall process to achieve sustainable building designs. Furthermore, they have neither sought nor discussed the need for a much more comprehensive approach in terms of multi-layered approaches, interdependent matrices or re-defined process maps to be followed by all actors involved in the execution of building design development.

Regarding all the previous research and studies on sustainability domain, there is still uncertainty in the definition or perception of this concept from the perspective of certain studies, such as whether the term invokes a justification or absence of an action (Kidd, 1992). Consequently, lack of critical or major components of the building design development processes negatively promotes this uncertainty that the process cannot be carried out as a sustainable action then. Continuing with the essentials of a lack of or insufficient awareness of sustainability achievements in the building design development research, one of the primary domains lies in the integration of diverse but highly interconnected and effective factors throughout the process's whole lifecycle. Local, regulative, contextual, administrative and people related factors have been some of the most influential factors on the development and improvement of sustainable building design processes and their success. These must be incorporated in the process beginning even before the design development process, since the absence of or improper sorts of policies, regulations, steering mechanisms and the associated instruments can impede the dissemination of sustainable practices (Chong et al, 2009; Hakkinen and Belloni, 2011). Different researchers have identified the existing integration approaches as insufficient and thus as serious barriers to the achievement of sustainability. According to Yalçın & Acar (2017), the fragmented structure of the building industry, where stakeholders have diverse priorities, visions, ideas and technical knowledge base, makes it difficult to develop a shared sustainability agenda and achieve goals in an integrated manner. Consequently, the level of collaboration, networking, and information exchange (Klotz and Horman, 2010) as well as knowledge on the types of decision-making phases, new tasks, actors, roles and networking methods, have been essential for an improved sustainability process and for a sustainable environment (Hakkinen and Belloni, 2011).

As Caradona (2014) also stated; most of the research associated with sustainability have expanded dramatically; introducing new tools and methods utilized to define, measure and assess sustainability of the building design outputs that they produced. The significance, however, lies in the new perception and approach of perceiving the entire lifecycle as total collaboration of multilayered processes with multidimensional sustainability approaches. This perception of integrated design process is crucial for the achievement of sustainable building design development, as not only do various interacting and effective but also conflicting factors act in the process. Furthermore, the entire process requires a multidimensional and multilayered approach to manage these ongoing interactions, considering the priorities, privileges and concerns of determinants. Thus, sustainable building design requires a comprehensive understanding and command of multileveled, interconnected, and sometimes contradictory requirements as well as the capacity to collaboratively create new innovative solutions that meet these demanding requirements (Rekola et al., 2012).

In continuation with the mutual and intersecting goals of above mentioned highly related and interconnected domains, seeking sustainability in the entire lifecycle of building design development processes, the main problem definition to be researched within the focus of this PhD dissertation has been determined as; the lacking of a comprehensive approach to be followed by different actors involved in different stages of the building design development process to achieve maximum sustainability for different scenarios including variations in scale, typology or context. This new approach and re-understanding also aim to address deficiencies and problems, caused due to a failure to integrate all interdependent factors into a single comprehensive and broader strategy. Furthermore, there is a risk that, today each building design's unique, multidisciplinary and complex development process, if not been perceived with the common concerns and priorities of both sustainability and integrated project design domains, and thus not executed within a comprehensive approach, will inevitably continue to end up with similar consequences of insufficient and lacking sustainability levels and to produce similar wastes being far apart of sustainable at all.

In conclusion, the main problem has been defined as the absence of a comprehensive approach to sustain the building design development processes and prevent insufficient implementations of sustainable building design development outputs in built environments. Therefore, developing a re-understanding to be followed by various actors like decision makers, professionals and the users of the building, in each stage of building design development process, beginning with the site selection and ending with the demolishment, if necessary, available for different scenarios of building projects independent from typology, scale, context or the location, has been determined to be proposed as an output of this PhD dissertation. This multidimensional re-understanding has also been developed further in this research to generate and serve a multi-layered design approach towards the concept of sustainability.

1.2 Aim

Considering the built environments as a result of current building design development practices, it is inevitable that there are still major and essential problematic domains to be researched, discussed and developed to contribute to sustainable building design developments. Consequently, the primary objective of this research is to develop a comprehensive re-understanding for sustainability in the multidisciplinary building design development lifecycles that not only contributes but also serves different paths of solutions and process maps to be utilized by various actors of any sustainable building design development process, in accordance with their changing and potentially conflicting or merging priorities, concerns, contexts and scenarios. This main aim has been structured on four divisions, which collectively constitute a broader intention for achieving sustainability. Understanding the current condition of successful developments, achievements and inadequacies in terms of sustainable processes and outputs is the first step. The second step, on the other hand, includes the intention to determine and clarify the process's fundamentals, justifications, and priorities that may not lead to or end up with the desired sufficient sustainable built environments. This step has been followed by a third step, whose primary objective is to identify the design inputs that are lacking or inadequately processed in the existing sustainability achievement methodologies. As a final step, which also establishes the grounding of the main aim, it has been determined to develop and propose a comprehensive multidimensional re-understanding; including multi-layered different design concerns and priorities, superimposed on different mediums to reveal and guide the required processes to follow for the enhancement of a sustainable building design development lifecycle. In this last step, as an addition, alternative checklists have also been developed to display the operability of this new approach. The fundamental characteristics and components of the elaborated lifecycles of sustainable multidisciplinary building design developments will contribute to the development of these multi-layered approach, which have been proposed in order to operationalize the new re-understanding.

The aforementioned possible intentions of this new comprehensive re-understanding have been established in an approach where the development processes involve not only the design aspects, criteria or system selections, but rather the impacts and interdependencies, those of which also establish the crucial relationships between the output, its context and the process through which the output has been achieved. This approach intends to comprehend the entire process as a sequence of interdependent relationships and interactions to be re-structured. In continuation of this intention, since different concerns are required and effective in every decision through the entire lifecycle, additional sustainability concepts are required to be developed and integrated to act together inside the process. Furthermore, the individualistic and dissociative approaches on 'one' feature in isolation from others, while neglecting the optimization and efficiency maximization potentials of their integration, resulted in unsustainable processes and environments. Therefore, a better and more efficient approach has better to emphasize an integrated and a much more comprehensive understanding of sustainability, with new additional sustainability concepts contributing to its broader achievement.

Due to the uncertainties on the improvement ways for the process itself, the execution processes of sustainable building designs have shown a second major concern. Particularly, perceiving the essentials of the process form the perspectives of various actors for the completion of various interdependent and superimposed tasks in different stages with multiple complex exchanges, in terms of individual priority or concerns occurring concurrently, revealing these different conflicts, potentials or continuities arising from the individual perspectives (concerns or priorities) of different actors involved in sustainable building design development processes. In addition, consistent with these concerns and considerations, it was determined that priorities would be derived by not only from extensive research and literature surveys, but also from data derived on the consequential analyses of built environment.

In continuation with the multidisciplinary nature of the design environments in sustainable building design development processes, it is also crucial to consider and elaborate on the process with an integrated approach that includes pre-design, and post-design processes as part of a comprehensive strategy. By perceiving the total process in such a broader perspective, a comprehensive new approach with its operational tools, has been developed with a new design approach. This multi-layered approach also has the potential to serve different paths and process maps to be utilized by different actors for different scenarios including new building design, adaptive re-use or rehabilitation.

In conclusion, the 'comprehensive re-understanding for multidisciplinary sustainable building design development processes is intended to be developed through the concept of sustainability, within this research. This new approach independent from the specifications of any building design may serve a base process-path in different formats of proposed of alternative tools, that might be referred, consulted, utilized, benefited and adjusted accordingly to enhance sustainable building designs as a common goal.

1.3 Methodology

As a general methodology on developing the new re-understanding of multidisciplinary building design development processes and sustainable lifecycles, a two-stepped methodology has been established and followed in this research.

The first step of the methodology entails the analyses and thorough research on the existing built environment to reveal the significant relationships between reasons and consequences, such as building design development process perception, design development stages, relevant regulations, standards, general design criteria, typological references and tendencies and common priorities. In this initial phase, the common design development path has been defined, including and focusing not only on the core design development stages but also on the procedures that precede and follow them. When developing these paths with a broader building design stages approach, the specifications and priorities of each stage that must be considered throughout the analyses of different approaches, have been identified as significant factors. These aspects revealed at this stage have contributed to the development of new approach, not only in terms of their cross-related impacts, but also in terms of their interdependencies and specific priorities or concerns within their own criteria and exchanges.

As a second step, the methodology includes further research and derivations on all fundamental features of a broader conception of sustainability. These additionally derived data have also been analyzed and supported with case studies and also with the developed multilayered, cross-referenced tables. In the process of conducting the case studies, multiple objective criteria were applied to selected real-life actual building design complexes, representing a range of typologies and scales in order to see and verify whether the newly proposed sustainability concepts comply to reality.

Furthermore, the extensive analyses on the existing studies, have been used as the foundation to reveal the lacking aspects and required additional aspects to achieve a broader sustainability. Based on this grounding, new additional sustainability concepts might have been derived, developed and proposed to set the framework of this re-understanding and the new approach developed within the main objective of this thesis. In the second part of the methodology these derived concepts have been subjected to multiple various different analyses in multidimensional aspects. One of the mediums that these concepts have been correlated was the case studies, which have been selected among the real-life realized building outputs. The reference of selected building design typologies and classification systems have been determined in reference to the classification of significant authorities of Turkish building industry such as: Chamber of Architects of Turkey and The Ministry of Environment, Urbanization and Climate Change or Turkey. The data and the regulations of Turkish building industry have been taken as reference also for further analyses, where the significance of these additional sustainability concepts have been searched in relation to each building classes' origin of investment as being either public or private.

As the final study of this step, alternative checklists have been developed in order to display the operability of the new multi-layered approach is developed for the re-understanding of multidisciplinary building design developments through sustainable lifecycles. In the development of these alternative checklists, all of the gathered data, findings of the literature survey as well as the correlations and superimpositions of the multilayered research have all been integrated to produce an efficient and effective tool. This tool has been intended to be utilized by different actors with various approaches, concerns, priorities or privileges, in different overlapping or dispersed building design stages in order to help the fulfillment of additional important sustainability concepts in different scenarios.

In conclusion, the re-understanding of multidisciplinary sustainable building design development processes has been developed in such a way that, independent from the building design specifications of typology, context, scale and location, it may be referred as a new multi-layered approach and a comprehensive mind map that helps to understand, perceive, plan, execute, monitor revise-if necessary, control and proceed, all of the building design development processes in a sustainable way with maximum efficiency and long term expectancies.

1.4 Limits of the Study

Sustainability is a broader concept that encompasses multiple industry domain, with complex interrelated relationships and interdependent impacts of numerous concerns due to priorities of different disciplines. This current complex and interdependent situation of the building design development domain in the industry has the disadvantage of dealing with closely connected and overlapping environmental variables and influences. However, in general the existing research miss the requirement of this highly dependent integration. Therefore consequently, the built environments face the undesired results in the outputs due to prioritizing one single concern over the other concerns to achieve sustainability. This type of approach also leads to dissociating the causes as well.

This PhD research therefore aims a broader framework and a comprehensive approach in which necessary aspects and required components of sustainability can be derived and developed. In order to be able to develop a re-understanding and to achieve such a comprehensive approach, three main limitations have been determined and considered to be excluded from the scope of this PhD research.

In further detail, within the scope of this PhD research, the following approaches and limitations have been determined:

i. Although the surrounding built environment has significant effects on the enhancement of a broader and more efficient sustainability, the improvement of existing building stock and relevant strategies to integrate existing building inventory in sustainability achievement approaches have been excluded from the scope and aim of this study.

ii. The local impacts and contextual references have significant impacts on the efficiency and sustainability of any building design development. Therefore, the thorough analyses on the typologies and building classes, the design development stage classifications, contextual references and relevant real-life examples, legal and legislative regulations, case study analyses and development of further matrixes have all been conducted with reference and in limitation of the building design context of Turkey.

iii. The third limitation has been determined related to a current sustainability concept; corporate sustainability. Since the main objective and concern of this PhD research is focusing on building design development and its consequential outputs in the built environment, all of the additional sustainability concepts have been developed and proposed according to and around this main concern, and therefore inevitably excludes this other important research study topic of corporate sustainability, which focuses on a rather different domain of study, namely the management.

For the first limitation, although it is really crucial to raise an awareness on the building design industry for the priority of first evaluating the existing building stock instead of immediately building new ones; this approach requires serious research, further studies and significant contributions of other disciplines. In further explanation, considering different ways of re-using of existing building stock such as, reuse, refurbish, adaptive reuse, re-function, re-model, revitalize, restore, renew or retrofit, additional and specialized studies from different disciplines like sociology, urban studies, macro and micro economy, cultural, heritage, human sciences or history are required. As Stone (2019) also highlights this multidisciplinary necessity as; the reuse of an architectural site is definitely connected with a bygone age and also it establishes an explicit relationship with context and history, not only with the building and its immediate surroundings, but also with the society that built it. Stone also continues to underline this complexity of re-use of an existing environment by discussing the symbiotic relationship created within the strata of time and space as a result of the communication between the original structure and details of an existing building and the newly added programmatic requirements and elements. These studies demonstrate, once again, that the inclusion of existing inventory / building design stock as a type of reuse for a comprehensive sustainability achievement exceeds the scope of this PhD study due to the numerous specialized studies it necessitates. Furthermore, the current building design industry has little patience to wait for a reevaluation of these potentials and is in a proactive position to generate new outputs. In order to prevent inadequacies and undesired results in their execution, the majority of the research focuses on the improvements of these new designs and on the development and support of the missing aspects of these studies.

For the second limitation, since the context is one of the major impacts within the building design development process by effecting not only design related concerns, but also local adaptations regulations, administrative and legal issues; the Turkish context has been determined as the main reference, during the development of this comprehensive re-understanding. As mentioned by numerous researchers, including Yalçın & Acar (2017), the surrounding context is an essential component and factor, which cannot and should not be isolated; thus, a better understanding of the significance of contextual factors that surround the technical aspects of sustainability debate is necessary. Furthermore, as Chong et al (2019) mention, the essential improvements of sustainability and the requirements of achieving sustainability are particular and very dependent to the project's scope, regional differences, backgrounds of the stakeholders involved and the economic and environmental developments and social perceptions of the context in which the building design project exists. Brand and Karvonen (2007) supports this importance of being bonded to the specific context of the local environment, by defining sustainability as 'being locally specific', because it is more a matter of defining local interpretation than of establishing objective or local goals" (Brand and Karvonen (2007)- cited from Guy and Moore (2004)). Moreover, the local system and local adaptations of global approaches generates additional discussions and reveals broader application possibilities as strategies, systems and the emphasis on the applicability of key objectives for addressing sustainability should be locally valid (Berardi, 2013a). Under the guidance and with the grounding of these discussions in previous studies, which reveal the impacts of local context to achieve much more effective sustainability, the second limitation has been determined as the contextual reference of Turkish building design industry. In further explanation, the real-life case study examples, the building class references for grounding the typological relationships as well as the building stages and the relevant building design development stage determinations, have all been conducted with the priority and reference to Turkish building design development context and relevant practice of the industry in mind. A further goal and potential of this limitation is in the prospective and short-term applicability of this new approach and the proposed alternative checklists, to be utilized and adapted by the professionals of the practice in the context of Turkey.

For the last third limitation, although among the various research on sustainability, corporate sustainability has been emerging as one of the important and recent approaches, due to its main focus on management, business and company-based aspects it has been excluded from the scope of this study. Corporate sustainability generally refers to a company's activities and includes the social and environmental concerns mostly in business operations in integration of stakeholders (Van Marrewijk & Werre, 2003) for the benefit of the companies in long term, which brings sustainability inevitably. However, this type of approach has been better to be integrated after developing and improving the existing building design development processes in terms of their fulfillment of sustainability in additional dimensions as well. Therefore, corporate sustainability has been excluded from the newly developed and proposed additional sustainability concepts of this research.

These limitations have been determined in order to both set a more accurate framework for the research study as well as to clarify the grounding discussions leading to the proposed re-understanding and developed multi-layered design approaches to achieve a comprehensive sustainability in multidisciplinary building design development processes.

CHAPTER 2

SUSTAINABILITY AS A BROADER CONCEPT IN BUILT ENVIRONMENT

Contrary to how it has been perceived in general, sustainability is an old notion that dates back to the time of Vitruvius (Dabija, 2020), when the relationship between place and design was discussed to determine the sustainability of a building design. However, it wasn't until 20 years ago that the term sustainability has gained attention and began to be more widely recognized and discussed, as a result of changing global conditions and environmental concerns. Moreover with the growing population resulting in an increase of urban developments and an uncontrolled expansion of the settlements through rural areas, excessive usage of resources has increased to such a degree that the awareness and sensitivity towards the issues of preserving the world and its scarce and limited natural resources with more controlled and optimized energy efficiency utilizations has become one of the most important approaches that many communities, initiatives, authorities have united and agreed. Through these discussions and studies, a number of analyses on the reasons and impacts have been conducted, followed by simulations of monitoring and comparison of the past and existing situation in order to foresee the future consequences, which have been followed by many proposals of approaches, strategies, systems, solutions and agreements in common. As a natural consequence of these discussions and studies, it became clear that the construction industry, with its rapid growth and impact on various disciplines / fields such as, economies of countries, social and cultural developments of communities, is one of the most significant consumers and polluters in our built environments. The foremost concern of the construction industry and all of its widely dispersed applications like construction, manufacturing, project development, urban planning or infrastructure, is the prevention of the undesirable occurrences, the control of their effects on the existing environment and the maintenance of an improved and better environmental development of the entire world.

It was with the World Commission on Environment and Development's (WCED,1987) report, when an official, or more agreed on, definition on sustainability emerged. In the publication called 'Our Common Future', sustainability concept has been defined as; meeting the basic needs of all people and extending to all the opportunity to satisfy their aspirations for a better life without compromising the ability of future generations to meet their own needs. Regarding this basic definition of WCED, one of the main issues in the definition has been raised as to meet the current or future populations' own needs. Consequently, the construction industry together with all of its associated actors, appear to be the main responsible that serves the demands, requirements or necessities of communities.

Going deeper into the fundamentals and components of the construction industry, the Architecture and Engineering disciplines have been identified as the primary parties responsible for the decisions and executions of the design outcomes, as well as the post–construction efficiencies (occupancy-based and operational) of the built environment. As Attia (2018) has also underlined, the building's being guilty of today's environmental situation is because of its both producing 40%of carbon emissions and 60% of waste worldwide and also at the same time consuming %14 of water (Petersdoff et al. (2006) as cited by Attia, 2018). Since the built environment has many impacts through of its lifecycle covering a large duration of time (starting from micro level to the macro level); additional terminologies like 'sustainable building', `sustainable construction' or 'sustainable development' have also been introduced to be more specific and contributive in those domains. In order to illustrate the approach variations between them, some examples of each distinct definition have been provided below. According to John et al. (2005) the term 'sustainable buildings' may refer to building practices, which strive for integral quality including economic, social and environmental performance. Whereas ‘sustainable construction’ as another term has been described as rather the process than defining the output, as it begins in the planning and design stages, well before actual construction and continues long after the construction where the team has left the site (Hill & Bowen, 1997). ‘Sustainable development’, however, focuses on the processes that integrate both sustainable building and sustainable construction. On the other hand, in the publication ‘Caring for the Earth’[1] `sustainable development’ has been defined as development that `improves the quality of human life while living within the carrying capacity of supporting eco-systems’ (Hill & Bowen, 1997).

Building construction plays a vital role in sustainable development, not only because of its effects on the economy, but also because of its significant influences on life quality, comfort, security and health (Zabihi et al, 2012). Therefore, the sustainability concept in the built environments and the ways to achieve those sustainable outputs have become more dominant and a governing approach among all of the sustainability discussions and intentions.

Another terminology regarding a better future, has been named as ‘green approach’ in general, which has been frequently used in many discussions on sustainability topic. Green emphasis is an avoidable component of sustainability; since it offers and highlights responsible and reduced consumptions of resources, or recycling efforts for wastes, as well as optimized and efficient utilization of energy. However, energy utilization; sustainable building design developments require a much more comprehensive approach than sole green emphasis and a thorough implementation of various strategies, tools and concepts to achieve a fully sustainable outcome.

Although green buildings, ‘energy–efficient’ or ‘environmentally friendly’ buildings and sustainable buildings share a common initial concern for a more controlled and

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[1] Caring For Earth A Strategy for Living’ is a publication by IUCN – The World Conservation Union, UNEP – United Nations Environment Programme and WWF- World Wide Fund for Nature in 1991.

less harmful impact on the environment, it must be acknowledged that sustainability includes much more than being solely dependent on energy or resources, but rather a much broader approach and concern for the whole lifecycle efficiency. Moreover, all relevant components of the building design developments should have been incorporated at several levels of sensitivity to fulfill different concepts of sustainability, such as environmental, economic and social. Although there are many different definitions for green building; Robichaud and Anantatmula (2011) have summarized some basic definitions and compared them with each other as green building vs. sustainable design vs. sustainable development with a brief figure in their research (Figure 2.1). After this comparison, they have concluded that sustainable design and green building design are considered to have a common philosophy and associated project and construction management practice that aim to achieve the following objectives:

i. minimize or eliminate impacts on the environment. Natural sources and nonrenewable energy sources to promote the sustainability of the built environment
ii. enhance health, wellbeing and productivity of occupants and whole communities
iii. cultivate economic development and financial returns for developers and whole communities
iv. apply lifecycle approaches to community planning and development

Term	Definition	Quoted source
Sustainable design	A design philosophy that seeks to maximize the quality of the built environment, while minimizing or eliminating negative impacts to the natural environment.	McLennan (2004), The Philosophy of Sustainable Design
Green buildings	Buildings that are designed, constructed, and operated to boost environmental, economic, health, and productivity performance over conventional building.	U.S. Green Building Council (2003), Building momentum
Green building	The careful design, construction, operation, and reuse or removal of the built environment in an environmentally, energy-efficient, and sustainable manner; may be used interchangeably with high performance building, green construction, whole building design, sustainable building, and sustainable design.	McGraw-Hill Construction (2006), Green building smart market report
Green building	The practice of (1) increasing the efficiency with which buildings and their sites use energy, water, and materials and (2) reducing impacts on human health and the environment through better siting, design, construction, operation, maintenance, and removal—the complete building life cycle.	Cassidy (2003), quoting the Office of the Federal Environmental Executive White Paper on Sustainability
Green building	The process of building that incorporates environmental considerations into every phase of the homebuilding process. That means that during the design, construction, and operation of a home, energy and water efficiency, lot development, resource-efficient building design and materials, indoor environmental quality, homeowner maintenance, and the home's overall impact on the environment are all taken into account.	National Association of Homebuilders (2006), Model green homebuilding guidelines
Sustainable construction	The goal of sustainable construction is to create and operate a healthy built environment based on resource efficiency and ecological design with an emphasis on seven core principles across the building's life cycle: reducing resource consumption, reusing resources, using recyclable resources, protecting nature, eliminating toxics, applying life cycle costing, and focusing on quality.	Kibert (2005), quoting the Conseil International du Batiment (CIB), Sustainable Construction: Green Building Delivery and Design

Figure 2.1.Comparison Of Green And Sustainable Practices (Design, Building Or Development) in Definition (Robichaud & Anantatmula, 2011)

However, Berardi (2013) mentioned many more other issues and requirements that must be met before considering about any building design as sustainable, as summarized in a table of comparison in Figure 2.2.

Table 1
Major issues in green and sustainable buildings, adapted from UNEP (2003).

Major issues of the building performances	Green building	Sustainable building
Consumption of non-renewable resources	x	x
Water consumption	x	x
Materials consumption	x	x
Land use	x	x
Impacts on site ecology	x	x
Urban and planning issues	(x)	x
Greenhouse gas emissions	x	x
Solid waste and liquid effluents	x	x
Indoor well-being: air quality, lighting, acoustics	(x)	x
Longevity, adaptability, flexibility		x
Operations and maintenance		x
Facilities management		x
Social issues (access, education, inclusion, cohesion)		x
Economic considerations		x
Cultural perception and inspiration		x

Figure 2.2. Major issues in green and sustainable buildings, adapted from UNEP (2003) (Berardi, 2013)

Sustainable development requires meeting four key objectives simultaneously on a global scale (Masood,2007, as cited in Zabihi et al, 2012).

- Social progress which recognizes the needs of everyone
- Effective protection of the environment
- Prudent use of natural resources
- Maintenance of high and stable levels of economic growth and employment.

Therefore, in order to achieve these objectives, the development and incorporation of concepts and approaches pertinent to these objectives are emphasized and prioritized.

Continuing with the discussions on sustainability and its (uncertain) definitions; there have been other definitions raised by different researchers, such as Mihelcic et al. (2003), who defined sustainability as the combined design of human and industrial systems to ensure that humankind's use of natural resources to adverse impacts on social conditions, human health and the environment (as also cited by Mukherjee & Muga, (2010)). This definition has also emphasized social conditions, economic opportunity and environmental quality as the three primary components of a sustainability approach.

These three important concepts of sustainability have also been emphasized and displayed by several research as the inevitable and fundamental components of sustainability. Similarly, Plassis (1999) underlined that a sustainable development requires a continuous process of balancing all three in order to achieve an optimum result in terms of sustainability. These three aspects are defined and named as ‘three bottom line (TBL)’ for sustainability and have strong, interdependent and bounded relationships with one another. As Mensah (2019) also supports this idea by stating that, for an efficient sustainability achievement, people should base their economic and social lives on the economic resources available for human development.

Despite the fact that sustainable development has become increasingly popular in surrounding built environment approaches and in contemporary development discourse, the concept still lacks a clear and agreed definition and is therefore perceived as a vague one, raising many questions about its meaning, realization and efficiency (Mensah, J. 2019). Remembering the literal definition of the terminology of sustainability, which is the capacity or ability to maintain some entity, outcome or process over a specific period of time or duration (Basiago, 1999); new approaches still are required; which can take into consideration the concept of sustainability with a much more comprehensive approach including a broader timeframe for the whole lifecycle of any building design development. These new approaches also will help to sustain the necessary efficient and long-term performances and thus achieve sustainability in the existing built environments.

2.1 The Limits of Sustainability in Built Environment

Architecture is evolving into a field, where increasingly diverse, challenging and sometimes contradictory conflicting people, constraints and involvements occur. Besides the major priority of developing the building design within the framework of technical, user and regulatory requirements, currently the tendency in practice is shifting to a much broader concern of which is to be accountable for achieving sustainable outcomes in building design developments.

According to Blutstein and Rodger (2001, as cited by Wand and Adeli, 2014) "a sustainable building requires more than identifying solutions to specific problems, but changes to attitudes, paradigms, processes and systems to deliver the project". However, it is not only achieving optimum energy efficiencies or minimum waste consumptions. On the contrary, in a cradle to grave strategy, the requirements and the global goals for building design developments are much more concerned with sustaining the whole building lifecycle, from the decision of development to even the phase of demolishment and even to the waste management of that demolishment. Thus, sustainability approaches are in the process of being re-defined with a totalistic approach of re-structuring the lifecycle of any building design and its process in an efficient and optimized way to end up with a sustainable output. As John et al. (2005) also state a sustainable building involves considering the whole life of buildings, taking environmental quality, functional quality and future values into account, and is therefore not only expected to integrate all other disciplines such as mechanical, structural or electrical engineering disciplines, specialists and consultants, in their contributions and involvements from early design phases but also to consider and involve different concerns. These concerns include essential factors related with building design, some of which are environmental impacts, economics and long-term costs, social and human perceptional aspects, aesthetical and contextual relations, energy efficiencies, waste reductions as well as resource and material utilization and managements.

According to the OECD Project (2002), sustainable buildings are defined as those that have minimum adverse impacts on the built and natural environment, in terms of the buildings themselves, their immediate surroundings and their broader regional and global settings. And in the associated study, the required definition criteria for a sustainable building have been categorized as having the aspects as such:

i. Resource efficiency
ii. Energy efficiency (including greenhouse gas emissions reduction)
iii. Pollution prevention (including indoor air quality and noise abatement)
iv. Harmonization with environment
v. Integrated and systemic approaches.

Although any intervention and impact begin with the minor components of the total in order to be fully effective, for a more global and permanent consequence, the impact target and the effective zone should have been widened to encompass a broader spectrum from multiple perspectives. Departing from the single entity level of the building structures to a broader perception of a larger approach of built environments, a wider and a multi-layered approach should be the main focus of the new domain, where the desired sustainable developments are defined.

The International Council of Research and Innovation in building and Construction (CIB) has recently reinterpreted the vision of sustainability buildings, which was originally adapted after the First International Conference on sustainable Construction (Kibert, 1994). According to this interpretation (CIB,2010), ten new principles for a sustainable building have been declared (Table 2.1)

Table 2.1 Principles of the Conseil International du Batiment (CIB) for sustainable Building (CIB, 2010)

Principles for sustainable building	
1	Apply the general principles of sustainability, and hence, promote continual improvement, equity, global thinking and local action, a holistic approach, long-term consideration of precaution and risk, responsibility and transparency.
2	Involve all interested parties through a collaborative approach, so that it can meet occupants' needs individually and collectively and be respectful of and consistent with collective social needs through partnership in design, construction and maintenance processes.
3	Be completely integrated into the relevant local plans and infrastructure, and connect into the existing services, networks, urban and suburban grids, in order to improve stakeholder satisfaction.
4	Be designed from a life-cycle perspective, covering planning, design, construction, operation and maintenance, renovation and end of life, considering all other phases during the evaluation of performance at each phase.
5	Have its environmental impact minimized over the (estimated or remaining) service life. This takes into consideration regional and global requirements, resource efficiency together with waste and emissions reduction.
6	Deliver economic value over time, considering future lifecycle costs of operation, maintenance, refurbishment and disposal.
7	Provide social and cultural value over time and for all the people. A sustainable building must provide a sense of place for its occupants, be seen as a means of work status improvement for the workers and should be related and integrated into the local culture.
8	Be healthy, comfortable, safe and accessible for all. Health criteria include indoor air quality whereas comfort criteria include acoustic, thermal, visual and olfactory comfort. It must allow safe working conditions during its construction and service life, and full accessibility to everyone in the use of building facilities.
9	Be user-friendly, simple and cost effective in operation, with measurable performances over time. Operation and maintenance rules must be available for both operators and occupants at any time. People should understand the philosophy and the strategies included in the building and should be incentivized to behave sustainably.
10	Be adaptable throughout the service life and with an end-of-life strategy. The building has to allow adaptation by changing performance and functionality requirements, in accordance with new constraints.

In the light of the significantly high effects of the construction industry on global sustainability, each and every sustainable building approach is important and has a high potential to make a valuable contribution for the achievement of more sustainable developments (Akadiri et al, 2012). As a result, achieving ever-increasing numbers of sustainable developments is inevitably crucial, given that, by definition these sustainable developments target an improved life and healthier environments for human future. According to Ortiz et al (2009), “The term sustainable development can be described as enhancing quality of life and thus, allowing people to live in a healthy environment and improve social, economic and environmental conditions for present and future generations”. This definition also incorporates the consensus on three components of the tripod of sustainability approaches, those of which have also been explained and discussed in further sections as various potentials and studies as well. However, Akadiri et al (2012), in their relevant study, have opened another discussion that each of these legs (or pillars as Hill and Bowen (1997) recall) and the principles related with each of them might be over- arched by a set of principles including the following items given in below table (Table 2.2).

These principles may also be referenced for a framework to constitute sustainable building designs and practices with environmental sufficiency and implementation, when applied during the planning and design stages of the building projects (Akadiri et al, 2012). However, the incorporation of these principles is required to begin with the very early decision-making stages of any building design development lifecycle.

Table 2.2 Principles to form a framework to achieve a sustainable building (Akadiri et. al, 2012)

1	the undertaking of assessments prior to the commencement of proposed activities assists in the integration of information relating to social, economic, biophysical and technical aspects of the decision-making process;
2	the timeous involvement of key stakeholders in the decision-making process (WCED, 1987);
3	the promotion of interdisciplinary and multi-stakeholder relations (between the public and private sectors, contractors, consultants, nongovernmental) should take place in a participatory, interactive and consensual manner;
4	the recognition of the complexity of the sustainability concept in order to make sure that alternative courses of action are compared. This is so that the project objectives and the stakeholders are satisfied with the final action implemented;
5	the use of a lifecycle framework recognizes the need to consider all the principles of sustainable construction at each stage of a project's development (i.e., from the planning to the decommissioning of projects);
6	the use of a system's approach acknowledges the interconnections between the economics and environment. A system's approach is also referred to as an integrated (design) process;
7	that care should be taken when faced with uncertainty;
8	compliance with relevant legislation and regulations;
9	the establishment of a voluntary commitment to continual improvement of (sustainable) performance;
10	the management of activities through the setting of targets, monitoring, evaluation, feedback and self-regulation of progress. This iterative process can be used to improve implementation in order to support a continuous learning process;
11	the identification of synergies between the environment and development

As is evident from the table of principles, they could easily have been grouped under some common topics, some of which involve social and cultural concerns leading to sustainability concepts, whereas others focus more on the people related issues such as the stakeholders or design professionals. In the second group, moreover, the issue is a much more effective management and integration of different approaches, constraints, priorities and sensitivities. Therefore, in this dissertation research, different approaches for classifications and identifications on the grouping of sustainability concerns have been considered in order to constitute the grounding and foundation for the proposed new re-understanding of sustainability processes of building design lifecycles. In the further sections, the relevance of these principles with respect to detailed and additional concepts of sustainability, as well as the various potentials and ways in which they can be employed and enhanced within a multi-layered design approach, are examined in depth.

2.2 The Significance of Building Design Lifecycle in Sustainability

By definition, sustainability refers to the maintenance of an entity, position, outcome, or a process through a considerable and acceptable duration or a quiet long period of time. Although sub concepts may exist, all of them must be related to that period of time in order to justify their focuses and achievability in that specific subject matter. Therefore, when sustainability in built environments is the subject of research, then the building design lifecycle unavoidably becomes the most essential domain to be referred, to analyze, execute, test and imply, as well as to conduct an in-depth search for the validity of a comprehensive sustainability achievement.

To be able to discuss any physical entity, its different stages from evolution to demolishment, or stages of existence should be considered. Therefore, the term building lifecycle has to cover all of these stages of any building design development, from the investment possibility, to planning, including project design and construction, through occupancy and finally until and even after the demolishment, in terms of its removal, waste management and disposal (Ginzburg, 2016). However, in the majority of research domains, the lifecycle is usually used and interpreted as referring to the performances of the building design beginning with the design phases for pre-estimates, but mostly focused on the estimations of the building's in-use durations and related performances. To acquire a broader perspective on sustainability and to achieve a comprehensive re-understanding on thorough sustainability processes; the lifecycle needs a re- definition and a new framework, as a part of this dissertation's research.

Within this approach lifecycle framework has been interpreted and considered to include all of the stages that the building design development has passed through. These stages begins with pre-planning stages of any building design development, including the investment concerns, market values and property issues as well as site selection criteria and feasibilities; continues with the planning and design stages; extends through the completion of construction; reaches and concludes with the post construction stages like handover , occupancy and post – occupancy period , including regular checks for any requirements of a revision or adaptive re-use possibilities and even afterwards finalizes in demolishment and post demolishment stages including waste management. Among different research on the definition and interpretations of lifecycle studies, Watson's lifecycle theory has a clear differentiation on building lifecycles where he offers two classifications of them being (a) temporal or (b) physical (Watson, 2004). Watson et al. (2004) also referred this theory of Watson and displayed a simple graphical comparison (Figure 2.3) on their phases and involvements of two lifecycle approaches. Here, the classification is based the building design processes' temporal design lifecycle actions and the flow and sequencing of materials, systems and objects that constitute the physical lifecycle. This basic comparison also reveals that understandings of building lifecycle differs significantly based on the various focuses, concerns and priorities of relevant stakeholders and the domains of the involved parties.

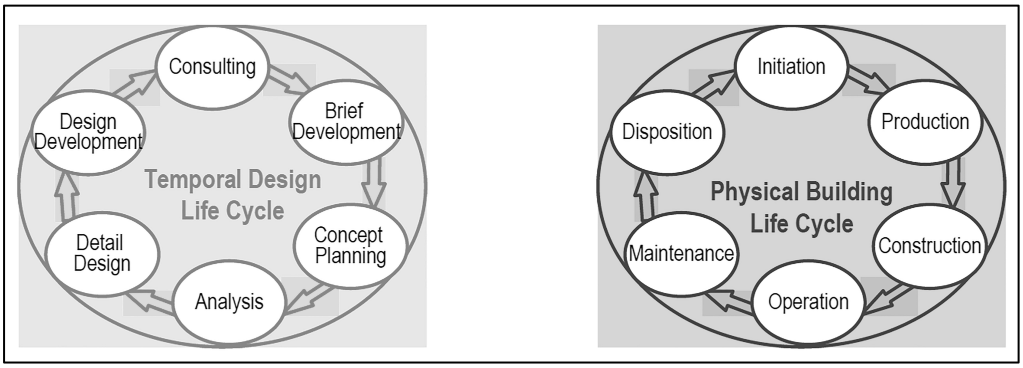

Figure 2.3. Concept Diagrams of (a) Temporal Design and (b) Physical Building Lifecycle (Watson et al, 2004)

In continuation with this approach, Watson et al (2004) has developed a table where these conflicting but also strictly dependent involvements of different actors are displayed in relation to their prior lifecycle of involvement (Table 2.3). Here, it should have been noted that this individualistic divisions of the parties with respect to different phases of lifecycle, also raises a discussion of whether or not the rigid division of lifecycle approach is appropriate to the concept for achieving a broader sustainability.

However, these divisions and distributions of the building design lifecycle also establish the template and components for the grounding of the stages of the lifecycle, those to be related and bounded with the other essential concepts of sustainability as well. Revealing both the actors involved and the tasks/ responsibilities they conduct as well as the stages with required breakdowns are important determinants taken as references in the establishment of the further alternative tools, to operationalize this new approach.

Table 2.3 Professional Building Environmental Assessment (BEA) by Application and Phase (Watson et al, 2004)

Stakeholder	**Profession**	**Communication**	**Documentation**	**Lifecycle Phase**
Investor	Broker, Client, Agent	Feasibility Literature	Policy Benchmarks	Asset Investment
Owner	Corporate, Community	Policy and Class	Classing System	Acquisition
Developer	Urban, Land, Builder	Bid Development, Estimate	Development Apps.	Development
Manager	Facility, Portfolio, Asset	Strategies/tactics, Standard	Management Systems	Management in-use
Planner	Portfolio, Asset	Guide, Benchmark	Guides, Benchmarks	Strategic Planning
Purchaser	Eco labeling, Costings	Brief/Tender Eco-Values	Bid Assessments	Procurement
Provider	Logistic, Marketing	Marketing Assessment	Campaigns	Project Initiation
Designer	Architecture/ Landscape	Design, Model	Blueprints/ Plans	Design lifecycle
Consultant	Engineer, Research	Data, Efficiency/IAQ	Reports	In-use, operations
Surveyor	Quantity	Specification	Bills of Quantities	Procurement
Manufacture	Environment Control	Eco-label, Product profile	Label, MDS	Procurement
Manager	Project, Site	Schedule, Specification;	Project Plans	Construction
Builder	Commercial	Plan, Certification	Construction Plan	Project Delivery
Operator	Facility & Building	Manual	Manuals	Occupancy in use

Continuing with the significance of the lifecycle thinking and its importance in achieving sustainability in a broader sense; Watson and Jones (2005) have stated that lifecycle thinking is essential and can have more comprehensive outcomes when applied to early decision-making stages due to its strong and objective strategic planning approach. They continued and developed a comparative but integrated diagram reveling operational flows throughout the product and building lifecycles (Figure 2.4). In this figure, it is obvious that although there appears to be a sequential flow from the existence of the materials, through their composition and transformation, to a built output, there is always the possibility of reuses and recycling in reverse application in between the determined stages of the lifecycle. They have also stated that the considered end of the lifecycle of any built output actually becomes the focus of urban renewal by promoting the possibilities of reuse, repair or renovate. This focus also supports further the idea that the approach and redefinition of building design lifecycle must be explained and redefined to include all of the relevant stages like day-zero, pre-, during-, post and even post-after stages.

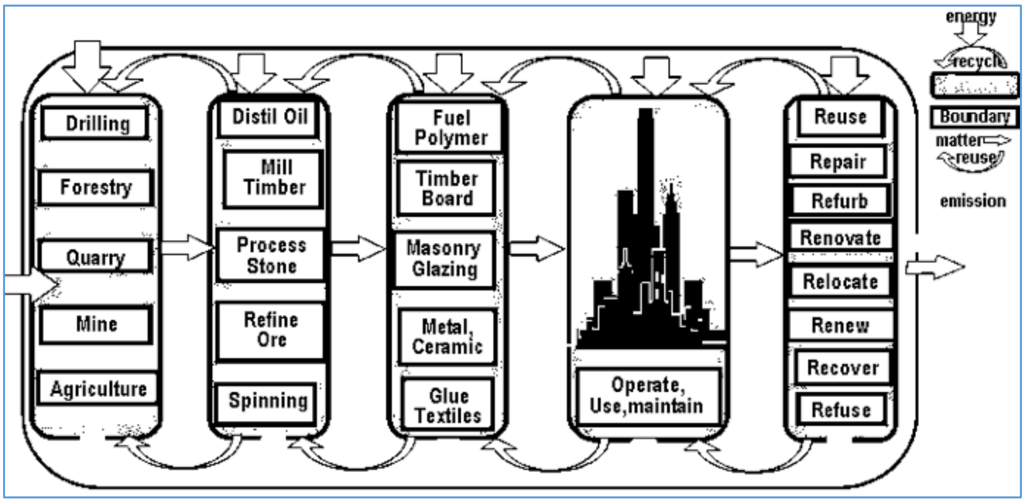

Figure 2.4. Concept Diagrams of (a) Temporal Design and (b) Physical Building Lifecycle (Watson et al, 2004)

Lifecycle approach in the studies of built environments, including their improvements in multi-faceted and multileveled approaches require a structured lifecycle track for the achievements of broader sustainability in those built environments. This necessity to ground the further strategies, procedures and implications of design studies on a lifecycle track is, therefore, crucial and necessitates a redefinition of the lifecycle, since existing lifecycle approaches are mostly focusing on selected portions of the whole according to their focuses. To provide a comprehensive re-understanding for achieving sustainable building designs with improved lifecycles, a broader lifecycle approach should have been developed, which has sub-stages, specific breakdowns and different milestone employments.

Another important issue in the re-definition and the configuration of this new lifecycle thinking approach; appears in the analyses of building inventory and comparisons of new buildings vs. existing buildings and their re-utilization potentials. In the context of new development, where the design has been conducted from zero-level for a new requirement for new clients with new actors and for a new context; the approaches, methodologies, concerns and also evaluations to enhance sustainability exists as different than previous. However, these strategies might have been determined in advance, monitored and revised if necessary, during the process of design development, finalized in post – construction and in post-occupancy stages. Only in this way similar actions, follow-ups can be proceeded and necessary excessive wastes of the processes such as trial-errors can be prevented. Keeping track of pre- and post- occupancy evaluations is significantly more valid and appropriate to follow, in the light of the impacts of this new development. Therefore, the possible intervention degrees would be primarily based on modest adjustments relating to occupancy-based evaluation feedbacks. Thus, this kind of a process in the entire lifecycle of these new developments would be naturally fulfilling the sustainability concerns relating to the occupancy-based sustainability concept. In contrast to the development of a new building design, existing developments are expected to have a greater variety of interventions. This is because there are more constraints preventing a thorough perception of the process from early stages, but involvements in late stages such as post-occupancy are possible. The definition of how to enhance sustainability may vary depending on the feedbacks. Some alternative approaches to enhance a degree of sustainability might be listed as: i. revisions, ii. adaptive reuse, iii. partial or full rehabilitation, iv. refurbishment, v. renovation and vi. demolition.

Since the construction industry with their outputs as building structures, covers most of the existing physical environment and is therefore one of the largest consumers in terms of energy and resources; the treatments applied to this inventory of building stock really need utmost caution. According to Pombo et al. (2016), the retrofitting of existing buildings provides excellent opportunities for reducing energy consumption and greenhouse gas emissions. More detailed analyses and research in the existing buildings potentials and impacts on the achievement of sustainability has also been discussed in further sections when occupancy-related sustainability concepts and alternatives of reuses of the existing building stock / inventory have been analyzed.

2.3 Sustainability Concepts in Building Design Lifecycles

According to John et al. (2005) sustainable buildings may be defined as building practices, which strive for integral quality including economic, social and environmental performance in a broad way. Thus, the rational use of natural resources and proper management of the building stock will contribute to saving scarce resources, reduction of energy consumption and improvement of environmental quality. Moreover, sustainable buildings have increasingly been regarded as complex socio-technical systems (Pan & Ning, 2014). Bagheri and Hjorth (2007) suggest adopting a dynamic approach, which considers transformable processes towards sustainability, as it cannot be a fixed goal, but rather one that evolves with time. Time, technology, requirements, priorities and constraints of both the local as well as the international domains constantly push and drive the sustainability targets to be updated and redefined, adapted and adjusted and achieved for any advancement to be sustained.

Although the concept of sustainability has been categorized in the environmental, social and economic dimensions (WCED, 1987) in various studies and by different researchers, it is questioned whether these three categories are sufficient to express the full context and capability of a sustainable approach to have an effect on both in the building design level and also in the environmental and global level. In addition to Berardi's point (2013) where he states that sustainable developments have shown the need for a pluralistic approach that considers multiple actors, not only the people's interventions and involvements but also the nature of the building design lifecycle's interaction and relations, should be analyzed and developed with a similar type of a perception that focuses on its other potentials, appropriateness or limitations.

Berardi (2013) defines a sustainable building firstly as an accommodation of healthy facilities, which has already been designed in a full percentage and full duration of resource-efficient manner, utilizing ecological principles, social equity and lifecycle quality value, resulting in concern and sensitivity of a sustainable community. According to him, sustainable building design developments should increase:

- demand for safe building, flexibility, market and economic value
- neutralization of environmental impacts by including its context and its regeneration
- human wellbeing, occupants' satisfaction and stakeholders' rights
- social equity

It should have been mentioned that despite being presented separately, the majority of the sustainability concepts in this section are strongly interdependent and interconnected to each other due to their reciprocal improvement impacts and priorities. Moreover, each specific sustainability achievement criteria of each concept effects and changes the efficiency of the others; hence, the sustainability degrees of the other concepts are directly impacted by the consequences. In further explanation during design process, determination or decisions on the psychical sustainability of any building design, directly effects the economical sustainability as well as the environmental and technology-based sustainability concepts of that specific building design development inevitably.

Another study questioning the necessity and highlighting the importance of additional dimensions to be fulfilled in the nature and dynamics of sustainability has been conducted by Najjar (2022). In his research he has defined the sustainability as a dynamic, complex notion that crosses over many perspectives and therefore cannot be perceived any more as only aiming to balance economic, social and environmental needs, as it used to be in the classical sustainability approaches. In order to present this new complex and multidimensionality of sustainability Najjar (2022) developed a system, where he can demonstrate the relationships of different dimensions and thus to highlight the dynamics of sustainability in a general manner (Figure 2.5).

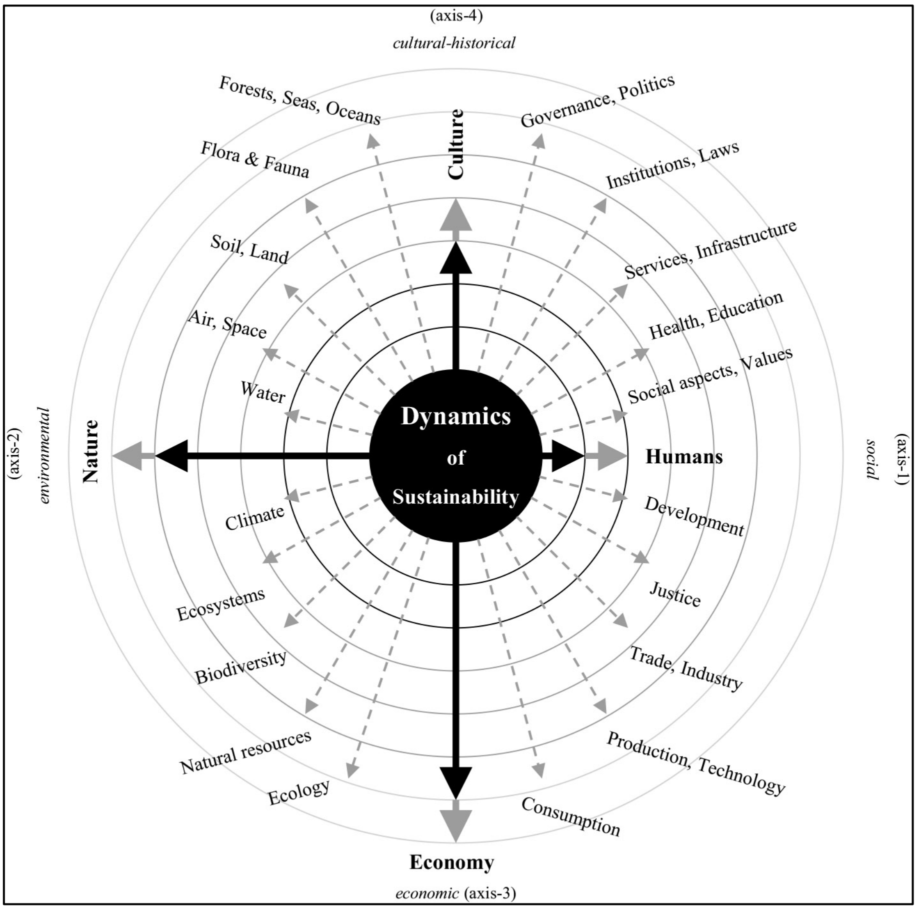

Figure 2.5. Dynamics of Sustainability (Najjar,2022)

This diagram also displays the important contributions of other factors like human impact, cultural aspects, contextual references for infrastructure values, or administrative regulations of laws and politics. Therefore, in order to achieve a broader sustainability in the built environments, additional concepts of sustainability should have been added to the approaches and the processes.

In light of the aforementioned research and general approaches in the domain of sustainability in built environment additional sustainability concepts have been developed. The relevant sustainability concepts, proposed to be analyzed, synthesized, and then utilized and integrated in the development of the re-understanding of sustainability process of multidisciplinary building design processes, have been determined as the following headings:

- economical sustainability
- environmental sustainability
- social and cultural sustainability
- contextual sustainability
- physical sustainability
- occupancy–based (operational) sustainability
- process-based (managerial) sustainability

Each of these sustainability concepts have been explained further individually in further sections.

2.3.1 Economical Sustainability

Economics, in its most basic and straightforward meaning, focuses on minimizing the costs, or more precisely, on the cautious and controlled consumption of resources. Furthermore, by definition, it focuses primarily on scarce assets and resources, those of which are limited compared to what is desired or required (Thiebat, 2019). If it is desired to go beyond to a more advanced level of domain of economics in design, it may be considered as improving the lifetime efficiency of any design by preventing wastes like direct and indirect costs, idle resources, overproduction or over processing, and providing values like producing energy, promoting recycle or optimizing the resource allocations. Obviously, in all of these approaches the target is to relate to the entire duration of any product, process and design, in order to be effective and hence sustainable. Robichaud & Anantatmula (2011) stated that, contrary to the common approach on environmental impacts, the research displayed that the primary decision point for any investment to decide either to proceed or not, is rooted in its financial liability and/or economic sustainability, including more as the initial investment cost but also for life-term operational cost.

An ideal project should be affordable to build, last forever with minimum maintenance, but return completely to the earth when abandoned (Bainbridge, 2004, as cited by Akadiri et al, 2012). Similarly, Hill and Bowen (1997) also state that sustainable building begins with the planning stage of a building and continues throughout its life to its eventual deconstruction and recycling of resources to reduce the waste stream associated with demolition.

In the very broader concept of economic sustainability, it could have been considered that there are two main separate but dependent topics in the whole lifecycle of any building design, which are: i.) economic sustainability in the building design development processes, and ii.) economic sustainability in the operational or functional processes when the building ins in use and experienced by the occupants. The first topic may cover all phases beginning with the initial idea of the development and the brief itself, as economic status and sustaining the economic projections throughout the lifecycle includes a feasible and optimized site selection as well. Therefore, in the first topic of economical sustainability in design development stages; all the multidisciplinary collaborations in favor of a sustainable design as well as the ability to have a sustainable process in achieving the design itself should have been improved. Furthermore, to achieve such economical sustainability not only the building but also the design process should be considered as sustainable to minimize the costs. There are many counterarguments on the economic status or strategies of a sustainable building design, one of which has been introduced by Kamar et al. (2010, as cited by Zabihi et al, 2012), when he discussed that while designing an economical building, it is generally the case that the social and/or environmental features, aspects are typically compromised. However, the existence of such effect and consequences may have been avoided by integrating many interdependent sustainability concepts together into the same path of building design lifecycles in an effective manner.

When economics of the building design projects and the economy of a built environment is in consideration, it shall not be limited to the specific building design itself, but also the background aspects and factors of the local and global environment, which is effective on that design, as well as the more specifically real estate property aspects behind. Some of these factors are derived from and associated with the market real estate and can be stated as; market value, rate, interest and return values. Although these concepts appear unrelated and not belonging to the domain of AEC field, in order to bring a broader perspective to the achievement of sustainable lifecycles to building design development processes, those concerns on the market, rates, interest and return values, by being initial investment decision catalyzers or investment promoting factors, have different impacts and significant effects on the overall process. Moreover, when considered in the context of sensitivity and sustainability, these concepts have turned out to include different meanings and interpretations as well as a broader of attention and priorities.

Going deeper into one of these investment related market factors; investment related specifications, concerns and investment decision-making criteria play an important role. In addition, there is a mutual impact and exchange between sustainability and economy when the investment is the subject matter. As Boyd (2006) explains, because real estate properties are so intertwined with human, gain their worth and importance from their utility by human and impact on them, thus the impact of human on the properties affects their sustainability. As Lorenz et al (2007) further reveal; the tendency in promoting the features of any property's worth and market value has been transformed to highlight their sustainability–related characteristics and performance aspects. Furthermore, even when determining the market –value of any property, in addition to the common hedonic pricing concerns, it has been suggested that the positive effects of sustainable design features implemented to that property's design and construction criteria, effecting and contributing to its environmental and social performance also are effective on the market value, as well as creating an add-value and reducing investment risks. Figure 2.6 from the research and report of Royal Institution of Chartered Surveyors (2005) is quoted by Lorenz et al. (2007) to display the relationship and interaction between the market value of a building and its green features with the related performance.

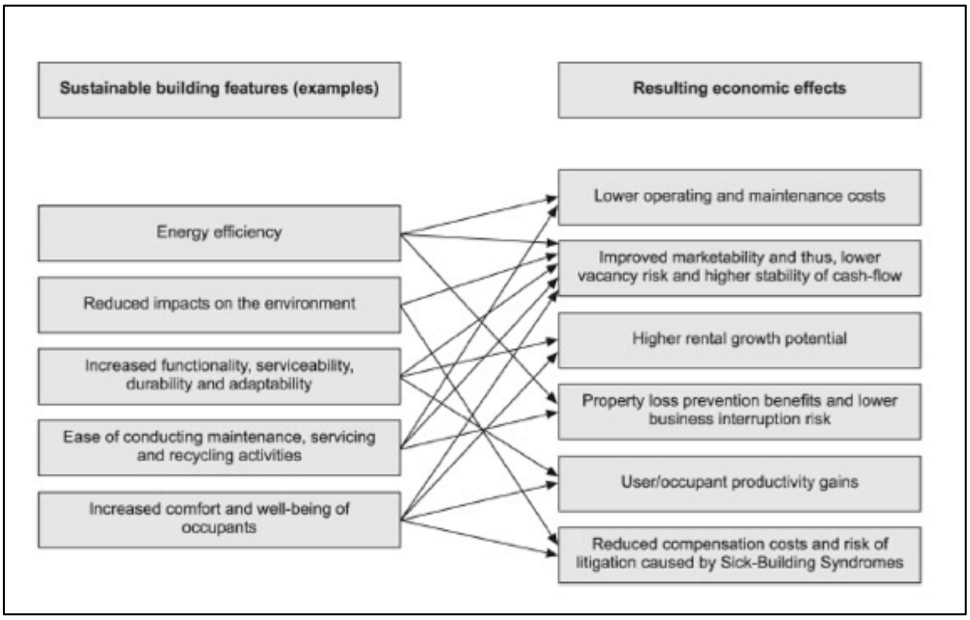

Figure 2.6. The Links Between Sustainable Design Features and Economic Benefits (Lorenz, D.P, et al, 2007)

Therefore, it is inevitable and significant that sustainability concerns should be implemented in the criteria of real estate property worth defining approaches such as the market value or return rates of the investment. This kind of concern may not only contribute to and support the economic sustainability of any investment, but it may also generate an additional feature in the market by being uncompetitive and so reducing the investment risks in multiple aspects.

There are various steps to plan, manage, evaluate, measure, revise and confirm the economical sustainability of any building design development (and construction as well), if the topic economical sustainability is examined. In addition, when it comes to the optimization of economic performance of buildings, several different variables need to be managed in order to meet the aspired levels of performance (Ahmad and Thaheem, 2018). This totalitarian approach is mostly based on life cycle cost (LCC) of any development. And the effective implementation of lifecycle costing involves utilizing a well-considered, all-inclusive design along with construction practices with selected environmental considerations (Akadiri et al., 2012). In his study, Akadiri et al (2012) has identified most of the costs and classified them under three main headings, which are the initial cost, the cost in use and recovery cost. The graphic below briefly depicts the basic strategies for managing these three key costs and their involvements throughout the building design lifecycles (Figure 2.7).

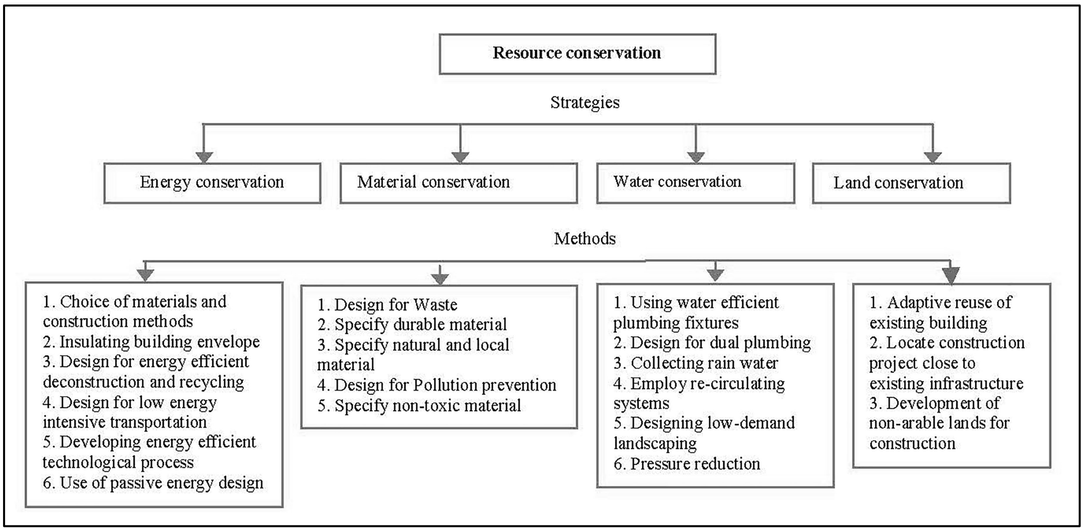

Figure 2.7. Strategies And Methods to Achieve Cost Efficiency (Akadiri et al, 2012)

Life cycle cost concern is not the only factor effecting the economic performance of a building. Affordability, manageability, adaptability and flexibility are also effective and defining factors in identifying any building design output as sustainable intelligent buildings (Alwaer & Clements-Croome, 2010). These indicators are also directly related to other sustainability concepts, as affordability is effected from the social & cultural sustainability of the built environment, or adaptability and flexibility are directly effected from the consequences of physical, contextual and occupancy-based sustainability approaches, whereas manageability as it is commonly understood, effects not only the economic status but also managerial process efficiency of the built environment. With reference to the research of Mangialardo et al. (2019), the theme of sustainability in the built environment is proposed to be summarized in four macro themes, having different concerns, aspects and benefits. These four themes have been re-classified in a new format to display their relations and interactions with the other sustainability concepts in Table 2.4 below.

Table 2.4 Four Macro Themes of Sustainability in Built Environment in Relation with Economical

Main theme	**Further detail**	**Interrelated sustainability concepts**
Investments' efficiency in sustainable real estate development operations.	Whether and to what extent investments are efficient and sustainable in terms of return of the investment and if it is possible with the reductions of operational costs (in energy consumption...etc.) [Warren-Myers, 2012].	Economical
View of property occupants,	Savings on operational costs, reduction in energy consumption	Economical Operational
View of developers and investors,	Increase in property worth, real estate (market) value and thus increase in investments	Economical
the issue of the psycho- physical well-being of the	increase in well-being and productivity of users	Economical operational social

In continuation with the aforementioned research findings, sustainability related rating criteria are significantly effective on the property market and have a substantial impact on the market transformations to push for more sustainable investments in built environment (Lorenz, D., & Lützkendorf, T., 2008). "Socially responsible investment (SRI)" is a phrase introduced by Lorenz and Lützkendorf (2008), who define it as "a process characterizes the behavior of investors who not only focus on the mere economic aspects of an investment but also follow ethical principles and consider environmental and social aspects". Within this approach, it is obvious that economic concerns are being in the way of transformation not only in terms of finance and global aspects, but also to meet other requirements and enhance the societies' social, environmental, occupancy benefits. Furthermore, the absence of these aspects and concerns in any property investments are considered as an investment risk (Filose, 2005, cited by Lorenz, D., & Lützkendorf, T., 2008).

Characteristics and attributes of sustainable buildings	Examples of reductions in/avoidance of property specific risks
Flexibility and adaptability	Reduction of risks through changes in market participants' preferences (obsolescence) and through restricted usability by third parties
Energy efficiency and savings in water usage	Reduction of risks through changes in energy and water prices; reduced business interruption risks (e.g. caused by power outages) through facilities that derive energy from on-site resources and/or have energy efficiency features
Use of environmentally friendly and healthy building products and materials	Reduction of litigation risks and of being held liable for paying compensations to construction workers and building occupants
High functionality in connection with comfort and health of user and occupants	Reduction of vacancy risks or of losing tenant(s)
Construction quality, systematic maintenance and market acceptance	Lower risks of changes in property values
Compliance with/over-compliance with legal requirements in the areas of environmental and health protection	Reduction of risks from increasingly stringent legislation (e.g. expensive retrofiting or losses in property values)

Figure 2.8. The Links Between Sustainable Design Features and Reduced Property Specific Risks (Lorenz and Lützkendorf (2008)

Lorenz and Lützkendorf (2008) continued and illustrated these potential risks of any property investment in terms of their fulfilling or lacking sustainability features implemented in the design and construction processes in Figure 2.8. As is seen in Figure 2.8, although economically researched, the consequences reveal the strong aspects in terms of other concepts of sustainability like social, environmental and user perception of occupancy. Consequently, it is inevitable to admit that fulfillment and enhancement of one concept of sustainability contributes to and further impacts other concept(s) of it as well. This broader perspective has been once more developed with an integrated study in the research of Lorenz and Lützkendorf (2008), where they combined effects and benefits of sustainable buildings with the concerns and priorities of property market and value generations (Figure 2.9).

In their study displayed, Lorenz and Lützkendorf (2008) not only compared and displayed the effects of sustainability concerns on achieving more cost-effective outcomes in built environment but moreover their simultaneous impacts effective on positive outcomes in the built environment in relation to other concerns like social and environmental sustainability. Furthermore, they have revealed the interactions between various actors having different durations and impacts weights.

		Effects and benefits on …	Developer/Owner/Landlord										User/Tenant			Society			Environment		
		Effects	*Increased marketability*	*Reduction of vacancy risks*	*Reduction of maintenance costs*	*Image and reputation gains*	*Advantages in tendering processes*	*Inclusion in sustainable property investment funds/indexes*	*Trading of C02-certificates*	*Access to better financing conditions, subsidy programs and tax credits*	*Higher prices/rents; more stable cash-flow; profit maximisation*	*Stability of value and worth/ Increases in value and worth*	*Occupant satisfaction and productivity gains*	*Reduction of operating costs*	*Image and reputation gains*	*Urban design quality/cultural quality*	*Fewer Sick-Building Syndromes/ lower costs for health care system*	*Reduction of 'external costs' through environmental damages*	*Lower resource use and raw material depletion*	*Reduction of impacts on the environment*	*Preservation of Biodiversity*
Building	B1	Energy efficiency/energy saving	■	■		■	■	■	■	■	■	■		■	■		■	■	■	■	□
Building	B2	Reduction of water cons./waste water				■	■	■		■	■	■		■	■			■	■	■	■
Building	B3	Environmental friendly material selection	■	■	■	■	■	■		■	■	■					■	■	■	■	□
Building	B4	Air quality/thermal comfort	■	■		■		■		■	■	■	■				■				
Building	B5	Functionality	■	■	■	■		■			■	■	■		■						
Building	B6	Adaptability	■	■							■	■	■					□	□	□	
Building	B7	Longevity/Durability			■											□		□	□	□	□
Building	B8	Design/aesthetic quality				■					■	■	□		■	■					
Process	P1	Integral design											□	□		□		□	□	□	□
Process	P2	User participation	■	■		□					□		□								
Process	P3	Systematic maintenance	□	□	■	□							■	□	□			□	■	■	

■ = strong/direct impact; □ = weak/indirect impact

Figure 2.9. The Effects and Benefits of Sustainable Buildings (Lorenz and Lützkendorf (2008)

2.3.2 Environmental Sustainability

A sustainable project is designed, built, renovated, operated or reused in an ecological and resource efficient manner (Ortiz et al., 2010) and inevitably results in an environmentally sensitive outcome. However, it is not sufficient to consider environmental challenges solely in terms of their reasons and consequences, the broader impacts that they suggest or are implying for the environment should directly be considered alongside with other dimensions and concepts of sustainability. Furthermore, over the last two decades, the concept of sustainability has been transformed and being forced to shift from its main focus on environmental issues based on resource efficiency, energy consumption, to rather a focus on much more broader issues like social and economic concepts including social equity and poverty reduction (Berardi, 2013).

Regarding environmental sustainability concept, a general definition has been raised as; sustainable architecture is replying and interacting with environmental and local conditions, and it is trying to apply contexts of ecological abilities to create desirable environmental conditions; (Williams, 2007, Zabihi et al, 2012). Therefore, there is an equilibrium between the building design and its surrounding in terms of its damages / impacts on it and its adaptability, flexibility to future changes, demands and local context related prerequisites. In continuation with this approach, four main objectives for an environmentally sustainable development have been classified: i. increasing the asset and economic, ii. reducing the impact and increasing, iii. increasing the social usefulness and iv. increasing the quality and optimization (Zabihi et al, 2012).

In order to be environmentally sustainable some major aims to be targeted have also been summarized by Bani (2007, as cited by Zabihi et al, 2007) as follows:

- Maximizing the human comfort
- Efficient planning
- Design for change

- Minimizing waste of spaces
- Minimizing construction expenses
- Minimizing buildings maintenance expenses
- Protecting (keeping) and improving natural values

Sassi (2006) has also defined major aspects of a sustainable and land use to contribute to environmental sustainability achievement as; i.) careful selection of the development site provided with facilities, public transportation, easy use of pedestrian / cyclist, with own ecological value, ii.) utilization of land efficiently considering needs of community, design of appropriate densities and building on already contaminated lands iii.) minimization of the impact of the development such as protection of natural habitats, enhancing additional landscaping for microclimate, inclusion of production of food and if possible. Obviously, in order to achieve an environmental sustainability, the essential issues are all related to the very early stages of the building design process, where you full and multidimensional attention is required especially on the decisions for the site selection, program development, or how to use the site efficiently and in accordance with program requirements.

The importance of environment and the impact of achieving sustainability in environmental domain priorly is evident in many existing studies. The landmark Brundtland report, published as 'Our Common Future' by World Commission and Development in 1987 (WCED, 1987), has conceptualized three dimensions, namely, social, environmental and economic within the broad idea of sustainable development (Goel, 2019). These were later classified and determined them as three bottom line (TBL) of development by Elkington (1998). Among many research that are basing their approaches on the developed Triple bottom line framework to enhance sustainability from their focus; one improved version has been displayed by Zakaria et al. (2014) where they have proposed a hierarchy of index system. According to their approach, each of the triple bottom line components (social, environmental and economic) are associated by one-dimensional degree of sustainability, the intersections of two of these components constitute an upper dimension, thus named as two-dimensional degree of sustainability, and lastly the central core intersection of three has been associated as the three-dimensional degree of sustainability. This kind of an interpretation has been presented in a form of a Venn diagram (Figure 2.10) by Zakaria et al (2014), which also displays and reveals the essence of these intersections in developing a broader approach of sustainability achievement in a multidimensional and multi-sided approach. Since in these upper dimensions other concepts and concerns are necessary to be integrated, to be comprehensive and efficient, this study sets a grounding of the development and research of other concepts of sustainability as well.

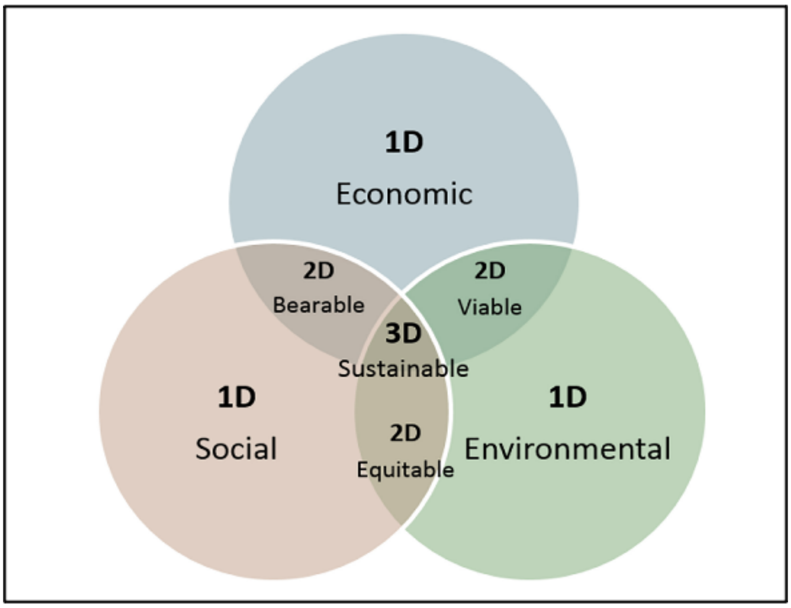

Figure 2.10. Venn Diagram for Sustainability Criteria (Zakaria et al., 2014)

TBL approach of sustainability, due to its limited focus on these three components only (economic, environmental and social) to achieve sustainability, have also been criticized by many authors because of being inadequate to capture the essence of 'Sustainability in Construction and Built Environment –SCBE' (Goel, 2019). Ofori (1998), one of these critics, suggested that SCBE should also include "community sustainability", "cultural sustainability" and "managerial sustainability". These concepts have also been identified as significant sustainability concepts among the basic inclusion and content of sustainability concepts contained in this dissertation and elaborated in detail in following sections.

In addition to these concepts generally associated with environmental sustainability, there are other additional aspects that contribute to environmental concern as well. Especially, the regional level of approach in the adaptability and appropriateness of any building design development in relation to its neighborhood and surrounding community defines its connections and interactions, thereby directly effecting its sustainability in terms of its long-term endurance within its context. Berardi (2013) has also supported this kind of as approach in local concern, where he illustrates this circumstance by analyzing the rationality of the sustainability of a skyscraper built in a desert.

The rational use of natural resources and appropriate management of the building stock will contribute to conservation of scarce resources, reducing of energy consumption and the improvement of environmental quality (Sassi, 2006, as cited by Zabihi et al, 2012). All of the research conducted on the efficiency on the lifecycle cost assessments and resource consumptions of the sustainable building design developments, reveal, once again, the interdependency of each and every strategy for the enhancement of sustainability, either serving or effecting one another in a broader context.

2.3.3 Social and Cultural Sustainability

Social and cultural sustainability domain is another important aspect of building design development approach, due to its origin of focus as human. In the existing proposition of triple bottom line of sustainability, social concept alone has been determined as one of the pillars of sustainability, however as it is highly connected with cultural aspects of any design development in this thesis study, cultural and social sustainability has been combined and defined as one of the additional sustainability concepts to be developed and integrated on the new approach of a comprehensive re-understanding of sustainability. To start with social sustainability, we can refer to the study of Berardi (2013) where he defines sustainable building on the basis of several studies of Chiu (2002); Dempsey et al., (2011) and Parr & Zaretsky, (2010). According to him to define the social sustainability of a building design, a sustainable building should fulfill the following.

- adhere to ethical standards by ethical trading throughout the supply chain and by providing safe and healthy work environments
- provide place that meets needs with a mix of tenure types and ensure flexibility wherever possible
- conserve local heritage and culture
- integrate the building in the local context also guaranteeing access to local infrastructure and services.

In the research study, Adaptable Futures[2], the research team identified 'flexible, available, changeable, moveable, reusable, refittable, scalable' characteristics as the higher level standards of adaptability (Manewa, 2009) which is a key factor to enhance sustainability.

Consequently, the construction industry should consider not only the environmental and economic impacts, but also the social impact of activities (Plessis, 1999). Therefore, public participation, a thorough analysis of the socio-contextual analysis and synthesis of the development areas in the very early stages of decision making, as well as a long-term whole lifecycle sensitive approach in appropriateness with both local and international regulations as well as social patterns and expectations, are some major concerns that are inevitably important and those should be taken into

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[2] Integrated research project, funded by the Research Council (EPSRC) through Loughborough's Innovative Manufacturing & Construction Research Centre (IMCRC), and industrial partners. www.adaptablefutures.com

consideration to enhance an efficient building design development with positive impacts on social sustainability. Achieving social sustainability is highly dependent on the continuous, dense and interdependent interaction among people; therefore, as Plessis (1999) also stated, sustainable development decision making requires the consideration of a multitude of ever-changing criteria and negotiation of trade-offs between stakeholders.

The comprehensive and complex structure of sustainability, as well as relative integrative character by integrating multiple disciplines and approaches to be realized, provides it a social dimension. In addition, it is obvious that this participatory process, in which different involvements and interactions by different parties occur, causes a social dependence and a social context (Moffatt & Kohler, 2008).

Cultural aspects, on the other hand are also inevitable and essential concerns in the built environments. Braganca et al (2010) also emphasized the necessity to add cultural dimension to sustainability where he discusses that a building can be sustainable only when the environmental, cultural, social and economic dimensions are dealt with. The built environments are collection of several spaces that built upon the continuation of the memories, habits, accustomed usages of the communities. These collections and commons should have been continued in various ways to end up with a broader way of sustainable life for the people. In order to fulfill this, the urban environment should be perceived as a collection of sustainable spaces which should include social cultural necessities (Ürük, 2020). Furthermore, the social dimension of sustainability also considers the satisfaction of basic human needs in terms of social and cultural necessities (Brown et al, 1987). As Sassi (2006) mentions, sustainability requires a critical examination of traditional values, which are often challenging to be questioned, as they are culturally generated. Actually, cultural sustainability does not only require the preservation of all the existing stock to result in sustainable environments, but rather the aspects, values and essentials of the existing environments should be analyzed, decomposed and re structured in today's complex design development processes.

This two individually important but also highly connected aspects are also directly interdependent to people and to each other in the fulfillment of the satisfaction of people and their necessities in a broader manner. Thus, have been determined to be combined and perceived as one crucial dimension of this new approach and re-understanding of sustainability.

2.3.4 Contextual Sustainability

In reality, the interconnections of a building with the surrounding infrastructure like public transportation, central workplace or public buildings, are increasingly recognized as unavoidable aspects of a sustainable building (Berardi, 2011). Contextual sustainability is often confused with environmentally sustainability, despite the fact that two are extremely strictly linked and intertwined in terms of their overall objectives, focuses, impacts, concerns and approaches. However, it includes the enhancement of various multileveled concerns to overcome, multidimensional constraints to solve and multidisciplinary requirements to fulfill.

In the discussion of contextual sustainability, selection of the appropriate site becomes one of the first criteria to be considered. In addition, to determine the specific function, typology and program of the building design project, acceptable or available land plots and site options play a significant role in the final decision-making process. Leaving the economic effects like financial, return of investment and real estate or marketing based aside, each site has strong micro and macro level connections, influences and relationships with its surroundings. The interrelationships between the site and its surrounding have an inevitable and extremely dominant effect on the sustainability of that building developments lifecycle. There are many possibilities to prevent or least minimize these undesired negative effects and consequences of locations, by choosing different paths in the process of building design development, beginning with very early decision-making stages. Utilizing already contaminated or used urban lands within the urban fabric may be one of these strategies. Akadiri et al (2012) also suggest a similar kind of an approach that may be utilized to implement sustainability in building sector by stating that conserving existing land opportunities by adopting a policy of zero expansion of existing urban areas needs to be increased and encouraged by especially the governmental authorities. There are two fundamental options that can be pursued within this approach; re-utilizing those already contaminated lots with changes and revitalization of the zones and areas, as well as the close surroundings, on a much more macro level, or introducing adaptive reuse potentials of existing building design stocks with improvements and rehabilitations on a rather micro scale. Second option whereas requires a more achievable intervention control level to enhance and according to Akadiri et al. (2012) this approach can be achieved by adaptive reuse of an existing building, thereby eliminating the need for new construction.

Returning back to the broader topic of contextual sustainability, if reuse, revitalization or rehabilitation of the existing inventory of building design development is no longer an option anymore, and a new development is unavoidable, then a very sensitive and comprehensive attitude to site selection is required. Placement of the development that is appropriate and consistent with its environment, as well as consideration of public facilities and amenities, walkable and reachable distance measurements and multiple modes of transportation provision opportunities have been identified as some of the major concerns to be considered during those decision-making processes which are fore sure to be implemented in very early stages of the building design processes for a full sustainable building lifecycle. Furthermore, locating any sustainable building project within easy access of public transportation, medical facilities, shopping areas and recreational facilities, would also prevent the expansion of built environment and occupation of agricultural and eco-sensitive areas (Akadiri et al., 2012) and thus contribute to the initial aim of keeping the used land and not extending them approach.

2.3.5 Physical Sustainability

As it has emerged as one of the pioneering factors to consider and enhance sustainability; physical aspects of the building designs emerge as one of the more common areas of discussion. In addition, majority of the research in the literature have started and still continues to focus on, how to achieve sustainable and inevitably energy efficient buildings by revealing and discussing ways of utilizing different and innovative solutions, approaches, systems and building technologies to effect buildings' physical performances', and thus end up with those desired goals of sustainability in multiple concerns.

However to discuss each and every criterion and constraint of different approaches and methodologies in a technical manner is beyond the scope and framework of this dissertation, as the primary objective of this study is to develop a totalitarian approach to enhance a sustainable building design lifecycle not only achieved by building performance, but also by perceiving sustainability starting from the initial idea of emergence of that specific function and program for that specific lot until the demolition of the building. Therefore, in this dissertation, the research and relevant studies regarding the physical sustainability of a building design have been discussed solely in a multidimensional and interdisciplinary content.

To proceed within the discussions of achieving sustainability for a building design, it should be remembered that sustainable buildings can only be achieved via the integrated collaboration of a multidisciplinary design team. Adeli (2002) has also envisioned a similar approach in his study, stating that successful creation of sustainable infrastructure systems and environmentally conscious designs requires a holistic, integrated and multidisciplinary approach. The determination and selection of the design criteria of all building systems concurrently and in advance to form the building's overall integrity has thus emerged as an important approach to be considered together with numerous other topics related to energy efficiencies, minimization of wastes and reduction of consumptions. In contrast to what has been agreed commonly as most important and far-reaching systems, serving sustainability in a positive manner such as HVAC, MEP or electricity production, structural systems are one of the major systems directly effecting physical sustainability of any building design. Since structural system decisions are independent of the scale, typology, context and character of any building's design, the structural system becomes the start and ending point of the design with its all interdependencies. Synchronously with the study and development of various design components, multiple alternatives, combinations and priorities in the structural system design have also been conducted. There are many diverse interventions and innovations that are still effective and helpful in the enhancement of sustainability of any building design.

In their study, Anderson and Silman (2009), displayed that structural engineering design strategies are inevitably effective in supporting to enhance sustainability which contributes to the physical sustainability of any building design. The design criteria that they offered as being highly effective includes the following approaches.

- by optimizing the structure so as to reduce greenhouse gas emissions, including material selection,
- by searching the modes and means of reusing the structure of existing building stock together with necessary but optimized interventions,
- by maximizing material efficiency by optimizing different combinations of material utilization, which also provide a better thermal mass efficiency,
- by estimating and designing for strength and maintenances for future adaptability.

Likewise, Wang and Adeli (2014) discuss the importance and efficiency of structural systems on sustainability, given that sustainable design and construction strategies are established based on the form and type of the structural system.

Obviously, the structural system is not the only component in physical sustainability of any building design. However, it may be one of the components which has been underestimated in contrast with its effects on the building performances and sustainability achievements, due to its impacts in the long-term duration of existence and even after demolition. The considerations related to the physical sustainability of any building design is also important and effective in the post-occupancy stage as well. Since in these stages the building performances, the flexibility aspects and its long-term existence of the building still matters, in terms of extending the lifecycle of that specific building and achieve a much more effective and strong sustainability.

2.3.6 Occupancy-Based (Operational / User- Perceptional) Sustainability

Following the basic roots of sustainability, another primary concern should inevitably be the achievement of operational efficiency and occupant satisfaction. When a change is required in terms of revise, remove or apply any kind of treatment to an already completed building design, the building is considered non-sustainable and wasteful in general, due to the produced wastes of efforts, of process, of resource and of materials & systems. However, if occupancy and operation related concerns are considered in the very early stages of any building design development, much more efficient outputs and flexible designs with future projection alternatives can be enhanced and thus these wastes may be prevented or reduced at least.

Occupancy –based sustainability concept is one of the most appropriate concepts where a sustainability approach can easily be applied, followed, monitored and become permanent. This also provides two individual benefits; i.) feedback on the existing/ current building design to be searched for alternative efficient re-uses; revitalizations, and thus still maintaining a sense of sustainability, and ii.) feedback on next/ future building designs, where lessons are learned and applied not to end up with undesired or future-wise risky solutions proposals of designs and thus ending up with a longer term of sustainability approach. Both benefits are important as the lessons to be learned and adapted approach are valid to promote sustainable processes for future executions of design developments.

Post-occupancy evaluations (POE) have been developed as an alternative solution and an approach to aid in the post-construction evaluations of the specific building design output, as well as to serve in the planning, design and completion of future designs with a much higher percentage of success in the fulfillment of needs and requirements, satisfaction in the perception of users.

Likewise with the integrated design approach concerns, one of the key aspects to enhance the sustainability in the operational or occupancy perceptional concept is to have the inputs of all stakeholders in very early stages, such as even the feasibility and planning stages of that building design development. As Kibert (2016) also emphasized green buildings have a positive impact not only on their immediate users and occupants, but also on the broader community and other people in their local environment. According to Zimmerman and Martin (2001); 'those who occupy and use the building or who ultimately pay the bills have little or no influence over the first cost decisions that affect the costs they bear'. This statement also reveals and highlights the significance of occupancy related sustainability concerns in the fulfillment of a totalitarian sustainable building design lifecycle. The process or the lifecycle of any building design is not complete once the design or construction has been completed, rather the building's life begins with occupancy and the requirement for a sustainable lifecycle continues until a replacement – meaning that sustainability considerations were also considered during the demolition as well. In order to sustain these processes throughout the lifecycle, pre- and post-occupancy evaluations are needed, in addition to the participation and contribution of other participants and stakeholders. Consequently, these types of approaches should be incorporated into the sustainability process for the execution of sustainable building design developments, especially within complex multidisciplinary design environments- where many various conflicting parties take part and interact.

2.3.7 Process-Based (Procedural / Managerial) Sustainability

As it has already been mentioned, with the raising population, the urbanization of the world's insufficient geographies driven largely by the extreme consumption of resources and resulting in the accumulation of uncontrolled wastes, has raised rapidly in uncontrolled extremes over the past few decades. Although the vast majority of research have been conducted to search for the ways, methods, systems and approaches to overcome these problems and to bring solutions for the so-called sustainability in building designs or achieving sustainable buildings / developments as individual outputs, there are still a very few- comparatively- stock of research focusing on the 'process' of achieving those building design.

In addition, because not all the processes result in the realization of building designs as physical entities, the quantity of building design processes can be far more than the realized outputs. Furthermore, depending on the uniqueness of each building design development processes including individual typology, context or location aspects, in each of these processes, the methodology and the way of achieving the output still is subjected to change and /or depends on the authority and initiative of the design team and the responsible manager, as a situation in full contrast what is already defined as sustainable. On the contrary, the processes themselves become one of the most consuming & waste-producing components in the entire building lifecycle, due to numerous iterations in the design, idle waiting hours, lack of communication or poor design communication, unstructured data exchanges or over-processing situations. The domain of project management that is more specific to building design development sector- 'design management' approach – although having numerous correspondences and interrelated issues or relevant aspects to be improved in order to have better, efficient, optimized and thus sustainable processes- still is not considered as one of the key principles or components to be integrated and followed in order to achieve sustainable design developments. Among the many issues that management of these design process requires, determination, planning, managing and monitoring and consequently managing the design communication taking place between all of the involved stakeholders and design participants, carry the utmost tension and effect in improving these processes and thus achieve the desires sustainable design development processes. As Labuschagne & Brent, (2005) also noted, project management cannot be excluded from the discussion of sustainability and is a highly effective factor of achieving sustainability as a totalitarian approach.

Project management in AEC domain has often been regarded as only a set of tools or methodologies which control and fulfill the requirements of the systems, such as waste management, materials management or site management. However, due to the long duration and lifecycle any building design, especially a sustainable building, it is preferable to see it as a process rather than a product (Wu & Low, 2010).

Going through the same concept of design process and sustainable management of these design development processes; the relationship and impact of project management approaches on sustainable design emerges as an important and lacking topic. The application of knowledge, skills and techniques to execute projects effectively and efficiently (PMI (2013), as cited by Brones et al., 2014) is one of the most accurate definitions in regard to building design development, although there have been many definitions for project management as being a broader practice domain.

Regarding the fact that being sustainable is the result of both internal and external drivers (Wu & Low, 2010), not only should the technological and environmental aspects for any design be met, but the internal process of achieving that specific design output in an efficient, sufficient and sustainable way should have also been considered and achieved in a similar approach of sustainability, where the process should be managed to be optimized, efficient and become sustainable as well.

Among the few research on management of design development for improved processes in sustainability approach, 'Design for Sustainability (DfS)', has attracted significant interest and attention from the researchers. It has been introduced as a concept to search for alternative and better ways of design development for more sustainable outcomes both in product and / or process design developments. Design for Sustainability is defined as the product design and development process with careful aspects that can mitigate many environmental, societal, and economic challenges during the lifecycle of the product (Brezet et al, 1997, as cited by Ali et al, 2016), which is the building design in our context. Very similar to what has been put forth as one of the most important barriers and issues to be improved in project management in the approach of DfS, also the interrelations of participants, or in other words the communication continues to be most important need and concern to be improved for better and sustainable design (development) processes (Ali et al, 2016).

Regarding these two approaches of Project management and Design for Sustainability, Ali et al. (2016) in his research raised the crucial question of; 'Is there a need for Project Management to complement and support the concept of Design for Sustainability? This question is significant because it not only highlights the requirement of integrating these two distinct yet interdependent approaches, but also contributes to the development of process-based and managerial sustainability concept in building design developments. The research has displayed the deficiencies of DfS in the management approach such as: having a poor communication flow between various stakeholders involved in the process or prioritizing technical issues and models or frameworks rather than managing the process itself (Brones et al, 2014). Furthermore, with similar concerns they have also highlighted the inevitable and important contribution of such a process management approach applied to building design development to improve levels of sustainability in their lifecycles. In addition to other important benefits like environmental, social and economic, this kind of a totalitarian approach also offers significant opportunity for growth in both construction management and product development as well as information change (Robichaud & Anantatmula, 2011).

However, the current practices and frameworks of project management lacks the full fulfillment of three goals of sustainable development such as social equity, economic efficiency and environmental performance, in their entirety (Labuschagne & Brent, 2005). As a result, a more comprehensive approach of firstly understanding various concerns in different sub-lifecycles of the entire lifecycle of the building designs should be enhanced, and then as a second step integrating and managing the interactions between these different components, factors and sub-lifecycles should be developed. As Labuschagne & Brent, (2005) also stated, there is a definite need to develop indicators especially in the early decision-making stages of design development processes to ensure that management approaches of those projects are in accordance with and contributes to sustainable development concerns (Warhurst, 2002).

When the traditional and conventional building design development processes are compared to the recent sustainable and integrated building design development processes, it has been easily noticed that the decision changes, change orders or revisions within the former process results in much more severe consequences, causing excess waste in resource, time and quality. In the latter one, however, each and every system selection or design criteria is highly dependent and effective on each other in those integrated sustainable building designs, so the decisions have been set in advance preventing or at least minimizing the re-works over or under production risks, which as a whole brings more optimized and efficient process improvements. Therefore, early involvement of all participants is essential, where the owner and project manager set sustainability goals prior to design and construction, or design criteria of each discipline is determined and shared with others to be super-imposed and optimized, and for sure the exchanges, communication and data flow in between those team members are fully set and provided for use. Although this kind of an approach seems to have increased the initial cost as it requires assigning more people from early stages and for longer durations, there is a significant effect in later savings due to a decrease in coordination based-problems (Reed and Gordon, 2000), and decrease in rework due to lack of communication or counterpart for specific design / system provisions, as well as a serious gain and higher efficiency in building operations at post occupancy stages.

Robichaud & Anantatmula (2011) have briefly summarized some primary questions that can help to determine these kinds of initial determinations and early decision-making subjects to contribute to achieving sustainable processes and better management approaches in building lifecycles, very briefly displayed in Figure 2.11.

Area	Question(s)	Justification
Environmental certification	Will the project seek LEED or other certification, and to what level? What is the cost/benefit of seeking certification? How will certification be used to market the project?	The degree to which certification is sought can dictate critical elements of the project, including site selection, design, costs, schedule, and documentation.
Design criteria	If the project is not seeking LEED certification, what design criteria will be used as requirements?	Establishing design criteria will help communicate the project's goals and priorities to the project team in a measurable, technical form.
Personnel criteria	What level of green building experience will be required from the project team?	Since hiring decisions are made much earlier in green construction, personnel criteria must be established early and align with the project's goals.
Initial investment capacity	Is the owner willing to make an upfront investment in sustainable construction that exceeds what would be required in a comparable conventional project? If so, to what level?	An integrated project team may require greater upfront investment; the owner's willingness to make such investment will impact the timing and quality of hires. This may also apply to costs associated with initial feasibility studies, site work, and design.
Return on investment	Is the owner willing to accept a life cycle cost analysis including lower operational costs as the return on a higher front-end investment?	Terms for measuring ROI must be established before pro-forma are developed.
Unique or other environmental considerations	Are there climatic or other environmental issues unique to the project's geographical location (e.g., arid climates with water-short characteristics, unique storm water considerations, etc.) that the project must address?	Environmental features unique to the region or a specific community should be defined and considered as part of the project's priorities.

Figure 2.11. Questions For Setting Sustainable Development Goals (Robichaud & Anantatmula, 2011)

2.4 Re-Understanding Sustainability in Building Design Development Processes

Sustainability is a complex challenge as Berg (2019) highlights, and it has several barriers on it to be fully accomplished. Furthermore, as it has been displayed clearly numerous research have been developed to focus and prioritize different strategies on achievement of sustainability; with some trying to focus on improving different aspects of sustainability, while others emphasizing the insufficiency of prioritizing only one aspect or concept of sustainability. Among the few research on implying the interrelations of sustainability concepts within each other, the work of Thiebat (2019) on the re-elaboration of the study of Pearce (1990) displays that economic and environmental concerns are in a very strong dependency, as displayed in the Figure 2.12.

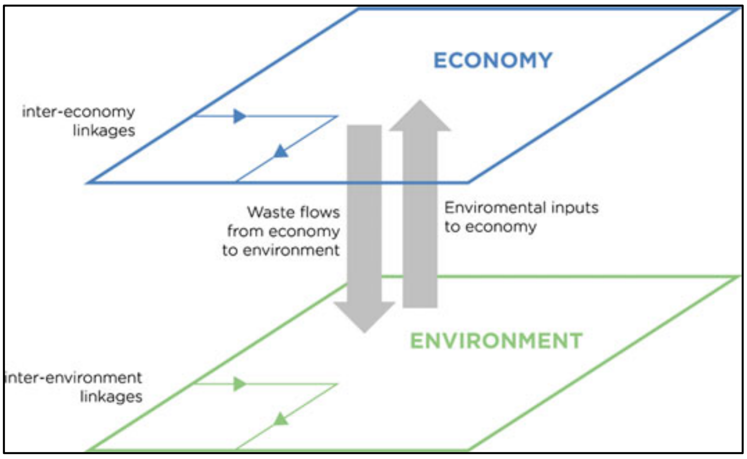

Figure 2.12. Interactions between the environment and the economic system (Thiebat, 2019)

Continuing with the approach of second group; where the lacking aspects and/ or inadequate strategies and concerns have been discussed and highlighted, it is inevitable that the building design processes will be lacking integrated and improved outputs, if different sustainability concepts have not been considered in a much more comprehensive and totalitarian approach. As Alwaer & Clements-Croome (2010) also emphasized, sustainable or green design implies not only better environmental performance and improved standards with new investment values, but also a re-evaluation of design "intelligence" and the ways of integrating them into the building design lifecycles. Therefore, this level of a design intelligence could have only been achieved with a comprehensive way of approach, in which different constraints and priorities of each and every sustainability concept were considered, superimposed with each other and optimized to be constituted as stages or paths to follow to proceed through a sustainable building design development process and reach an inevitable sustainable building design development lifecycle.

Similarly, Garcia and Vale (2017) have also proposed that the integration approach should be pursued and fulfilled in order to enhance a stronger and permanent sustainability in built environments. They have introduced a brief comparison of weak and strong sustainability models, where the strong model may have been achieved with the fulfillment of one before it in an inclusive approach and dependently to the previous one. This way of a totalitarian and integrative approach is highly consistent with the main approach of this dissertation study and the proposed re-understanding of its output. The brief display of this comparative analyses of Garcia and Vale (2017) has been given in Figure 2.13, with the further additions of recently proposed new sustainability concepts to continue this approach and to display their compatibility and dependent relations of each other (red parts are the parts added later).

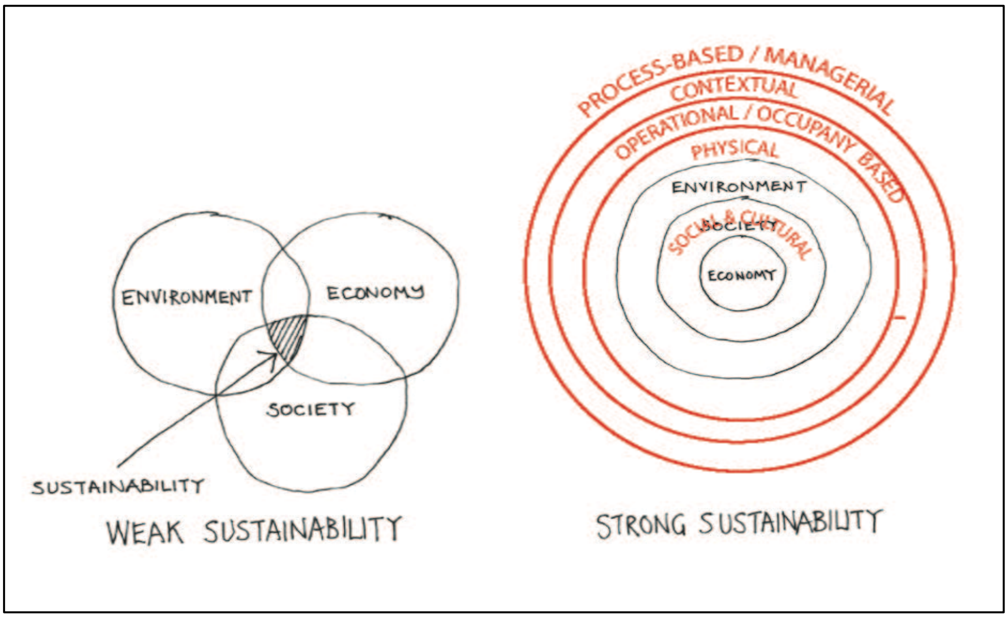

Figure 2.13. Re-adaptation and extension of the comparison of Weak vs Strong sustainability models (Garcia &Vale (2017)

Despite the fact that the three-bottom line of sustainability which are economic, social and environmental, have been the most studied and emphasized concerns in the achievement of sustainable building design development processes, it can be observed from a few studies that additional concepts might be needed to be integrated. The components or factors that few research are highlighting actually coincides with the additional sustainability concepts proposed within this PhD study. The study by Thiebat (2019) emphasizes the importance and necessity for a lifecycle approach in the achievement of sustainability in building design development and illustrates this holistic approach in a circular loop, in which the sustainability components have been integrated. This concept map by Thiebat (2019), however can also be reinterpreted with the addition of a second layer , shown in yellow and red and implemented by the author of this dissertation, to demonstrate that the seven proposed sustainability concepts are always valid and existing throughout the entire lifecycle of any sustainable building design development process (Figure 2.14). Although they may be named or grouped under different topics or concerns, the relevance of them with the proposed sustainability concepts is obvious.

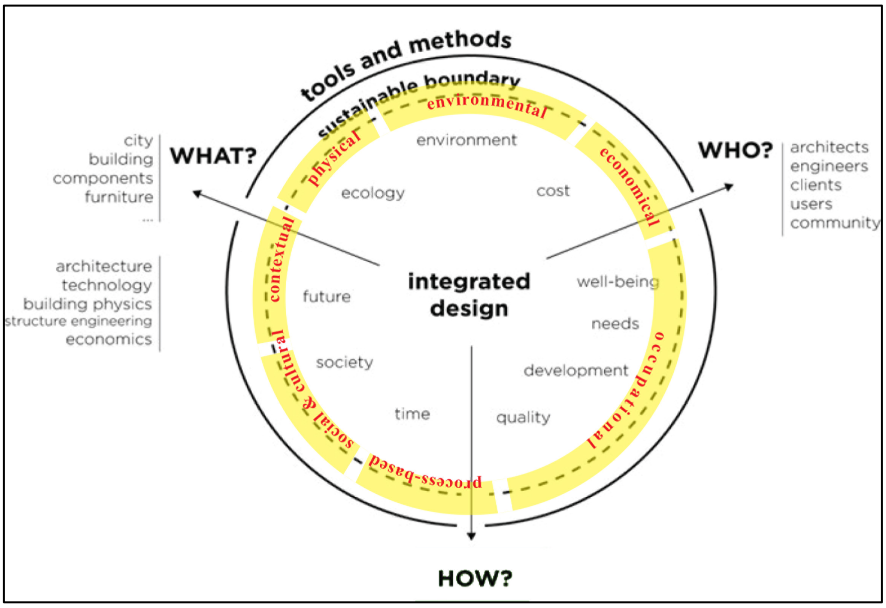

Figure 2.14. Sustainable Building Issues (Akadiri et al., 2012)

Within such an overview approach to derive a common consensus on achieving sustainable building design lifecycles, the work of Akadiri et al (2012) may have been referred as well. In the research, they have categorized and listed some of the principal issues that help to define and reference key sustainable building themes, as seen in figure below (Figure 2.15).

Title	Key Theme	Principal Issues
Economic sustainability	**1.0 Maintenance of high and stable levels of local economic growth and employment** 1.1 Improved project delivery 1.2 Increased profitability & productivity	Improved productivity; Consistent profit growth; Employee satisfaction; Supplier satisfaction; Client satisfaction Minimizing defects; Shorter and more predictable completion time; Lower cost projects with increased cost predictability; Delivering services that provide best value to clients and focus on developing client business
Environmental sustainability	**2.0 Effective protection of the environment** 2.1 Avoiding pollution 2.2 Protecting and enhancing biodiversity 2.3 Transport planning	Minimizing polluting emissions; Preventing nuisance from noise and dust by good site and depot management; Waste minimization and elimination; Preventing pollution incidents and breaches of environmental requirements; Habitat creation and environmental improvement; Protection of sensitive ecosystems through good construction practices and supervision; Green transport plan for sites and business activities
	3.0 Prudent use of natural resources 3.1 Improved energy efficiency 3.2 Efficient use of resources	Energy efficient at depots and sites; Reduced energy consumption in business activities; Design for whole-life costs; Use of local supplies and materials with low embodied energy; Lean design and construction avoiding waste; Use of recycled/sustainability sourced products Water and Waste minimization and management
Social sustainability	**4.0 Social progress which recognizes the needs of everyone** 4.1 Respect for staff 4.2 Working with local communities and road users 4.3 Partnership working	Provision of effective training and appraisals; Equitable terms and conditions; Provision of equal opportunities; Health, safety and conducive working environment; Maintaining morale and employee satisfaction; Participation in decision-making; Minimizing local nuisance and disruption; Minimizing traffic disruptions and delays; Building effective channels of communication; Contributing to the local economy through local employment and procurement; Delivering services that enhance the local environment; Building long-term relationships with clients; Building long-term relationships with local suppliers; Corporate citizenship; Delivering services that provide best value to clients and focus on developing client business

Figure 2.15. Sustainable Building Issues (Akadiri et al., 2012)

Sustainability, on the other hand, offers an intellectual "commons" where new information can be shared, developed, and adjusted (Mihelcic et al., 2003). Consequently, these interactions of different disciplines and transmission of information have been of the utmost importance for achieving a fully successful sustainable lifecycle of the building design. As a result, an extended adaptation and adjustment of Akadiri's table have been developed, with additions for a higher integration of more sustainability concepts supplied by the inputs and outcomes as either tools or focuses of different disciplines. Thus, the revised extended table (Table 2.5), includes all of the sustainability concepts defined in this section, which also serve as the basis for the new re-understanding of sustainable building design development, in order to be referenced in the processes.

Table 2.5 Extended Table of Principal Issues of Sustainability Concepts

Title	Key Theme	Principal Issues
Economic sustainability	**1.0 Maintenance of high and stable levels of local economic growth and employment** 1.1 Improved project delivery 1.2 Increased profitability & productivity	Improved productivity; Consistent profit growth; Employee satisfaction; Supplier satisfaction; Client satisfaction. Minimizing defects; Shorter and more predictable completion time; Lower cost projects with increased cost predictability; Delivering services that provide best value to clients and focus on developing client business
Environmental Sustainability	**2.0 Effective protection of the environment** 2.1 Avoiding pollution 2.2 Protecting and enhancing biodiversity 2.3 Transport planning	Minimizing polluting emissions; Preventing nuisance from noise and dust by good site and depot management; Waste minimization and elimination; Preventing pollution incidents of environmental requirements; Habitat creation and environmental improvement; Protection of sensitive ecosystems through good construction practices and supervision; Green transport plan for sites and business activities

Table 2.5 (cont'd) Extended Table of Principal Issues of Sustainability Concepts

Environmental Sustainability	**3.0 Prudent use of natural resources** 3.1 Improve energy efficiency 3.2 Efficient use of resources	Energy efficient at depots and sites; Reduced energy consumption in business activities; Design for whole-life costs; Use of local supplies and materials with low embodied energy; Lean design and construction avoiding waste; Use of recycled/sustainability sourced products Water and Waste minimization and management, the possibility of demolishment
Social and Cultural Sustainability	**4.0 Social progress which recognizes the needs of everyone** 4.1 Respect for staff 4.2 Working with local communities and road users 4.3 Partnership working	Provision of effective training and appraisals; Equitable terms and conditions; Provision of equal opportunities; Health, safety and conducive working environment; Maintaining morale and employee satisfaction; Participation in decision-making; Minimizing local nuisance and disruption; Building effective channels of communication; Contributing to the local economy through local employment and procurement; Delivering services that enhance the local environment; Building long-term relationships with clients; Building long-term relationships with local suppliers; Corporate citizenship; Delivering services that provide best value to clients and focus on developing client business Involvement and participation of all relevant stakeholders as well as possible community and user feedback
Contextual. Sustainability	**5.0 Contextual appropriateness** 5.1 Relations of the design with infrastructure of the surrounding 5.2 Micro and macro level impacts 5.3 Typological coherence with the existing building stock 5.4. Architectonics, material and scale wise relevance	Analysis and synthesis of existing infrastructure, the relevant transportation mediums utilizations or additional requirements for different modes of accessibility. Building design structures' impacts on the nearby and further regions in terms of scale, silhouette, landmark, public use and accessibility Effective, appropriate, coherent adaptation in terms of physical and social contextual suitability (in scale, proportion, aesthetics, area, use or materials) in the surrounding built environment as well as urban region. Adaptation of existing or recently developed masterplans with the proposal. accessible neighborhood and walkable city sensitivity

Table 2.5 (cont'd) Extended Table of Principal Issues of Sustainability Concepts

Physical Sustainability	**6.0 Systems, materials and technology adaptations** **6.1** Selection of efficient optimized and sustainable systems for building performances **6.2** Initial, interim & lifecycle wise economical coherence with respect to design criteria and relevant system and material selections **6.3** Integration and optimization of different systems and design approaches, outputs of different disciplines	Determination of design criteria of relevant disciplines as building design components Superimposition of multiple various design criteria Utilization of passive systems (orientation, location of building design structure) and natural resources (tri-generation, water-base heat pump, PV…etc.). Integration and optimization of design systems and tools as an output of multidisciplinary collaboration process Selection of sustainable, responsibly obtained, environmentally friendly, less consumer or waste producing but more energy efficient (and if possible local as well) materials. Evaluation, simulation (and /or accreditation) of determined systems for sustainability performances. Estimation and/ or planning of sustainability continuation in the case of demolishment (regarding still to be included in the lifecycle)
Occupancy – based (operational) Sustainability	**7.0 Execution of a wide-ranged collaborative design decision (input) environment in early decision-making stages** **7.1** Regulating, incorporating and utilizing pre-and post- occupancy feedbacks and/ or evaluations for the building design lifecycle **7.2** Considerations of possible interventions, revisions or requirements of post-occupancy related treatments' applicability	Determination of building program with respect to initial feasibility studies and potential stakeholder involvements (as surveys, analysis, offer-demand ratios) Details of program development with necessary flexibilities for future adaptations or adaptability for further progress. Determination of economical strategies of the design development in relation with possible occupancy and other related stakeholder involvement or perceptional approaches; as well as operational estimations with that regard.

Table 2.5 (cont'd) Extended Table of Principal Issues of Sustainability Concepts

(Process-based) Managerial Sustainability	**8.0 Integration of a total design process management approach to sustain the efficiency and improvement of the sustainable building design development lifecycle** **8.1** Determination of design communication tools with necessary technology adaptation **8.2** Determination of data exchanges and related information flow process **8.3** Determination of responsibility matrices **8.4** Management of design development documentation	Determining the appropriate and agreed design communication medium to be followed during the whole design development process Issuing and allocating responsible parties, participants and other stakeholders within the system as a common digital design communication platform. Determination of design data management and relevant procedures of exchanges (from whom to flow who with what level of detail and in what sequences…etc.) Superimposing the data exchanges with respect to determined schedules (of submission, approval, ...etc.) Regulating and managing necessary design documentation within all of the design team as well as other third-party stakeholders and/ or authorities to proceed with and fulfill the required procedures, time slots, documentation and closing.
Design Development Technology Support and significance in sustainability	**9.0 Determination of appropriate design development technology for project execution and multidisciplinary integration** **9.1** design/ project data / execution and exchange mediums (digital design environments) **9.2** superimposition and (clash) control detections of different disciplines' **9.3** improved and effective design communication availability	Determining the best appropriate and efficient design development technology (software, digital medium or application) to be followed. Allocations, determination and assigning of people vs. product (tasks) vs. time (submission,) within selected design development technology. Determination of necessary exchanges (of data, of information, of submittals) and required (control) check valves Determination of developing the base design model and required (control) check valves Possible integration of improved design models with different dimensions (time, schedule, cost, efficiency, facility…etc.) and development levels of building design lifecycle

It has already been agreed that it is not enough to merely have sustainability assessment systems, they must also be incorporated in the design and development processes (Ahmad and Thaheem, 2018). According to Bragança et al (2010), the agreed dimensions of sustainability, which are environmental, economic, social and cultural must be addressed for any building design project to be considered as sustainable, and moreover these dimensions must also be interwoven with the high level of integration of relevant participants of the design development environment.

The goals displayed by Bragança et al. (2010) in several building sustainability assessment methods (in Table 2.6 left column) and their association with the sustainability concepts determined in this dissertation (Table 2.6 right column) is displayed in Table 2.6. The interrelationship displays clearly that each concern on the way of achieving sustainability is tightly and inseparably bonded with at least two or more sustainability concepts.

Table 2.6 Goals Associated with Sustainability Concepts

<table>
<tr><th>Goals</th><th colspan="2">Sustainability Concepts Associated with The Goals</th></tr>
<tr><td>▪ optimization of site potential,</td><td>Environmental S. & Contextual S.</td><td rowspan="7">Process-based / Managerial S.</td></tr>
<tr><td>▪ preservation of regional and cultural identity,</td><td>Social & Cultural S.</td></tr>
<tr><td>▪ minimization of energy consumption,</td><td>Physical S. & Economic S.</td></tr>
<tr><td>▪ protection and conservation of water resources,</td><td>Physical S. & Economic S.</td></tr>
<tr><td>▪ use of environmentally friendly materials and products,</td><td>Physical S. & Economic S. & Environmental S.</td></tr>
<tr><td>▪ a healthy and convenient indoor climate</td><td>Physical S. & Occupancy –based S.</td></tr>
<tr><td>▪ optimized operational and maintenance practices</td><td>Occupancy –based S. & Economic S.</td></tr>
</table>

As a conclusion regarding the research and relevant literature studies conducted on the broader sustainability topic and on more specific sustainability concepts, it is obvious that numerous studies have proposed different strategies for enhancing higher levels of efficiency in the sustainable outputs in our built environments. Although they seem to focus on or prioritize different aspects as strengths of their proposals; it has clearly been displayed that each and every one of the introduced sustainability concepts are directly related and primarily effected by one another. Therefore, a totalitarian approach, whose process stages have been determined, whose priorities have been defined, whose focus of involvements in terms of actors has been assigned, and whose possible superimposition within these different concerns has been set, with a base reference of a comprehensive process of sustainable building design lifecycle is required. This totalitarian approach thus constitutes a re-understanding of multidisciplinary building design processes towards the concept of sustainability, with a proposition of a multi-layered design approach.

CHAPTER 3

DETERMINANTS OF SUSTAINABLE UNDERSTANDING IN BUILDING DESIGN

Design and building have been considered as a phenomenon determined by the factors such as time, context, politics, legal and administrative regulations, cultural utilization and accustomed habits. The physical environment also has an effect on each and every one of them. Even for some unplanned developments, this effect begins with the planning stage and continues as a process. Building design development is an intermediate stage within this effecting process, which ends up with the building's demolition as a last stage. Therefore, it should have been reconsidered and redefined that; sustainability concept cannot be discussed exclusively on the basis of one single building design development. In contrast, the discussions of sustainability should be evaluated from a multilayered perspective, with all the impacts and inputs of building design development process have been taken into consideration beginning from the very early stages of the lifecycle.

In the Turkish context, similarly, numerous typologies such as mass housing, second housing and slum housing, all of which were realized through governmental investment, have evolved by defining their own typologies. In this process of evolvement, many different actors have played significant roles at various stages of the whole process. Therefore, it would be insufficient and inaccurate to understand sustainability achievement approaches by examining the final outputs, without considering these transformative consequences. Therefore, it is not only essential but also required to understand these traditional processes, which were developed with varied inputs of sustainability concept and were also shaped by the traditions and habits of building design production. In addition, the sub-components of this process such as legal, legislative, administrative regulations, actors, stages, exchanges and documentation should have been analyzed in order to completely comprehend and appreciate, and so improve the achievement of a sustainable building design development process.

3.1 Factors Effecting Sustainability in Building Design Development

As mentioned in the previous section, several research and studies have been conducted on the extremely broad domain of sustainability in building design. Each and every concept focusing on the efficiency and achievement of sustainability in any building design is naturally connected and interdependent in terms of their primary and/ or side effects. A design criterion related directly with the energy efficiency of any building design for will inevitably effect the building's own performance and will have impacts on its surrounding; thus energy-efficiency related physical sustainability concerns will inevitably contribute to environmental and ecological sustainability concerns. Likewise, a social and cultural sustainability related concern in any building design including the program determinations, function mix or site selections, user expectations vs satisfactions, definitely effects the infrastructural requirements and results in environmental and economical impacts effecting those specific concepts of sustainability as well. Therefore, it is impossible and also not a valid approach to concentrate on only one concept as being the primary factor for enhancing sustainability. On the contrary, it is preferrable to consider the majority of these concepts as interdependent sets of effective factors those of which share similar groundings, common concerns or priorities of domains on their enhancements. In continuation with this approach, in the analysis and identification of these sustainability concerns, a number of significant common domains that are effective in achieving efficient or causing insufficient sustainability degrees, have been observed. These possible commons have been reconsidered and categorized under three primary topics of factors, based on their existence and effectiveness in achieving sustainability in a broader scale. The classification of these factors thus has been determined as: i. People, ii. Planning of Process and Products and iii. Sustainability Concepts.

These factors were also considered and rephrased as ‘priorities’ in the further discussions of this dissertation and enclosed in next section of this chapter-. This new phrasing is valid since the prioritization of these would contribute to the development of the strategies and the establishment of process action maps for the achievement of sustainability in building design development.

To conduct a more comprehensive study, these mentioned factors are better to be discussed and analyzed thoroughly according to the variety and scale of their effecting domains as well as the amount of impacts and their weights on the whole domain.

Alwaer and Clements –Croome, (2010) have described sustainable buildings also as highly related with three components, with a similar approach. According to them, a sustainable intelligent building can be understood to be a complex system with three fundamental challenges that are interconnected:

i. People : decision makers, professionals, occupants or users of the building design
ii. Products : materials, fabric, structure, facilities, equipment, automation and controls, services
iii. Processes : maintenance, performance evaluation, facilities management and the interrelationships between these issues.

As obviously understood from the study of Alwaer and Clements –Croome, (2010), these three fundamental issues must be addressed prior to achieving general sustainability in any building design, as they are the primary factors effecting the achievement of individual sustainability concepts mentioned in Chapter 2. In further explanation, it can be considered that without ‘people’ interference and involvement, the perception of the social and cultural sustainability cannot be fulfilled, or likewise if the lifecycle of any building development is excluded from the overall evaluation criteria of any building's sustainability, both the economic and the process-based sustainability and also occupancy-based sustainability concerns cannot be achieved. One important remark better to be mentioned in relation to Alwaer and Clements – Croome, (2010)'s study would be related with the second issue of product. In this dissertation and approach of this study; the product item has been considered as the whole outcome, due to the impact of multiple different sustainability concepts on the building design outcome; therefore, in the further section in addition to further discussions of people and process; third item has been determined as sustainability concepts, as a substitute of product. Different than previous research focusing on the final products and performance of the final product and attempting to derive strategies backwards basing on these final products; this dissertation study aims to focus on the process of any building design; in a much more broader approach by considering the whole process as a long-term lifecycle where the very early stages of decision making are as effective as the decisions related with the performances and efficiencies of the design, and also as much important as the final responsibilities of decisions on reuse, recycle or demolishment and proceeding waste management. In the following section these factors with their corresponding components and effecting criteria on the process and the building design itself are explored.

3.1.1 Actors Effective in Sustainability Processes

First main factor topic appears to be the domain of 'people'; by both being the most effected domain by the provision or lacking sustainability in the global world, and also at the same time by being the main effecting factor on the entire domain on the achievement or non-achievement of sustainability as the professionals of design and construction industry. Recalling the primary considerations and concerns on the introduction and definitions of sustainability as a concept and as an approach; 'people' related sensitivities and concerns emerge as the driving force behind both its evolution and also its rapid rising. Better life, fulfillment of people's basic needs, future generations, preservation of natural sources for the continuation of healthy and self-sufficient environments are some of the key aspects that have been highlighted and contributed to both the development of sustainability concept itself as well as to the development, improvement and integration of strategies, tools and approaches to enhance it.

Concern about sustainability began with the sensitivity on people and with a concern on how to improve life (quality) of people. Recalling one of the earliest definitions of sustainability by WCED (1987), the majority of the concentration and emphasis were on satisfying the needs aspirations of people for a better life. Similarly, in the definition of IUCN (1991), sustainability has been defined as a development to improve of the quality of human life and in other research is to create a healthy built environment (Kibert, 1994). Benaim et al (2008) have also stated that in any concept of sustainability 'people' matter, because all planned and/ or engaged developments are centered on people. Basing on these highly emphasized aspects creating the basis of sustainability approaches and the main sensitivities on enhancing sustainable developments, the subject of 'people' in terms of authority, both in the stage of decision making and in the stages of execution as well as in the stages of experiencing, perception and evaluation arises as one of the important domains to be analyzed and developed further.

Another research feature revealing the importance and impacts of people factor in the enhancement of sustainable building design developments, are observed as the interactions, correspondences, exchanges and mutual-dependents or cross-relationships that occur between different domains by different people. Both enhancing a much more totalitarian sustainable outcome as the building design product and enhancing a much more efficient and a sustainable process on the way of achieving these outcomes, depend on the correct, appropriate and planned involvement of people within each concept of sustainability. This second domain must be analyzed based on the varying circumstances in terms of actions, responsibilities and tasks that occur at different stages of the entire lifecycle. Throughout the whole lifecycle, it is important to remember that the amount of people, sometimes the amount of the involvements and the amount of interactions and collaborations may fluctuate.

User interferences have also been identified as a significant aspect, in the research revealing people effect and consequences of different impacts of people on the paths of achieving sustainability. Briefly; how spaces are designed for which people and how people use their spaces or to what extent the consistency of to be designed for and to live in it can be fulfilled, become some important concerns revealing the key factor of people not only in means of guiding the process or executing the quality, efficiency and appropriateness of the product but also effecting the post-product stages, which are inevitably parts of the lifecycle of building design development and thus highly effected on the enhancement of a total sustainability.

To achieve sustainability, we need to assess people not only in terms of who has what kinds of impacts on the process, but also in terms of who will ask which questions to sustain the process in terms of sustainability.

Numerous research has referred to the terminology "stakeholder", while discussing the broader topic of people involved in any building design development domain. Freeman (1984) was one of the pioneers introduced and discussed the term "stakeholder" as any group or individual in an organization that has the potential of effect or have been effected by the achievement of the organization's objectives. Although the term has been introduced firstly in other disciplines with different aims, with the increase in the complexity of building design development projects in AEC field and with the inevitable raise in the involvements and interventions of many different people acting in the multidisciplinary complex design teams, further and specific determinations on the definitions of responsibilities and degrees of dependencies as well as interrelational organizational strategies have all become required. Consequently, the stakeholder approach has become more prevalent in building design development research to address these issues. Furthermore, even additional searches and studies on the need for further subclassifications or different organizational and relational determinations among these complicated stakeholder groups have been proposed.

Considering Freeman's (1984) research on stakeholders, which defines them as parties (individual or group), the relationship between the stakeholders could have been taken into deeper considerations to enhance sustainability both in the output (of building design) as well as in the process (design development process of that output). Again, in Freeman's study (1984) the key stakeholder groups have been classified into two categories; those who are effected and those who can effect. The motivations and expectations for such a classification were hidden behind the questions such as: how and on what domain is this classification effective? How may each of these categories effect the design development processes for sustainability? Should these two groups be prioritized for the improvement of building design development processes and their continued long-term lifecycle's viability? The reason why studies like Freeman's or others are important and have been enclosed in this study is due to their elaboration of people factor with its different aspects and consequently considerable impacts on the building design development processes.

Vos (2003) did an additional study on stakeholders and their significance in building design development processes, in which he proposed a system of stakeholders categorized under two key headings: 'the involved: can affect' and 'the effected: is effected'. It is obvious that Vos has based his research on that of Freeman's (1984) by improving and detailing the features of each category. Vos's system of stakeholders has been displayed in Figure 4.1 below; with their further extensions of questions on how to determine any stakeholder to belong to which topic.

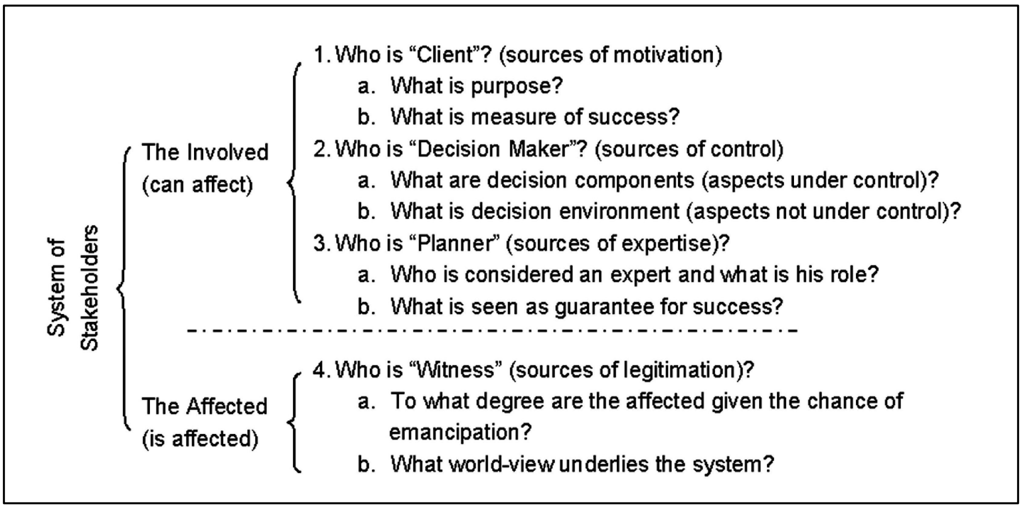

Figure 3.1. A System of Stakeholders (reproduced by Vos, 2003- with permission and adapted from Ulrich (1983))

Such classifications and additional research on stakeholders are essential on the development of the comprehensive guidelines for sustainable building design developments because the concept of people is permanent throughout the entire lifecycle and is highly effective in the achievement of these integrated sustainable design development processes. Depending on the category to which each actor belongs, the involvements, contributions, impacts and responsibilities to improve and enhance sustainable building design development lifecycles vary.

Considering that there are always exchanges, interactions and correspondences between different people having conflicting concerns, priorities, requirements; not only arranging and managing these multidisciplinary and chaotic design environments but also being able to utilize this multidisciplinary contribution and collaboration potential in favor of improving the processes and the outputs have been taken in utmost concern when developing the structure and details of the comprehensive re-understanding of sustainable building design development. In summary, the determinations of who will and is eligible to ask which questions, in which level of details to be specified, developed, explained, to whom, in which specific stage in the whole lifecycle, and in what kind of responsibility to decide, to execute, to evaluate for which kind of impacts and improvements on the building design development lifecycles from the basis of this comprehensive study.

3.1.2 Process Planning Approach for Effective Sustainability

Continuing with people in one hand, on the route to developing an efficient and hence sustainable building design output, the second group of components has been identified as the 'process' that is under the direct effect of people. Moreover, since the term of sustainability itself requires and calls for time-sensitive durations to be kept as intended to be verified as a terminology; 'process' becomes the key factor for sustaining the sustainability in building design development approaches.

Robichaud & Anantatmula (2011) also emphasized that, an integrated approach to executing sustainable design development processes is successful in overcoming the problem of splintered functional experts, who had difficulty communicating and collaborating as a team. They continued to support the benefits of this approach by introducing a five-step approach to be adapted for improved process achievement of sustainable building design developments. The headings for these steps are given below:

i. Begin with the end in mind:
ii. Integrate the project team
iii. Design with the whole team approach
iv. Use bonuses and rewards in project contracting
v. Provide for training and communications throughout construction

This five-step methodology for achieving sustainable building design developments, reveals once again the importance of perceiving the entire lifecycle as a matter of holistic approach and the primary intervention. Specifically, the first three steps emphasize and further justify the importance of prioritizing and integrating the relevant issues of integration in planning a totalitarian approach, in the sustainable design development processes to prevent any excess wastes like idle waiting hours, over processing, revisions or reworks and provide an improved more efficient value as an output including occupancy satisfaction, accuracy in budget-time-resource estimations and realizations. In addition, these three items strengthen the idea of prioritizing people, processes and products to enhance sustainability throughout the entire lifecycle of any building design development.

Baldwin et al. (1999) propose one of the definitions of building design based on the study of Hassan (1996), which defines it as 'a process which maps an explicit set of client and end-user requirements to produce, based on knowledge and experience, a set of documents that describe and justify a project which would satisfy these requirements plus other statutory and implicit requirements imposed by the domain and / or environment'. Here, it is obvious that in any building design there have been many interactions and exchanges in the process by means of data, knowledge, documents, information and requirements, those of which actually constitutes, develops and thus defines the building design itself. In light of the rising complexity of building design outputs as well as the earlier briefs and requirements that led to these outputs, the focus on improving the design quality of the output has inevitably needs to be transferred to improving the processes, as improved processes directly result in improved outputs. Although the classifications, determinations and definitions of the building design lifecycles vary, it is a generally accepted fact that the efficiency and the sustainability of each stage are directly impacted by the exchanges and interactions of data, communications, documents that occur in between. The multidisciplinary character of any complex building design development requires input, feedback, communication and data flow as well as information exchanges to be proceeded, regardless of the typology, context or location. Considering the sustainable lifecycle of a sustainable building design in particular, all individuals participating in the design environment should contribute and share their concerns, priorities, constraints and goals as early on as possible, beginning with the very early stages of the lifecycle. Since decisions taken in the early stages of design have a significant impact on the total cost of the project

(Baldwin et al., 1999), they have a preventive impact on revisions due to lack or late sharing of necessary information between participants, as well as they also serve as a bonding framework and a guiding principal for the process itself.

Lifecycle has been generally considered as focused mostly on the performance of the building design mostly after construction and also when it has been taken into operation, but rarely it includes design process. To bring a broader perspective and a comprehensive approach to the domain of achieving total sustainability in building design development processes, lifecycle has been considered and used to define 'an overall process beginning with from the emergence of the project possibility and ending with (or even including) the demolishment processes and waste management of the demolition in this dissertation. To contribute to the improvement of sustainable lifecycles of building design developments, all of the already-mentioned commons as factors have been and should be analyzed in detail with regard to the interrelated and cross-effective aspects of their impacts as well as their potentials and limitations to contribute on.

Keeping in mind this new conceptualization of the lifecycle approach of building design developments and the effective commons occurring in these lifecycles to sustain more sustainability concepts to reach to a comprehensive sustainability in a broader domain, three priorities have been analyzed in more detail in the following sub-sections that follow in order to reveal their potentials and limitations and then to search for the better utilizations of these priorities integrated within each other for the establishment of the comprehensive re-understanding.

Per definition, sustainability always refers to a period, an interval of time a duration. Although there have been uncertainties and confusions regarding the precise definition, or there has not been yet a common consensus on the concept, each and every different study on it refers to this time dimension where a broader sustainability is anticipated to be enhanced. Therefore, the process itself becomes the critical factor in achieving sustainability. Sustainability is an abstract term that has more concerns and characteristics to satisfy in its life or to sustain in other words, than only producing an output. As stated by Basiago (1999), sustainability means to maintain some entity or outcome but also the process over time, this process happens to be the domain where the sustainability should exist. In continuation with this abstract aspect of its perception, the concept of sustainability has been generally referred to imply the capability to be maintained or to continue existing across time (Herremans & Reid, 2002).

Continuing from the concept of sustainability and the sustainable process effecting on the achievement of sustainability, the building design developments (and their process executions) become the subject of consideration as to whether and to what extent they can be carried out in a sustainable manner. Since these processes are the domains and durations where all the interactions, exchanges, correspondences, productions, revisions, trials and errors, take place among a considerable large amount of actors; the efficiency and the capability of each process to sustain its life by fulfilling its intended targets become essential and highly effective on the enhancement of sustainable building design developments.

Having mentioned the significance and impacts of the process on the achievement of a broader sustainability in building design development, there have been other discussions highlighting the uniqueness of each building design development process and thus proposing that due to this uniqueness it is inconvenient and impossible to optimize, somehow standardize and/ or structure these processes so that they become sustainable over the long term.

Grierson & Moultrie (2011) in their research, state that the shift towards sustainable buildings requires a transformation of the architectural design process as well. Furthermore, they also suggest a new framework utilized and served to navigate the complexities of sustainable design within a context that is promoting changes in building performances.

3.1.3 Sustainability Concepts as Multidimensions of a Broader Understanding of Sustainability

Third one of the group of factors effecting on the achievement of sustainability has been identified as the sustainability concepts, as they effect the efficiency and hence the overall sustainability of building design developments, sometimes individually but mostly together in interaction and close interdependency with each other on.

There have been numerous variants of products appearing in any building design development, ranging in typology, in scale, in complexity and in their own manufacturing approaches, where each and every outcome of a process could be also determined as a 'product'. Within this approach, every decision is made at each stage and topic of building design process; beginning with the program and / or site selections or feasibility studies conducted on both the expected performances and efficiencies, as well as the validity, of proposed typology of that future building design. Then they continue through the overall design criteria determined in the development of the building design project in multidisciplinary collaborations as well as the material and system selections to constitute and construct the intended design through the transformation of the design to the construction output- the building. Final stage for decisions to be effective is at the post-construction stage related to facility management, operational and occupancy-related issues. All these stages should be counted as durations where decisions and their impacts that contribute to the total enhancement of sustainability, should be considered in the building development's overall lifecycle.

Therefore, in order to search further the aspects to be prioritized in the development of such a product, the impacts on these products play a crucial role. In continuation with these concerns, various concepts acting on the achievement of sustainable building designs as outputs are effective in different scales and in different combinations of impacts.

As it has been previously discussed and mentioned, a solitary or narrowly focused method is never sufficient for achieving a total and much more through result in sustainable building design development as an output. Similarly, sustainability concepts and principles are not sufficient on their own to prioritize the brief or to guide the process map to proceed. On the contrary, these principles should be integrated with a thorough analysis and synthesis of an entirely new sub-set of social, environmental and economic goals, together with the establishment of specific criteria and functional requirements to have efficient sustainable design processes (Grierson & Moultrie, 2011).

3.2 Priorities of Sustainable Building Design Development

Sustainability goals within an efficient building design development process are strongly and broadly tied to the factors effecting the process. The domain of people or namely the actors; mentioned as one of the mostly influential one of these previously listed factors. Given that not only the execution of a sustainable building design development but also the perception of the outputs of these building design development processes are all related to people, it is inevitable that the priorities, concerns and privileges of the people play important role in the entire sustainability achievement process. Nonetheless, based on the literature data gathered from the thorough survey of literature; it is evident that these priorities, preferences, or privileges show variations and differences with respect to the different groups of people involved within the process as well as with respect to the different stages that these people involved within the whole process considering the full lifecycle. Not only the tools, techniques, exchange strategies and methodologies may vary in terms of the preferences of people involved and executing these sustainable building design developments, but also the effectivity ranges, percentages or perceptions of the sustainability concepts to the broader sustainability achievement also changes according to each and every actor and according to the stage in which they take part.

The next sub-sections of this section reveal these cross relationships between these three-partite factors that exist and have an effect on one another.

3.2.1 The Interactive Relation between Actors and Concepts of Sustainability: Revealing the Priorities

People domain, as explained in previous sections, has been one of the most effective factors not only on defining and transforming building design development process in its long-term lifecycle; but also, in evaluating its achievement of sustainability with all of its sub-concepts in a much broader manner, resulting in a complete satisfaction or fulfillment of efficiency of that particular building design development. According to their involvement in the process, both their effects on the process and the final product and their contributions to sustainable design developments have shown varieties. Thiebat (2019) also supports this idea; by mentioning the different concerns of different actors within the same stages and especially early decision-making stages of building design development, such as developers concentrating on the global costs, final users focusing more on environmental and economic impact of the products and public authorities searching for concrete answers for raising awareness (Ryan (2014) cited by Thiebat, 2019). In addition, he continues to emphasize that the actors must follow a long-term approach, categorizing their visions of strategic objectives under four headings:

- minimizing the use of natural resources
- maintaining efficiency for a pre-established period of time (durability)
- ensuring adaptability to changes in use over a period of time (flexibility)
- ensuring the deconstruction and recycling of building components.

The effect of actors has been perceived in a broader domain in a systemic way. Regarding the complexity of the systems or approaches that are interdependent for the achievement of sustainable built environments, multiple efforts from many sources at multiple levels with multiple distinct approaches are required (Künkel

(2019) as cited by Berg, 2019). Continuing back with the effects of individuals on the achievement of more efficient and sustainable building design developments; the involvement of these actors becomes significant, raising the question of how effective actors are and how they might participate in a more productive and contributive way. As Berg (2019) explains, these actors are not individuals, but rather multiple-level actors with different responsibilities and priorities, who eventually play a different role based on their own choices and individual orientations. Furthermore, these actors represent and execute the commercial (market), political, legal, technological and institutional systems in general, thereby identifying and defining these sustainability concepts. Moreover, this is why each approach and impact of these actors on sustainability concepts is essential for the improvement of these processes and achieving a much more effective sustainable building design development process.

3.2.2 The Interactive Relation Between Concepts and Stages of Sustainability: Highlighting Essential Criteria

Building stages as discussed in previous sections, are essential in restructuring the fundamental and relevant concerns for a sustainable building design development achievement. Although there are numerous classifications of different sub-divisions of the stages of a typical building design development process, some commonalities can be found or established by dividing the whole process into three primary groups; i) pre-project; ii) project and iii) post project. There are similar divisions in the literature displaying a similar approach of classification; one of which is given in the research of Thiebat (2019), where he mentions the three main groups as ; design stage including the planning, design and construction, use stage including operational, functional and facility based planning, applications, maintenance, technological utilization or updates, and, efficiencies and end of use stage including demolishment, waste management, reuse or recycling of materials and components, and even soil regeneration (Sinopoli (2014) as cited by Thiebat, 2019). In addition, he mentioned that a decision-making method should be established, clarified and agreed upon in the very early stages of the building design development lifecycle in order to define and achieve the sustainability of the solutions in the proceeding interim stages of the process and eventually as the final output of the sustainable building design development at the end.

The interrelationship between the stages and the sustainability concepts significant to that stage is also crucial since prioritizing and identifying some decisions is also required within these stages. The decisions on the system selections and materials have a higher impact on the physical sustainability of that. Building design, whereas giving these decisions have another significant impact on the process-based sustainability, as it enables the actors optimize their design criteria earlier to reduce the possible negative impacts. Likewise, the occupancy-based sustainability concerns followed, evaluated and fulfilled in the early stages may inevitably effect and contribute to the long-term social and cultural sustainability of that building design. The detailed and accurate perceptions of each sustainability concept highlight certain criteria which are significant and essential, thus clarifies the concerns and related actions to be followed. These tasks and actions, since they are associated with certain stages within the lifecycle, enables the actors to be much more clearly and appropriately engaged with that stage to fulfill that specific sustainability concept in collaboration.

Therefore, establishing these important links between the sustainability concepts and the design stages, both highlights the essential criteria for the fulfillment of that specific sustainability concept and also reveals the specific responsibilities and possibilities of collaborations between actors. With the help of these links associated between specific involvements of specific actors to take those decisions and thus fulfilling those sustainability concepts could have been achieved.

3.2.3 The Significance of Actors in Different Stages of Sustainable Design: Determining the Breakdowns

Building stages reflects the breakdowns of the total lifecycle of any building design development; and their detailed relevance with the relevant actors' involvement for that specific stage is crucial for improving the efficiency of the processes and thus achieving a broader sustainability. In order to achieve a total lifecycle enduring sustainability for any building design development, it is necessary to establish the sustainability goals and criteria that are valid and continuous throughout the whole lifecycle. Consequently, the criteria, responsibilities and tasks should be specified in the very early stages answering the questions such as how the building will be developed, designed, used, operated, maintained. Therefore, it is never too early to involve the relevant actors. Since the sustainability construction approach includes the very final stages of the lifecycle; relevant actors should be involved in advance to assess and build assets at the end of the building design's first use life. There should be considerations of different possibilities to extend the useful life and building design's endurance. Introducing new actors to develop, use, change or (if these are not possible) to deconstruct (demolish), recycle and also be responsible from the disposal and management of the very end wastes should be considered (Halliday & Atkins (2019).

Throughout the entire lifecycle, it is necessary to determine, plan and adhere to the various degrees of involvement with various tasks, responsibilities and actions, as well as the relevance of achieving sustainability concepts. In the research of Thiebat (2019), the involvements of different actors within different stages of building lifecycle have been represented in three main stages, which are consistent with the previously proposed grouping of pre-project, project and post project design stages of a building design development process.

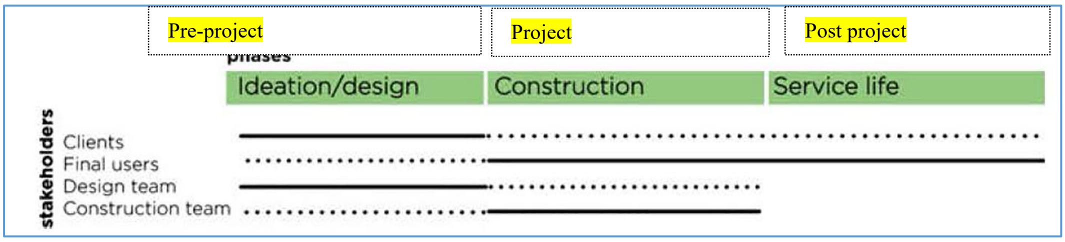

Figure 3.2. The Diagram Revealing the Involvement of Actors Within Different Stages of The Building Design Development. (Thiebat, (2019)- Yellow Highlights Added by The Author Afterwards)

In continuation of these discussions of impacts and involvements of actors in the building design development process, for the professionals / executors of sustainable building design development in particular; some essential sustainability tasks for the whole design team have been determined by Halliday & Atkins (2019), where they have listed these tasks as shown in Figure 3.3.

Proceeding with this determination of tasks for the actors of primarily the design team, some additions have been made by this dissertation study; the first being the addition of relevant stages to the right column of the tasks in order to relate them to specific stages of the building design development lifecycle, and the second being the addition of relevant actors like decision makers, professionals or occupants, in relation with those specific stages.

• understanding strategic sustainability considerations	Pre-project stags	Decision makers
• improving sustainability briefing procedures to establish the Sustainability Strategy within the Strategic Brief and Business Case		
• establishing, developing and communicating client sustainability priorities as Sustainability Aspirations		
• engaging with stakeholders and involving users and management at an early stage		
• selecting a project team with the necessary multidisciplinary design skills	Pre project stages & Project stages	Decision makers & Professionals
• identifying the need for specialist advice		
• setting fee structures appropriate to delivering a sustainable project		
• developing teamwork and robust communication.		
• develop passive design solutions and good ergonomic control		
• ensure assessment of the environmental integrity of materials and products		
• reduce waste throughout the life cycle, including designing for ease of maintenance, deconstruction and recycling		
• minimise use of toxic substances in line with the precautionary principle, adopted by the EU and member states		
• encourage fail-safe innovation of products, systems and processes.	Project stages	Decision makers & Professionals
• developing the Sustainability Aspirations into targets and maintaining a focus on these throughout the project		Decision makers & Professionals & (possible users) Occupants
• establishing supply chain management where specifications involve real or perceived innovation		
• establishing contractually based post-construction integrity testing		
• preparing tender documentation which ensures that the key performance indicators (KPIs) derived from the Sustainability Aspirations are requirements, and not optional extras	Project stages & post- project stages	Decision makers & Professionals & Occupants
• implementing environmentally and socially responsible site procedures	Project stages & post- project stages	Decision makers & Professionals & (possible users) Occupants
• ensuring that handover provides for fine-tuning and optimisation of performance		
• establishing and implementing formal feedback mechanisms.		

Figure 3.3. Tasks For the Design Team (Halliday & Atkins, 2019) In Relation with Building Design Stages and In Relation to Responsible Group of Actors

3.3 Determination of the Stages of building Design Development Process (Broader Lifecycle of a Sustainable Building Design)

Buildings have both a logical as well as a hierarchical structure in terms of their development processes (Leaman & Bordass, 1993). This structure describes not only how and under what kinds of technical constraints that the building design should have been developed, but also and rather the way that it should have been planned, designed, executed and monitored, as well as revised for further implications if required. The logical constraints and the hierarchical concerns should also be consistent and compatible with one another in order have a sustainable, optimized and efficient lifecycle governing the whole process. On contrary, it can be discussed that such a hierarchical approach in the establishment of building design lifecycles, also requires a multilevel-based organization, in which the levels are separate and hence perceived as independent and autonomous individual stages to be accomplished. This kind of an approach is totally in contrast with the main sustainability concerns, where the interdependency and multiple level of affectability of each and every component of the building design components naturally constitute the sustainability, in term of process and the design itself.

Leaman and Bordass (1993) have also presented a similar approach, in which they identify a series of hierarchical level systems in the office buildings (Figure 3.4). Since it has been agreed that the impact of typology on the sustainability of any building design is negligible, the proposed hierarchy can serve as a base ground for the establishment of a comprehensive building design lifecycle structure. Even though was limited to office buildings, the revealed relationships between the constraints and relevant actors have been displayed as a network, which has a hierarchy to be followed.

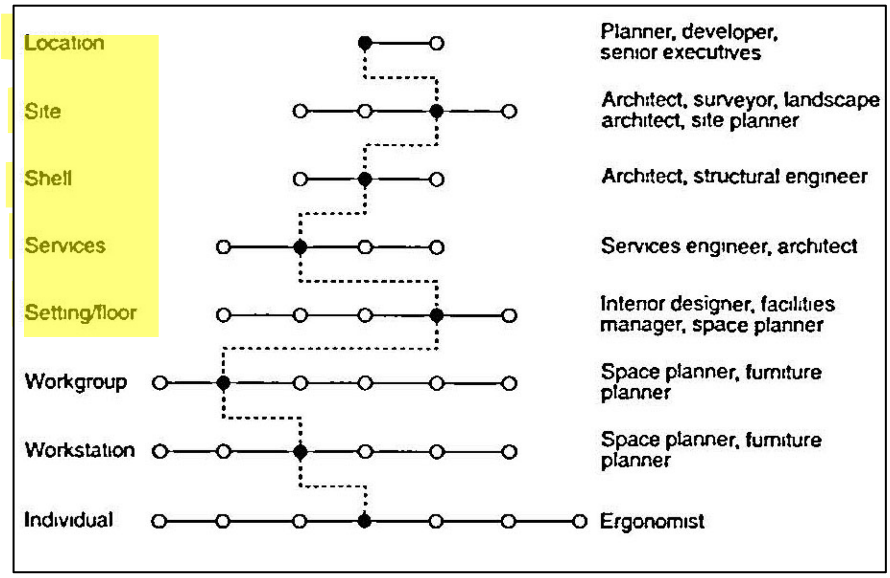

Figure 3.4. Hierarchy Of Constraints for Office Buildings (Leaman, & Bordass, 1993) (highlights have been added by the author)

Although, it is evident that this hierarchy is insufficient to cover and integrate all the focuses and aspects required to complete any building design development and execution, the first five highlighted stages can be incorporated into the proposed lifecycle structure of this dissertation, as they pertain to a general process.

This figure also highlights that there are and should be many interactions between various actors through different stages of the building design development. Furthermore, these interactions have different significances and densities according to the different stages at which they occur. Therefore, it was also necessary to identify these stages beforehand to associate the relevant tasks and actors.

Globally accepted, accredited and authorized institutions have been continuously and effectively working on these issues to provide a common consensus on the identification of building design stages for the actors involved to proceed.

Royal Institute of Architects (RIBA)[3], American Institute of Architects (AIA)[4] or Chamber of Architects (CAT)[5] are some of these authorities responsible for displaying and accrediting the previously agreed-upon issues in terms of practice, process, stages, regulations and ethics with their local or international adjustments and then sharing them with their members as well as the community. Although in each specific country context there is a local authority that is regulating or re-adjusting the processes of building design developments, these three were chosen, because the first two represent significant global authorities in the industry, and the third represents the authority for the Turkish contextual implications.

Although there may be some differences between these individual approaches, there are unquestionably overlapping general classifications of the fundamental stages of any building design development process. The table below (Table 3.1) displays a very brief comparison on the general stage determinations of above-mentioned organizations.

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[3] The Royal Institute of British Architects is a professional body for architects primarily in the United Kingdom, but also internationally, founded for the advancement of architecture under its royal charter granted in 1837, three supplemental charters and a new charter granted in 1971. https://en.wikipedia.org/wiki/Royal_Institute_of_British_Architects accessed on 05.06.2022

4 The American Institute of Architects is a professional organization for architects in the United States. Headquartered in Washington, D.C., the AIA offers education, government advocacy, community redevelopment, and public outreach to support the architecture profession and improve its public image. https://en.wikipedia.org/wiki/American_Institute_of_Architects accessed on 05.06.2022

5 Chamber of Architects Turkey (Mimarlar Odası in Turkish). The Chamber of Architects of Turkey (CAT) was founded in 1954 with a special law. It is a Constitutional professional organization entrusted with the formulation of rules and regulations pertaining to architectural practice while seeking public interest and the benefit of the society in general. Chamber membership is a pre-request for practice of the profession in Turkey. http://www.mimarlarodasi.org.tr/english/index.cfm accessed on 05.06.2022

Table 3.1 Comparison of Different Classifications in Project Stages. (Developed by author of this study, 2017)

	RIBA	AIA	CAT (TMMOB)
Phase - 1	Phase A / Appraisal	Pre-Phase A / Concept Studies	Phase-1 / Preparations and preliminary studies (feasibilities)
Phase - 2	Phase B / Design Brief	Phase A / Concept and Technology Development	Phase-2 / Pre-Project Studies: Concept Design and Schematic Design
Phase - 3	Phase C / Appraisal	Phase B / Preliminary Design and Technology Completion	Phase-3 / Design Development & Detailed Design- Frozen Architecture Stage
Phase - 4	Phase D /Design Development	Phase C / Final Design and Prefabrication	Phase-4 / Construction Drawings
Phase - 5	Phase E / Technical Design	Phase D / system Assembly, Integration and Test, Launch	Phase-5 / System and Application Details
Phase - 6	Phase F / Product Information	Phase E / Operations and Sustainment	Phase-6 / Fabrication Details
Phase - 7	Phase G / Tender Documentation		Phase-7 / Technical Specifications
Phase - 8	Phase H / Tender Action		Phase-8 / BOQ and Building Construction Cost Estimations
Phase-9	Phase J / Mobilization		Phase-9 / Tender Documentation
Phase - 10	Phase K / Construction to Practical Completion		Phase-10 / Tender
Phase - 11	Phase L / Post-Practical Completion		

As clearly displayed, these stages have been used by professionals for many years to refer to each and every specific period of the overall process. However, this basic classification even though it has sub-divisions and subheadings, is insufficient, especially when the primary approach is to achieve sustainable building design developments of future within complex multidisciplinary design team environments.

These staging approaches lacks important aspects to determine the priorities for defining fundamental concerns on different sustainability concepts. Furthermore, they are not questioning other required aspects such as cross-related criteria and interdependencies of different concepts or the varying intensity of impacts for the achievement of a broader sustainability.

Among the few research questioning that, there shall be further and more comprehensive approaches on the analysis of sustainability achievement,(rather than the ones focusing and emphasizing one or few concepts), the study by Güzer et.al (2016, conducted on behalf of Energy Affairs General Directorate/Renewable Energy Department) is one of the most comprehensive, since it incorporates a variety of headings and priorities that have a significant effect on the building design development processes in terms of not only integrated building design but also in terms of total sustainability achievement. This study, after conducting extensive research on various fields contributing to and effecting the entire process, proposes an application model consisting of a series of main and subsection stages in which different priorities have been determined to improve the efficiency. This model categorizes three major stages: the pre-project development stage, the detailed design development stage and the construction stage including activities & monitoring. These stages are inevitably basing on the general classification of previously mentioned stages with respect to involvements of relevant actors to have a consistency. However, the significance of this model is hidden in the sub-headings because of its focus on highlighting in new focuses, concepts and collaborations and promoting innovations to improve the building design development processes. Table 3.2 presents the classification of this process model with their respective headings:

Table 3.2 Project Stages to Be Proceeded to Achieve an Efficient and Integrated Building Design Development (Process.) (Güzer et al, 2016)

• Project requirements and Program development
• Demand for the building
• (Determination of) Program sizes
• Facilities
• Re-utilization of existing building (stock)
• Flexibility
• Site selection
• Orientation
• Topography
• Context
• Transportation
• Schematic Design
• Alternatives
• User participation
• Site/ mass organization
• Materials
• Language of the building
• Sustainability components
• Engineering and other specialists design criteria
• Construction Documentation design and development
• Material selection
• Detailing
• Integration with consultants, engineers, specialists
• Multidisciplinary integrations
• Engineer
• Consultants
• Stakeholders
• Specialists
• Vendors
• Contractors
• Approval
• Hand over & occupancy
• User
• Manager
• Administration
• Technical
• Demolition
• Evaluation of existing buildings
• Re-consideration(re-evaluation) of the building parts
• Re utilization of the wastes

Another study contributing to the determination and classifying necessary stages in a broader sustainable building design process has been conducted by Grierson & Moultrie (2011), as shown in the table below (Table 3.3). The table, which they named as 'The Sustainable Design Process Matrix', generally bases its references on the stages of RIBA Outline Plan of Work , where there is a clear classification of design stages, and it includes a classification to map the principles, environmental brief, parameters, environmental strategies, evaluation, tools and techniques. In this study, it is also notable that there is a superimposition of common stages and their potentials in terms of different sustainability concepts that may be utilized to enhance much more efficient and sufficient building design development processes. This significance also demonstrates Grierson & Moultrie's (2011) proposition that sustainable design processes demand increasingly complex and integrated approaches, as well as requirements of involvement of the application of design principles at various stages of the design process.

Table 3.3 Sustainable Design Process Matrix (Grierson & Moultrie, 2011)

Outline plan of work	Sustainable Principles	The Environmental Brief	Parameters	Environmental strategies	Evaluation	Tools & Techniques
A Appraisal	✓					
B Brief		✓	✓	✓		
C Concept		✓	✓	✓		
D Design		✓	✓	✓		✓
E Detail Design		✓		✓	✓	✓
F Production / Tender					✓	✓
J/K Construction					✓	
L Occupancy					✓	

This table is better to be perceived as a transitional and foundational framework for defining an approach for achieving sustainability in building design development practices. Thus, the table has been interpreted as revealing and reinforcing the approach that each stage has overlapping strategies and defining the interdependency and cross-effectiveness of multiple concepts acting synchronously throughout the entire lifecycle of any building design development process.

Another study on how to classify necessary phases to guide sustainable design development processes has been developed by HOK (2005, cited by Gultekin, 2011). In this approach, 10 main phases have been identified, each of which has different task considerations to be met, referred to as guidelines. On the one hand, this study summarizes and brings an alternative on the staging of the entire design development lifecycle, but it lacks a totalitarian approach, as it only focuses and includes design development phase, ignoring the pre-project and post project phases. (Table 3.4).

Table 3.4 Sustainable Design Guidelines Adapted from the Guidebook to Sustainable Design Book (HOK, 2005) cited by Gultekin, P., 2011)

Sustainable Design Phases	**Guidelines**
1. Project Definition	Owner/rep and design team leaders should establish and clearly embed sustainable design (SD) tasks in the scope of work, document these in the contract agreement and coordinate these with the project schedule.
2. Team Building	Seek design team members who are experienced and committed to SD and working collaboratively. Assemble the full design team and identify sustainable champions for owner and design team.
3. Education and Goal Setting	Engage team in discussion of sustainable issues and opportunities, including cost and schedule impacts. Then hold a sustainable goal session with all team members to set broad goals and measurable outcomes (as LEED target). Review design criteria, standards and challenge those that work against integrated sustainable solutions.

Table 3.4 (cont'd) Sustainable Design Guidelines Adapted from the Guidebook to Sustainable Design Book (HOK, 2005) cited by Gultekin, P., 2011)

4. Site Evaluation	Analyze the site to identify constraints and sustainable opportunities. Evaluate the microclimate and macroclimate to determine solar and wind availability and orientation, potential thermal sinks and rainfall. Inventory plant and animal species and their habitats. Identify transportation networks and cultural/ historical resources that should be preserved.
5. Baseline Analysis	Develop baseline energy and water analysis; establish budgets and compare with benchmarks and project SD goals. Explore potential for renewable energy, financial incentives, and/or utility rebates for energy efficiency, water and renewables.
6. Design Concept	Use an integrated and collaborative design process to embed sustainable strategies within a design concept that is responsive to the project site and regional ecosystems.
7. Design Optimization	Explore, test and evaluation a broad range of solutions to discern those with greatest potential. Engage the design team in a multidisciplinary approach to seek synergies in the development and refinement of building and site systems.
8. Documents-Specification	Carefully document all project requirements. Engage in a process to update and improve contract documents and specifications to ensure that sustainable goals, including materials, systems and other requirements are being incorporated
9. Bidding and Construction	Engage design team, contractor and owner in a collaborative approach to bidding, buyout, procurement, construction and commissioning to deliver a healthy, environmentally responsible facility that meets project SD goals.
10. Post-Occupancy	Engage design team and building users in discussion to discover ways to improve building operation, maintenance and occupant satisfaction. Undertake a post-occupancy evaluation to evaluate hard and soft metrics and identify lessons learned.

3.4 Digital Background and Technological Support for Sustainability

As mentioned earlier, it is not sufficient to have the building itself as a sustainable entity as the final target, rather the process of achieving that target is equally as significant and an essential component for a comprehensive sustainability gain. In addition to many other factors effecting and contributing to building design development process, the technology integration of the design environment plays a crucial role in the efficiency, optimization and thus the improvement of these processes. Accepting that design development technologies have undergone and continue to undergo a rapid digital revolution; the interdisciplinary adaptations of these technologies lag behind those of other industries such as manufacturing, or management.

Technology integration is required not only in the building design systems and solutions but also in the execution of the design development process (and management process) of that specific building itself. Although the integration of technology with the building design process began with the digitalization of the design development processes through the use of 'computer – aided design' (CAD) tools; today in all stages of building design process it is beneficial and required to utilize different mediums of technology to contribute to a more efficient, integrated and thus sustainable outputs.

In this section; the integration and contribution of technology to building design development processes have been analyzed and discussed from two main approaches in different utilization domains; first of which based on CAD and further developments of it with multiple dimensions of BIM (Building Information Modeling) ; second based on different cloud-based tools taking place in the very early decision making stages of building design development processes, in order to select, analyze, try, test and decide for many aspects effecting the efficiency of the building design like, site, orientation, building mass & articulations, sunlight and wind.

Starting with the first initial introduction of technology utilization to AEC and primarily building design development processes; it is accepted that the slow but stable transition from traditional to innovative and integrated design development processes has been supported and acknowledged as having the required potential to contribute to those processes as well as the outputs. Consequently, CAD and its further implementations in collaboration with side-uses of interdisciplinary domains have found their place rapidly and have spread over as the main design development technology tools for decades. However, when considered from the approach of sustainability then; Building Information Modeling (BIM)[6] has gained a much fuller attention and importance, as the conventional typical CAD environment proved inadequate owing to its lack of capabilities throughout the early design and decision-making stages, where all of the input and feedback for sustainability are discussed and agreed.

Building information modeling (BIM) is a very intense and comprehensive domain raising for the last 20 years, although it is in use since 1970s, common agreements and consensus is active since 2000s. It is one of the most promising recent developments in the architecture, engineering and construction (AEC) industry (Azhar, 2011), offering not only the virtual simulative models of the planned and designed entity, but also enabling to superimpose each and every related input of the multidisciplinary design team on one major model, as well as providing to see and overcome possible crashes, conflicts and problems both in the design as well as in the construction processes before they occur.

Building information modeling (BIM) refers to a combination or a set of technologies and organizational solutions that are expected to increase inter organizational and disciplinary collaboration in the construction industry and to

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[6] Building Information Modeling (BIM) is the foundation of digital transformation in the architecture, engineering, and construction (AEC) industry.
https://www.autodesk.com/solutions/bim

improve the productivity and quality of the design, construction and maintenance of buildings (Miettinen and Paavola, 2014). Reizgevičius et al. (2014) has very briefly summarized some important featured definitions and key aspects of BIM in his research as such: (a) elaborating an integrated and holistic building creation strategy encompassing design, construction and lifecycle management based on modeling and computer simulation (Miettinen, 2014); (b) creation and utilization of system of integrated graphical data management and information flow in connection with the description of construction process; and, (c) turning single contractors into teams that work as decentralized units that tackle complex problems and integrate separate tasks into coherent processes. In consequence, an increase in the efficiency and a reduction in the expenses of various operations throughout the entire building lifecycle is expected (Love et al, 2014). These features also emphasize and strengthen the important aspects enabling a more integrated and optimized process by integrating different inputs of different disciplines on a single model, and a more continuous and efficient lifecycle for any building design development in consideration of a totalitarian sustainability concept approach.

Continuing with the developments in BIM studies pertaining to sustainability concerns, it is important to note that new dimensions and layers have emerged in BIM utilizations in relation to the requirements of the involvements (both the participants as well as the project specifications) for various priorities. Conventional BIM, which began as a three-dimensional (3D) model, has been upgraded and improved to include other dimensions incorporating additional features and integrations such as: four (4D)- time schedule, or five (5D) - cost; six (6D) – sustainability, seven (7D) – facility and even eight (8D)- security and healthcare (Reizgevičius et al., 2014). This multilayered and specialized divisions within the utilization of BIM have also been emphasized by Thiebat (2019) by also stating its valid use throughout the while building lifecycle as mentioning; BIM’s intention to facilitate an interoperability between software applications which is valid, effective and can be used in all stages of the lifecycle of construction works, including briefing, design, documentation, construction, operation, maintenance and demolition.

Schematic display of those different dimensions of BIM, with their specific focus areas have been given in Figure 3.15.

Figure 3.5. BIM Dimensions (https://biblus.accasoftware.com/en/bim-dimensions/ accessed on Sep.10th, 2021)

Montiel-Santiago et al. (2020) in his research, has emphasized that there has been common consensus over the meaning of BIM 3D, 4D and 5D; however still there is no consensus regarding further stages of BIM, such as BIM 6D and beyond. The following diagram provides a concise summary of different dimensions of BIM, with their respective priorities, emphasizes and the contents or aspects to be included in each (Figure 3.15) (Montiel-Santiago et al., 2020). As it can be clearly understood, each newly developed dimension has tried to introduce new approaches and extensions to other previously developed dimensions in order to provide solutions for constraints or requirements of different technical and managerial aspects in different environmental concerns. Although the dimension related to the main subject matter of this dissertation is related with 6th dimension, or 6D BIM specifically, as it is primarily dealing with efficiency and sustainability issues, when analyzing this dimension, the main approach and criticism still has been concentrated on its potentials and/ or lacking aspects in the overall process and lifecycle of any sustainable building design.

In further explanation, (6D) sixth dimension focuses on the introduction of sustainable development principle into the investment process with an emphasis on energy efficiency. This dimension enables gathering information about the building's estimated energy consumption at a very early (conceptual) stage (Reizgevičius et al., 2014). Although ability to obtain energy model using BIM methodology is one of the least utilized aspects of BIM (Montiel-Santiago et al., 2020) , this 6D BIM is also considered to be a threshold and close to 7D dimension related with the lifecycle of building design and materials, as with the aspects it is associated with such as: environmental pollution and sustainable building or efficient and sustainable maintenance (Figure 3.16).

Dimensions BIM	Properties	Aspects Developed in the Model
2D	2D Basic Documentation	Traditional two-dimensional (2D) plans Lines, planes images
3D	3D three-dimensional model	Graphic documentation in three dimensions (3D) Special geometric information Objects with properties 3D visualization of the project
4D	Programming the Execution Plan (Deadlines)	Simulation of Project phases Installations Simulation Design of the execution Plan
5D	Planning, Monitoring and Cost Control	Budget estimate of expenses Measurements of materials and labor Analysis of operating costs
6D	Sustainability and energy efficiency	Energy analysis Envelope variations and interactions Analysis of simulations and energy efficient and environmentally sustainable proposals
7D	Facility Management	BIM Life Cycle Analysis (LCA) Strategies BIM as built Building Operations and Maintenance Plan Model Logistical Control of the Project

Figure 3.6. Dimensions of BIM (Montiel-Santiago, et al.,2020)

In continuation with aforementioned research and recently developed studies, the coupling of sustainable design strategies with BIM utilization can change conventional design practices and help to the development of high-performance facility design (Ahmad and Thaheem, 2014). BIM can be seen as an evolution of CAD systems by providing more "intelligence" and 'interoperable information' (Miettinen and Paavola, 2014), as it refers to a set of interacting policies, processes and technologies that generate a methodology to manage the design development process and relevant data throughout a building's whole lifecycle (Succar et al, 2012). Therefore, in the constitution of a comprehensive sustainability in multidisciplinary building design development processes; BIM as a technological integration tool by all means cannot be neglected, but rather should be fully incorporated into the process flowcharts.

As the second domain where the technology contributions are inevitably important and effective is existing in the very early decision-making stages of building design development processes. In the recent decades, with the increase of virtual environments and the awareness of potential of simulations to simulate and test every decision in different fields, building design environment has demanded the implementation of this approach in building lifecycles as well. Therefore, different tools, applications have been introduced to the practice, where virtually all early design decisions can be made with a synchronous generation of the decisions to outputs and thus reflection and testing of the consequences of each and every given decision. Consequently, any revisions, problems and incorrect decisions with significant effects and results on the processes or outputs could have been avoided. Specifically, within these new tools which are mostly working as cloud based, the design sites can be set with their real locations embedded with their environmental conditions of sun or wind, all constraints, potentials and limitations of the sites can be pre-loaded and verified, multiple design alternatives can be generated within their contexts and compared with comprehensive analyses, reported and decided without the need for any further and excessive overwork for the team, thus contributing and enhancing more sustainable processes in the overall. Among various recent developments; i. Saferia [7]; ii. Spacemaker [8] ; iii. Archistar [9] ; iv. Testfit[10] stand out as the most significant and beneficial. Figure 3.17 depicts the logo brand display of these tools for further reference.

Figure 3.7. Logotype / brand logos of mentioned generative design and analyses development tools

All these tools have been designed to operate in cloud-based environments, which enables access to and derivation of the latest data in terms of environmental / location data, generating the most current and accurate integrations for design vs. contextual appropriateness. With respect to the detailed analyses performed on the aforementioned tools, the Spacemaker is observed as to be the most effective, comprehensive and beneficial one due to its ability to set the scene with all of its real-time features, potentials or constraints, to generate alternative designs for different typologies, different height & floor decisions, various mass and volume articulations and with respect to all of these trials and decisions, to determine the optimal solutions (in accordance with multiple analyses related with environmental, regulations and feasibility studies). All of these tools have already included templates and designs within their libraries, making it easier for designers to test for the best

[7] https://www.sketchup.com/products/sefaira
[8] https://www.spacemakerai.com/
[9] https://www.archistar.ai/
[10] https://testfit.io/

possible layout of in every given site, context and location; as well as allowing particular design developments to be independently located and tested in selected sites.

As a summary, to achieve maximum efficiency and sustainability, technology has an inevitable role and impact on the process and building design development, nevertheless, the modes and systems of these technology utilization ways as well as their impact on different domains may vary. Therefore, without being reliant and strictly depended on a single tool, it should have been kept in mind and followed as a main strategy that the utilization of technology should be one of the most essential sustainability concepts for enhancing the required optimized, efficient, integrated and thus sustainable building design development.

CHAPTER 4

MULTIDIMENSIONAL UNDERSTANDING AND OPERATIONAL ADAPTATIONS FOR SUSTAINABLE BUILDING DESIGNS

4.1 The Background and Grounding Discussion on Multidimensional Understanding for Sustainable Multidisciplinary Building Designs

Until today, all the existing proposals including tools, methodologies and strategies, have been derived from studies focused primarily on subheadings such as building standards, regulations, design preferences, system selections. Although each of these concerns is important and contributes to the improvement of building performances for achieving sustainability, an integrative approach is required to support and combine these individualistic existing studies in terms of their sustainability related priorities. This necessity of an integrative and comprehensive approach is also required to compile the interrelationships between these sustainability concerns in terms of the involvements of actors and their consequent impacts to the entire process. Therefore, this comprehensive re-understanding has been considered to constitute neither an alternative nor a replacement to the existing studies, but rather a complementary proposal that integrates them all through a holistic perspective. The revealed inadequacies of existing approaches, which evaluate the achievements of sustainability based on their limited focuses and priorities, have necessitated the support and implementation of additional dimensions of sustainability domain. The nature of sustainability, which is to be sustained on multiple dimensions and with multiple concerns and sensitivities; requires this change of its accomplishment methodology, from a limited perspective of sustainability achievement methods to this complex and integrated perspective of a method requiring the fulfillment of as many complementary and interdependent sustainability concepts simultaneously as possible.

4.2 Multidimensional Understanding of Sustainability in Multidisciplinary Building Designs

Based on the discussions and under the light of the findings of the study, it has been determined that a multidimensional understanding of sustainability is required for today's complex multidisciplinary building design development processes. According to Dillard et al. (2009), different expertise and numerous contributions of different approaches are required to adequately fulfill the multidimensionality of sustainability. This multidimensionality is required not as an alternative approach, but rather as a necessity for addition, due to the fact that the integration of these fragmented priorities highlighted in the existing studies is fundamentally required. This approach should be developed as a new strategy to integrate and compile all existing limited proposals, prioritizing one or a few sustainability concepts for fulfillment so as to cover them for a much more efficient, effective and comprehensive achievement of sustainability. This kind of a proposal, however, could not be realized without first conducting a comprehensive study of the entire lifecycle, followed by a breakdown of the components and factors influencing it, and concluding with the restructuring of the process. In order to enhance such a new approach to sustainable building design development, the process requires multiple actions to be followed throughout its lifecycle. These actions may include different determinations and allocations, along with responsibility breakdowns for specific domains and for specific intervals. Moreover, these domains must be cohesive with one another, as they are interdependent for the fulfillment of multiple sustainability concepts, which means fulfilling one fulfills or at least contributes to fulfillment of another concept. They must incorporate the essential actions based on an efficient plan to prevent excessive consumptions and wastes and to deliver optimized and efficient outcomes of the process, as well as the required interventions of the authorities, in order to be effective throughout the entire lifecycle. As explained in section 3.2 of Chapter 3, the actions need to be structured on a long-term basis with this multidimensional approach and should consist of the following.

i. the stages of decision-making,

   a. these very early stages of the design development process are very important and effective on the efficiency of sustainability level of the building design. All of the decisions related to site selection criteria, program development, brief to the designers, system and material selections, investment estimations on budget, cost control and operation, innovative and integrated design accomplishments, operational outcomes, occupancy expectations and satisfaction targets, possible re-use alternatives or in the issue of demolishment requirement possibilities of recycling are some examples to prior decisions effecting the output in the first degree.
   b. the identification of responsibilities, scopes, tasks and relevant exchanges to be held during the design development process is another domain to consider. Determination of these in the earliest stages of the process will prevent re-works or overproductions, while simultaneously providing a far more efficient and sustainable process over the entire lifecycle by optimizing the correlations between resources, task and time.

ii. the stages of execution within the whole team (design development, execution of building efficiency in terms of multidimensional approach and simultaneous fulfillment of multiple sustainability concepts

   a. the efficient, synchronous and iterative interaction of all the actors is inevitable in the design development process through an agreed and multidimensional follow up sequence approach
   b. in order to fulfill many sustainability concepts synchronously, the concurrent involvement of different actors is also essential. Thus, the multiple verification of these systems in relation with the priorities concerns and limitations of each actor's contribution should have been coordinated and incorporated.

iii. the stages of construction and handover
   a. construction process covers and is primarily responsible for the majority of the consumption of resources and wastes produced in consequence. Therefore, the process should have been planned in an integrated manner from the beginning, where the inputs determined, the logistics and provision of materials planned, the benefits of superimposed synchronous execution of works coordinated, the recycling of wastes planned to be utilized.
   b. the necessary follow ups on the whole process are essential, where the fulfillments of initial physical sustainability design criteria, initial economical sustainability design criteria and initial environmental sustainability design criteria are monitored and revised, if necessary, to accomplish a broader sustainability.

iv. the stages of post-construction
   a. post construction stage is crucial to check whether the anticipated outcomes were achieved, and if not, whether any possible revisions are required to attain the desired levels of design and sustainability in accordance with it.
   b. in terms of possible revisions, the following sustainability concepts should have been considered for final decisions
      i. economic sustainability: if the required revision will cause any unnecessary or excessive cost, outside the limits of contingency of that building design without any gain expected
      ii. social and cultural sustainability: if the required revision is to raise of the usability potential and consequently, will provide a longer duration in the lifecycle of that specific building design
      iii. contextual sustainability: if the required revisions are promoting a positive impact or a reduction in the demand for excessive urban expansion, in the existing context or not

v. the stages of post-occupancy

a. Enhancing alternative modes of dialogue with the users to gather feedbacks or requirements, to check the user satisfactions (either they are complying with initial user expectations or not, and if not attempts to revise, improve to certain extent to enhance occupancy-based sustainability in the entire lifecycle of the building design

b. Providing and promoting interactive trainings for users to increase effective and much more efficient operation and usage for the building design, also for effective maintenance accomplishments in the long term

c. Determining and constructing the operational organization and facility management structure of the building design to continue in a maximum efficiency; and thus, to be able to sustain the intended sustainability levels in the rest of the lifecycle is crucial and needs to be conducted.

vi. the stages of end of the lifecycle

a. if there is no alternative viable option for reusing the existing building design, the demolishment decision should have been taken.

b. considerations on how to manage the outcoming wastes due to the demolishment is under the responsibility of the team to enhance a broader sustainability

i. in terms of reutilizing some of the components in the construction (as structure or as constructive materials or as finishing) of another building design

ii. in terms of recycling some of the components/ wastes to be re-utilized as the inputs of another building design

iii. in terms of upcycling some of the wastes for new design domains

iv. to manage the remaining wastes to be processed to be recycled within the nature for environmental impacts construct and implement an efficient plan to enhance a comprehensive sustainability as briefly mentioned ; it should be the utmost concern to determine who will and is authorized to ask, which questions in which level of details to be specified, developed, explained, to whom, in which specific stage throughout the entire lifecycle and with what type of responsibility to decide, to execute, to evaluate for which type of impacts and improvements on the building design development lifecycles. These questions and the approach basing and guided under the projection of these questions are fundamentals of this integrative approach and constitute the foundation of this comprehensive study. Based on this approach, it is crucial that all of the components of the process are aware of on another. In further explanation, each of the actor involved in the process should have an awareness and be informed of the others' actions, responsibilities, scope, executions and moreover the concerns, privileges and limitations.

This study attempts to establish a comprehensive re-understanding on the grounding of this interconnected and multidimensional correspondence network. And in order to implement this approach, a number of simultaneous and rapid actions need to be activated, some of which are listed in the subheadings that follow. These headings provide a basic overview of the action approaches, many of which require further elaboration. However, the significance has been considered in identifying and highlighting the necessity of enhancement of each.

4.2.1 Interaction Between Different Actors for Effective Sustainability

As displayed in previous chapters, the process defines the efficiency of the output, and the efficiency of the output is totally dependent on the involvement of the actors within a planned and structured approach to carry out required actions. Furthermore, the process is also effected and guided by the actors involved, hence, the very first action should be to re-regulate the interactions and relationships between the actors. These interactions include communicative, technical, managerial, hierarchical and administrative exchanges; but, depending on the stage at which they occurred, they may be effective independently. The research data has also showed that there are still inconsistencies in the workflows, insufficiencies in the utilized methods / tools and undefined and imprecise relationships between the responsibility allocations of actors, which are the causes for the absence of a totalitarian integrative approach. The absence of a consistent and comprehensive road map for interactions of actors to follow has been identified as one of the main causes of inadequate sustainability achievements in the existing built environment.

As Lambin and Thorlakson (2018) also discussed in their study, there are both horizonal and vertical interactions between the actors in any building design development process, where the former occurs between the actors at the same level, and the latter focuses on interaction between actors at different levels and having different impacts on the process. Furthermore, as they have also highlighted these interactions as dynamic since they may change due to the specificity of both the stage and the privileges of that actor as well as the building design itself in terms of sustainability priorities. Interactions may be intentional, planned, structured and controlled but also, they may be conducted as unintentionally due to the certain priorities of the building design teams' dynamic environment.

A brief classification of some major breakdowns revealing and highlighting the required interactions between different actors are listed below.

i. Pre-design development

    a. Site selection:

        i. searching possibilities of re-utilization of existing stock or proceeding with new construction: the decision makers and relevant authorities should interact for best decisions / roadmaps to proceed.

ii. searching for site & investment coherence: the decision makers and relevant design professionals in the team should interact for best decisions to proceed.

b. feasibility studies

i. conducting feasibility studies to check the building design development decisions, in terms of its validity for contextual, cultural-social and user-based potentials and competencies. The decision makers and professionals responsible for the market surveys and feasibility studies should agree and decide on the details of the design development.

c. Program

i. checking the comprehensiveness of the program for optimization, effectiveness and sustainability: the decision makers and relevant design professionals (the team) should interact for best decisions to proceed.

ii. negotiating on the program outline and content, with the relevant authorities for preventing any future problems of investment or additional requirements, for infrastructural provision for contextual sustainability achievement and for process-based sustainability achievement.

iii. agreement on the program, by the decision makers and the potential users of occupancy, whether its compatibility for user expectancy and post-occupancy-based sustainability achievements is satisfied or not.

d. Briefing

i. all the design team should receive the detailed brief and develop their individual design approaches respectively, all of which afterwards should be coordinated and integrated with others' to reach to the best optimum design solutions favoring sustainability.

ii. the details of the brief should have been negotiated with the relevant authorities for preventing any problems, inadequacies and re-works later in the process (for contextual sustainability achievement and for process-based sustainability achievement)

iii. the details of the brief should have been discussed and agreed by the design team and the decision makers for economic aspects of sustainability, as well as the potential users of occupancy for user expectancy in post occupancy-based sustainability achievement for total consensus.

e. approvals

i. the milestones for interim and final approvals should be set between the decision makers and the design team for the design to proceed.

ii. the required stages of approvals and the details of these approvals with relevant submission contents should be defined and set in advance between the design team and relevant authorities in charge of the approval.

iii. the design team in between each other should organize and set the data exchanges and the modes of data flow with respect to determined approval procedures.

ii. Design development

a. Superimpositions

i. design development studies should be exchanged by the whole design team within the determined intervals and superimposed in order to prevent any re-works or incoherencies and to enhance process-based sustainability.

b. Efficiency calculations

   i. the regular efficiency checks from multiple dimensions should be conducted and shared among all the actors to search for any improvement or change is needed or not.

   ii. especially the decision makers should have been informed or involved in these efficiency control check-valve points to intervene, push and provide the continuity of the sustainability of the building design.

c. Follow ups

   i. the program and the details of it should be checked by the decision makers and consultants of the market to ensure that the program is still valid and appropriate within its context.

   ii. the schedule of the building design should have been monitored regularly and revised if required to keep the process-based sustainability aims, that were set in the beginning without any undesired delay int the process.

   iii. the systems and the design criteria implications should have been monitored and revised, if necessary, through the design development, to enhance the intended design efficiency and sustainability in the final output.

d. Construction

   i. logistically all of the required arrangements and determinations should be completed and planned by the design and construction team, with the approval of relevant decision makers in advance, to prevent any re-works or excessive consumption of resources, in terms of enhancing both environmental and process-based sustainability concepts.

ii. supply chains securement for systems, materials or construction components should have been conducted by the design and construction team for the sustainable achievement of each supply and for their impacts in the environment like excessive carbon and exhaust emissions during transportation.

iii. budget follow up; the budget and cash flows should have been checked by the decision makers and the responsible actors in charge to enhance the economic sustainability.

iv. schedule follow up, the schedule should be monitored regularly by the decision makers and / or design professional in charge to prevent any delays, to utilize estimated contingencies and thus to comply with the planned duration and enhance the process-based sustainability.

v. revisions, change orders should be determined and agreed by all the related actors including the design team, decision makers and authorities, if it is a legal legislative issue to proceed or not

vi. the management of the wastes produced by the construction should have been managed and sustainably deployed to be re-utilized, recycled or transformed to be decomposed and destroyed by nature.

iii. Post-design development stage

a. Post construction and handover

i. the building design should have been checked and tested by the design and construction team before the handover to confirm that it fulfills all of the requirements determined in the beginning.

ii. the building design should have been checked and confirmed by the decision makers to approve and proceed for handover, occupancy stage for post occupancy-based sustainability achievement.

iii. the building design should have been checked by the authorities to approve and proceed for handover, occupancy stage.

b. Occupancy and operation

i. the previously determined users or the newcomers should agree on the usability and performance of the building design, as well as whether or not it complies with the user expectancies and the long-term user satisfactions. All of the actors involved, should reach consensus before and during the start of occupancy for the enhancement of this occupancy-based sustainability concept.

ii. the occupants and users of the building design should have been provided with necessary trainings or information to operate and maintain the building design through its entire lifecycle

iii. the facility managers of operation should have been allocated and trained by the design professionals and decision makers, for the enhancement of best effective operation process of the building design

c. Revisions / reuse possibilities

i. the opportunities and possible reuse, rehabilitation, refunctioning possibilities should have been discussed and negotiated by all of the actors involved such as the users of occupancy, design professionals and decision makers.

d. Demolishment and waste management

   i. the decisions for demolishment should have been taken by decision makers and related actors involved, after ensuring and securing the invalidity of any possibilities of revision, refunctioning or adaptive reuse, and the lifecycle needs to be terminated.

   ii. the strategies for the management of the wastes should be planned, either reutilizing or recycling of structure, components and materials for other building designs. If none of them are possible then suitable and sustainable decomposition and deployment of the wastes are required by the design professionals and decision makers.

In accordance with the importance of re-structuring the interactions between the actors, it is important to note that these required actions are not only crucial and beneficial in the short-term, but also in the long run. Particularly, the agreements emerging from the correspondences and relating to the workflow of exchanges are all improving the planning for future building design development and preventing any unexpected risks. By adhering to their individually established checklists; each actor involved in the process defined in the specific user-group for actors, will be able to understand the essence of the entire process with the emphasis on certain stages, be prepared for required preparations, take preliminary actions, correspond for necessary exchanges or contributions and prevent or at least minimize any possible risks due to miscommunication, lack of allocated responsibility or task, or delayed information, in advance. Furthermore, despite being tailored for the specialized usage of specific actors, the recommendations are also flexible enough to be perceived and utilized by other actors in interaction for specifically overlapping stages and sustainability significances per stage.

4.2.2 Re-Evaluating the Construction Process in Sustainable Building Design Developments

In any type of building design development process, the building design itself as an output, is continuously under consideration for improvement. Processes are the most influential factors on any outcome, which are covered in Chapter 2 and serve as the foundation for the problem definition of this research study. Therefore, prior to the output, the process leading to the realization of that specific output should be improved. Since construction stage covers more than half of the building design development process, besides the concerns of improving the pre-design and design stages of the whole lifecycle, the construction stage related aspects and priorities also need to be reconsidered for higher sustainability achievement.

Construction stage has its own requirements for building performances and design system decisions for implementation, nevertheless, other process and supplementary sustainability concept related issues also needed to be integrated within this process as priorities. Construction in general, due to the majority of simultaneous and interdependent tasks, productions, exchanges and activities taking place, has severe negative impacts on the environment, cost, time, productivity, resources as well as community in the context it is located (Nagapan et.al.2012). Therefore, the improvement of construction and its substages with breakdowns of tasks or topics of accomplishment, should be forced to fulfill not only one or few aspects but as many different sustainability concepts as possible, with a totalitarian approach.

Furthermore, as Kulatunga et al. (1987) state that wastes associated with construction can be generated at any stage of the development process and that their underlying causes may arise from design choices, system and material selections, even with dispositions of individuals. In addition, the following list represent the domains in which wastes can be minimized by improved planning and sustainability-aware practices, hence enabling higher degrees of sustainability in a longer lifecycle.

i. Design
ii. Management
iii. Logistics,
iv. Construction Site planning and Organization
v. Supply chains
vi. Optimized and efficient flow of works through the construction
vii. People
viii. Construction work impacts to the neighborhood
ix. Demolishment and waste management

Considering the last topic above, related to waste management, it is regrettable that the building professionals and, in fact, the majority of actors involved in the whole process, have been considering the waste aspect as an exception to their specific responsibilities, and thus, not considering or concerning it in advance in relation to their tasks, which ends up excessive wastes in different means. However, waste in the construction stage does not only pivot on waste generated on-site (Formoso et al, 1999; Nagapan et al., 2012), but also closely connected to useless or unnecessary actions like idle waiting time, mis-orders, overproduction, misplacement of labors or material. Furthermore, wastes can be classified in two general categories: physical and non-physical. While physical wastes include all of the materials arising from construction related activities, non-physical wastes may be considered as Womack and Jones (1996) defined “as any human activity that absorbs resources but creates no value, such as mistakes that require rectification, production of items no one wants, process steps that are not needed, unnecessary movement of employees and people waiting for the conclusion of upstream activities”. Therefore, the management of the construction site is also essential to improve the construction process and thus brings a broader sustainability with an enhancement of process-based sustainability concept.

Continuation with the management of demolition and wastes; it is also worth to mention that as a positive consequence, the majority of the construction wastes can be considered as recyclable and reusable, while the remainder can still be utilized as landfill. Al-Hajj and Iskandarani (2012) have depicted the process for wastes for alternative strategies in their management and in terms of displaying possibilities in their lifespan in Figure. 5.1. This figure supports once more the necessity and validity of considering alternative means within the components of the process, to end up with more efficient sustainable processes and respectively more sustainable outcomes.

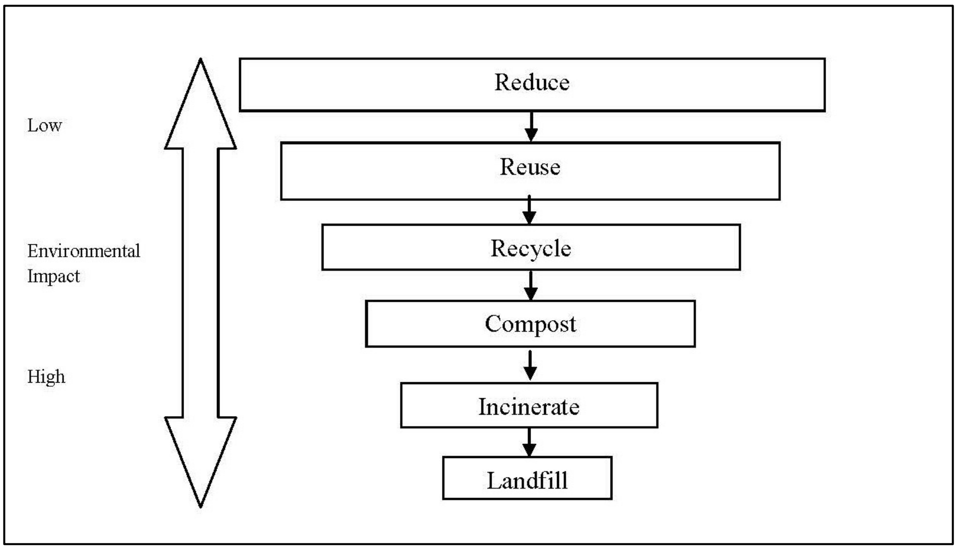

Figure 4.1.“Hierarchy of Construction and Demolition Waste (source: Tam, V. W.Y and Tam, C. M. (2006) cited by Al-Hajj and Iskandarani (2012))

Particularly, due to the advancement of technological tools and their integration into the processes of today’s complex building design developments , the pre-monitoring and planning the whole process is possible and required in most of the advanced project developments. In light of this potential, all of the design criterion decisions related to site selections, program definitions, entire system determinations can easily be simulated, tested, revised and finally verified before implementation. Therefore, the justification of any design development decision before and during the construction stage should be processed as obligatory actions. Some examples for these verifications to prevent the negative consequences of construction stages especially and provide an improvement in the sustainability intentions, are system selections leading to excessive or optimum wastes or design decisions such as infrastructure, system and / or material selections, or the wastes generated whether or not to be recycled or responsibly achieved as a waste of another design.

4.2.3 Effects of Post-Construction and Occupancy Stages on Sustainability

Issues associated with the occupancy process in the post-construction stages have been determined as the last, but not the least domain of action. Contrary to the belief that the majority of the responsibilities have been completed upon handover or completion of the construction, the lifecycle continues throughout the post construction stage as well. In this phase, which follows handover or beginning of occupancy and user interference, all necessary documentation and feasibility checks are preformed, along with actions and responsibilities related to warranty, operation and maintenance. The documentation and controls are intended to check the compatibility of initial ideas and whether or not, or to what extent, they could have been covered until the completion of the construction; and consequently, to create a database and provide a sustainable process for providing feedback to improve future building design developments. In further explanation, building program and feasibility compatibility checks, operation efficiency controls and building performances are examples to such kind of check topics. Occupancy stage is considered as one of the most crucial stages since it occupies the longest duration in the whole lifecycle of any building design development (Salem et.al, 2018). However, all decisions effecting this longest and comparably the latest stage of the entire lifecycle, are taken in the very early stages of it. Furthermore, the efficiency and sustainability of this stage is very dependent to the involvement of actors.

All concerns raised by facility managers, occupants and temporary users of the building design have an impact on the achievement of broader sustainability approach. Discrepancies between user expectation and resulted outcome as experience, insufficiencies in user satisfactions and incompatibility of the spatial designs and space provisions with respect to the program requirements are all features that hinder the accomplishment of a multidimensional sustainability. Developing action plans for each level is required to avoid all of these challenges. These action plans should identify and clarify the required tasks, that should be completed within the party-actor allocated responsibility distribution for each of the specified design stage interval. It should be recalled once more that post-occupancy sustainability concepts do not cover and occur in the final stages of the building's lifecycle, rather, they are active from even the very early-stages decisions, determining the program, user, system, contextual, social and environmental relations within the built environment, throughout the whole process in order determine the achievement of this particular sustainability concept. Furthermore, this sustainability concept covers further in the post-construction stage the issues pertaining to preventive concerns like maintenance, auditing, performance measuring, analysis, revisions and optimization (Salem et. al., 2018). Therefore, several reviews on different intervals throughout this stage should be performed in order to check if any action is required to improve the building designs efficiency, and thus its sustainability over a longer lifecycle. These evaluation approaches as briefly given in the following topics:

i. Functional performance evaluations: if the building design still keeps and complies with its original functions, or if the users have any requirements for additional functions or revisions for the existing functions to be improved, or if any rectifications are needed. These evaluations should be carried out regularly within 2 years of intervals to check the consistency.
ii. Strategic (contextual) evaluations: to see and evaluate the building's reaction to its changing context and if any strategic alteration is required to sustain its sustainability in the future. Additions of new hybrid functions, combination

of recently introduced facilities, provision of different spatial developments for different experiences by the users are some examples to possible searches or interventions. This evaluation may be conducted within 3-5 years after the handover.

iii. Building performance evaluations: if the intended energy efficiencies, or resource consumptions as well as the waste generations as a building entity and the building performance in general, is still acceptable and efficient or if not, what type of revisions/ updates are required. These evaluations should be carried out regularly within 2 years of intervals to check the consistency.

Not only the user perception for the spatial satisfaction, but also the possible emergences of long-term adaptations such as adaptive reuses, refunctioning of the spaces, revisions in the system solutions are crucial and should be anticipated for the maximum efficiency and optimization of resources and environmental sensitivity. By examining these possibilities and making them mandatory in the final stages of the lifecycle of every building design development, the resources would be utilized with considerably more care and sensitivity. Furthermore, the demand to search for various 'R' words such as reuse, readaptation, rehabilitate, refunction will inevitably contribute to the contextual and environmental sustainability concept achievements.

In summary occupancy stages cover the longest duration in any building design lifecycle. Moreover, as their actively effecting/ or effected time extends from the initial decisions of 'for whom to build' to the very final decision of 'whether demolition is required'; they can be considered as the utmost important stage of the entire building design development process. Therefore, in order to achieve a comprehensive sustainability in a building design development this stage should have been executed using a multidimensional and a multidisciplinary approach throughout all the stages with regular reviews, updates and revisions if necessary.

4.3 Legal and Legislative Grounds Effective on Sustainability

The administrative aspect of sustainability is a highly significant domain, which also requires quick and extensive action. Policymakers, as one of the primary actors of decision makers, play a vital role in pushing, advocating, or opposing the improvement and widespread implementation of sustainability enhancements in the outputs of the built environment. The legal and legislative regulations are generally open to be modified in response to market pressures and/ or real estate demands. In the majority of these cases, however, these changes have not worked in favor of increasing and contributing to higher sustainability achievements, rather, they have had negative consequences. Despite the increased awareness that the policies and market have high influences on the enhancement of sustainability and on the improvement of consciousness for a broader sustainability achievement in built environments, still more accurate, comprehensive and detailed regulations and specifications are required to be developed and integrates to the system.

In Turkey, the specifications on building design development processes are primarily developed and handled as a part of a general tender specification methodology, which unfortunately remains insufficient in terms of enforcing any sustainability enhancement or prioritizing and pushing the competency of sustainability aspects in the building design developments. Therefore, the building designs cannot take use of contextual advantages that contribute to and promote higher levels of sustainability due to a lack the opportunities for local specialization. The universal standards (e.g.: car parking capacities, passive systems utilizations, promotion of different modes of transportation) may not be fully compatible with the specifications, priorities or preferences of the community and the built environment for which the building design is developed. The organization structure to determine the responsible actors for the development, execution, approval and demolition stages has been defined independently among separate authorities with no coordination in between, resulting in re-works of conflicts for the fulfillment of requirements and thus wastes in the process.

Turkey has lagged behind the rest of the world in developing, improving and implementing all of the essential studies as well as legal or legislative regulations for sustainability achievement. (Karaca & Çetintaş, 2015). The first legal regulation is accepted as the 'Law of Environment', which has been enacted in 1983, and it was a decade later, in 1993, a second attempt as the regulation based on the 'Environmental Impact Evaluations' [11] was introduced. Numerous regulations or new updates for existing regulations have been developed and enacted for the industry since the Habitat II conference in 1996; however, these multiple revisions, in terms of authority or definition or scope also resulted in an uncertainty and a loosening of authority for activating and enhancing sustainability in a widespread execution (Gökçe et al., 2018). As it is globally acknowledged that the improvement of sustainable building design development processes inevitably leads to the reduction of undesired environmental impacts; in order to achieve this aim, legal and legislative regulations have also been determined as important tools to be re-considered, re-defined and re-activated in order to be more efficient. The majority of the regulations enacted in Turkey over the past three decades have focused on energy efficiency and environmental protection. In addition to these regulations concentrating on specific domains, it is necessary to also introduce a broader perspective and an immediate action requirement, in which other dimensions of sustainability are incorporated and enhanced.

In this point green building certification systems also have been introduced to set a reference for these energy performance or sustainability evaluation related regulations. This benchmark provision approach although initially intended to evaluate and encourage the enhancement of more sustainable buildings; lacks a comprehensive perception of sustainability across the full lifecycle due its limited and one-dimensional criterion foundation of it. In further explanation nearly none of

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[11] Environmental Impact Evaluations: (in Turkish "ÇED- Çevresel Etki Değerlendime Yönetmeliği") is required for any building developed in the defined specific areas to measure and evaluate their environmental impacts in order to allow the construction or not

the certification systems include adaptive, reuse possibilities of a new building in the long-term or demolishment and waste management of it in the end of its lifecycle. Furthermore, it is evident that nearly all of these systems and certifications are basing on the building performances with the exception of a few criteria they include focusing on site features and furthermore, all of them are neglecting a broader perception of these building design developments to be evaluated in terms of other sustainability concepts such as economic, cultural & social, process-based or occupancy based. Karaca & Çetintaş (2015) have summarized and briefly depicted the tools utilized in Turkish building design development industry in the following table.

As shown in the table, the utilized tools are mostly concentrating on energy performance measurements or technical specifications on a single domain of building components like structural, mechanical systems or ventilation standards. Furthermore, none of these systems, either worldwide or in Turkish context, have a concern or sensitivity to search for and at least raise questions about the buildings' accomplishments or insufficiencies in other supplemental aspects or complementary concepts of sustainability.

By being so independent from each other, the consequential outputs may have the risk of over-designed or lacking an optimization in favor of a higher sustainability from multiple dimensions. The following cases can be mentioned as examples to these situations: to fulfill the requirements of ASHRAE, the mechanical designers may have a priority to require excessive energy load supplies; whereas by following the criteria proposed in the alternative checklists on site selection, and thus with a much more integrated site orientation and mass layouts utilizing sun-wind sources more efficiently, this situation could have been prevented.

Table 4.1 Tools utilized in Turkish building design development industry for the evaluation of sustainability

Tools	Definition	Example
Building standards	Including performance values on sustainable building design for general site, energy and resource consumptions	ISO ASTM ASHRAE EPBD
Certifications on products	Certification systems on the environmental impacts of building materials' production processes	GreenSpec EPA
Evaluation Systems	Voluntary based (non- obligatory) systems focusing on the environmental impacts of the buildings lifecycle through different categories	LEED BREEAM CASBEE GREENSTAR DGNB HK-BEAM National Green Building Evaluation system (TR)
Design Tools	Software used to evaluate the performances of entire or partial building designs in terms of their environmental performances via different domains	ATHENA SB TOOL BEES GABİ ENERGY PLUS BEP-TR

Especially in the building design and construction industry in Turkey, despite the late provision and loose enforcement of these regulations; all of the manuals and tools are based on the measurement of special performances such as standards, materials, energy performances, light and water consumptions, but not on the process or on the other interdependent factors promoting or limiting a broader achievement of sustainability. In further specification, examples to main binding and compulsory regulations on building performances are given below.

- TSE 825 Heat insulation Rules in buildings
- Regulations on Heat Insulation in Buildings
- Regulations on Energy performance in Building
- Regulations on Building Materials
- Regulations on Documenting Sustainable Buildings and sustainable Environments

In continuation with the attempts to promote legal and legislative regulations for sustainability in Turkey, the Republic of Turkey Ministry of Environment, Urbanization and Climate Change enacted a new regulation titled "Regulation on Green Certificate for buildings and Developments" on December 23, 2017[12]. This regulation intends and focuses on the identification of the procedures on the evaluation process of any building and/ or development for their compatibility of achieving a green certificate. Although most of the standards have been developed in recent past and mostly focusing on the improvement of only new constructions; this new Turkish regulation and its guideline have been developed to cover both existing and new constructions to comply for all of the criteria included. This feature is absolutely essential, as it promotes firstly "building less" approach, one of the base sustainability achievement strategies, which can only be realized through the improvement of the existing stock.

Nonetheless, this regulation has undergone several revisions and updates. In general, this regulation focuses both on the evaluation process and also the approved evaluators for the process (and their authorization process as well). It is also crucial to note that the primary appendix of this regulation has a manual, titled as "Green Certificate Building and Developments Evaluation Guideline" [13], which describes and specifies the evaluation criteria in detail for different headings. This guideline has been re-enacted on June 12,2022, which is a very recent development in relation to the finalization of this dissertation study. In this re-launch; the previous versions of this guideline have been deactivated, and also different details of the evaluation process and the education process for the evaluators, both for the licensed actors as well as the evaluation organizations have been re-defined. The relevant actors who

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[12] https://www.resmigazete.gov.tr/eskiler/2017/12/20171223-3.htm accessed on 15 June 2022

[13] Green Certificate _Building Evaluation Guideline" Manual https://www.resmigazete.gov.tr/eskiler/2022/06/20220612-1-1.pdf accessed on June 15th, 2022

are assigned and approved by the ministry to conduct these evaluations followed all procedures, and after this detailed evaluation process, the proposed buildings or developments were assigned to one of the five scales: pass, good, very good and national excellence[14].

Despite this promising attitude of the legal and legislative situation in Turkish building design and construction industry, especially covering both the existing stocks improvement as well as forcing sustainable development achievements for new building designs , it is also an obvious problematic case that, there have been many complications and inconveniences in the execution and application of most of the regulations, due to the uncertainties and confusions in responsibility distributions and/ or authority identifications between different institutions. For most of the regulations specified, the definition of existing and new building specifications even differ according to their respective enactment dates (Karaca & Çetintaş, 2015). Furthermore, it is eventually difficult to define and specify the required improvement methodologies in Turkey; due to vast quantity of unqualified, off-record building inventory. Consequently, the first action plan is required to generate a full inventory of the existing building stock, including all of their potentials or deficiencies for improvement in order to be sustainable. Afterwards, based on this inventory, the regulations determining to use the existing stock priorly, and if not, building in accordance with sustainability concerns, including a multidimensional approach of sustainability perception should have been established. These action plans would constitute the sustainability road map of Turkey, which would also contribute to the long-term achievement of a significantly more sustainable built environment.

At this point Turkey's Action Plans for 2030 Agenda for Sustainable Development[15] should have been mentioned. It was in 1996, after 1992 Rio conference, that Turkey

[14] An example template of the certificate format has been given in the Appendix C
[15] Report on Turkey's Initial Steps towards the Implementation of the 2030 Agenda for Sustainable Development, Ministry of Development, July 2016, Ankara.

has introduced a sustainable development concept. Since that introduction numerous plans have been developed on one another and currently Turkey has still in a very dense action approach to develop and fulfill 11th National Development plan for sustainable development. The latest plan consists of four main axes [16]:

1. Qualified People, Strong Society
2. Innovative Production, High and Stable Growth
3. Livable Places, Sustainable Environment
4. International Cooperation for Development

As it can be seen these axes of the action plan stands and highlights once more the importance of People factor as well as the built environment's sustainability to achieve a broader national-wide sustainability.

Turkish policies have been focusing on the highest possible level and effective coordination among all stakeholders, to achieve and fulfill the determined sustainable development goals in national and local levels (NSDG[17]). As the report of Ministry of Development states, the participation of different stakeholders or actors as called in this research such as, local administrations, academia, NGOs and private sector in the policy making and implementations of these policies should and will be enhanced.

Turkey has also launched a National Climate Change Action Plan (NCCAP) in 2010 (National Climate Change Action Plan, 2012), which is including the national vision the strategic targets and has defined specific purposes and objectives for the determined sectors like, Waste, Building, Energy, Land use, Industry, Agriculture, Transportation, Adaptation and Crosscutting issues. For further explanation, for

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[16] Report on Turkey's Initial Steps towards the Implementation of the 2030 Agenda for Sustainable Development, Ministry of Development, July 2016, Ankara.
[17] National Sustainable Development Goals

building sector the main determined purpose has been defined as the increase in energy efficiency in buildings, which has detailed objectives given in the Figure 4.2

BUILDING

PURPOSE	OBJECTIVE
PURPOSE B1. Increase energy efficiency in buildings	OBJECTIVE B1.1. Establish heat insulation and energy-efficient systems meeting standards in commercial and public buildings with usable areas larger than 10 thousand square meters and in at least 1 million residential buildings by 2023
	OBJECTIVE B1.2. Effective implementation of the Regulation on Energy Performance in Buildings (EPB) and other energy efficiency regulations until 2017
	OBJECTIVE B1.3. Develop instruments that will provide the necessary financial support with regard to energy efficiency, renewable energy and EPB until the end of 2013
	OBJECTIVE B1.4. Issuing "Energy Performance Certificates" to all buildings until 2017
	OBJECTIVE B1.5. Decrease annual energy consumption in the buildings and premises of public institutions by 10% until 2015 and by 20% until 2023
AMAÇ B2. Binalarda yenilenebilir enerji kullanımının artırılması	OBJECTIVE B2.1. At least 20% of the annual energy demand of new buildings met via renewable energy resources as of 2017
AMAÇ B3. Yerleşmelerden kaynaklanan sera gazı emisyonlarının sınırlandırılması	OBJECTIVE B3.1. Reduce greenhouse gas emissions in new settlements by at least 10% per settlement in comparison to existing settlements (which are selected as pilot and the greenhouse gas emissions of which are identified until 2015) until 2023

Figure 4.2. Purposes and Objectives in Building Domain (Climate Change Action Plan, 2012)

As it can easily be observed, these purposes and objectives are mostly related to the efficiencies in energy and building performances, but not the efficiency in the overall development processes or lifecycles of those specific built outputs. However, in the detailed explanations and identifications of the actions related to each sector, it is more evident that the coordination and integration of different actors with different responsibilities are required and incorporated in the action plans. This approach supports the important impact of actors within the process, so enhancing not only the output but also the process itself. The action plan is planned to be completed by 2023; hence, all the projections and determinations have been done based on this target. Below are some examples of the objectives related to building sector, defined and launched in the NCCAP (Climate Change Action Plan, 2012) by the Ministry of Environment and Urbanization of Turkey, as part of the studies of Climate Change Action plan for 2011-2023.

PURPOSE B1. INCREASE ENERGY EFFICIENCY IN BUILDINGS

OBJECTIVE B1.1. Establish heat insulation and energy-efficient systems meeting standards in commercial and public buildings with usable areas larger than 10 thousand square meters and in at least 1 million residential buildings by 2023

Action Area	Actions	Time Period	Co-Benefits	Outputs and Performance Indicators	Respon-sible/ Co-ordinating Organiza-tion	Relevant Organizations
Action Area B1.1.1. Identifying energy efficiency potential and priorities in order to ensure heat insulation and energy-efficient systems in buildings	B1.1.1.1. Preparing a database containing energy consumption data for building subsectors, and developing benchmarking indicators	2011-2014	Capacity building	Database, benchmarking indicators	MENR	MEU, MoF, MIA, MoNE, TURKSTAT, TOKI, PSA, Municipalities
	B1.1.1.2. Identifying the technical specifications of model buildings set forth for building typologies	2011-2017	Capacity building	Model Building technical specifications	MEU	MENR, MOF, MIA, TURKSTAT, LA
	B1.1.1.3. Identifying short, medium and long-term targets for ensuring energy efficiency in buildings by comparing existing buildings against model buildings	2011-2018	Capacity building	Benchmarking indicators, report on energy efficiency objectives in the buildings	MEU	TOKI, LG, NGOs, Professional Chambers
	B1.1.1.4 Developing action plan to increase energy efficiency in existing buildings	2011-2014		Action Plan on Energy Efficiency in the Buildings	MEU	MoF, MIA, MENR, LA, TOKI, NGOs, Relevant Professional Chambers, Private Sector Organizations
	B1.1.1.5. Finalizing the cost-benefit analyses of measures taken to ensure energy efficiency	2011-2014		Energy Efficiency Measures Cost-Benefit Analysis Report	MEU	MSIT, MoCT, Relevant Associations, Relevant Professional Chambers, Material Producers and Sellers, Private Sector Organizations
	B1.1.1.6. Assessing the building materials and technologies available on the market in terms of energy efficiency	2011-2014	Increased competitiveness	Market analysis report	MEU	MENR, MSIT, MoCT, TSE, TURKAK, TUBITAK, Universities, Relevant Associations, Relevant Professional Chambers, Material Producers and Seller, Private Sector Organizations
	B1.1.1.7 Identifying R&D priorities and areas to be supported for development of building materials and technologies to increase energy efficiency	2011-2014		R&D Needs Assessment Report, list of research areas to be promoted for energy efficient technologies and products	MEU	MENR, MSIT, MoCT, MoD, TURKAK, TSE, TUBITAK, Universities, Relevant Associations, Relevant Professional Chambers, Material Producers and Sellers, Private Sector Organizations

OBJECTIVE B1.2. Effective implementation of the Regulation on Energy Performance in Buildings (BEP) and other energy –efficiency regulations until 2017

Action Area	Actions	Time Period	Co-Benefits	Outputs and Performance Indicators	Respon-sible/ Co-ordinating Organiza-tion	Relevant Organizations
Action Area B1.2.1 Improving and strengthening the BEP Regulation to ensure use of heat insulation and efficient energy systems in buildings	B1.2.1.1. Reviewing and, if necessary, revising the minimum requirements and criteria related to building technical systems specified in the BEP Regulations	2011-2014		Proposal package for improvement of technical building systems and criteria provided for in current legislation, cost/ benefit analysis reports for suggested technical system modifications, publication of required regulation amendments in the Official Gazette	MEU	MENR, MIA, TSE, Universities, Sectoral Associations, Professional Chambers
	B1.2.1.2. Analyzing 25% threshold specified in the BEP Regulation for improvements in the modification of existing buildings, and preparing a technical report including cost/benefit analyses for improvement conditions for existing buildings	2011-2014	Improved life quality, decrease in energy consumption costs per household	Technical report containing cost/ benefit analysis	MEU	MENR, MIA, TSE, Universities, Sectoral Associations, Professional Chambers
	B1.2.1.3. Identifying and making the necessary changes in the related legal arrangements to support the implementation of the BEP Regulation (Property Ownership Law, Municipalities Law, Building Inspection Regulation etc.)	2011-2023		Publication of the amendments in other laws and regulations made in line with BEP Regulation in the Official Gazette	MEU	MENR, MoF, MSIT, MoCT, MIA, TSE, Universities, Sectoral Associations, Professional Chambers
	B1.2.1.4. Conducting a technical assessment including cost/benefit analyses to upgrade Energy Performance Certificate (EPC) classification ranges (TS 825 – lowering the U values of building components per years), and ensuring coordination in revising the BEP and TS 825	2011-2023		Technical report containing cost/ benefit analysis, publication of revised BEP Regulation in the Official Gazette	MEU	TSE, MENR, TUBITAK, Universities, Sectoral Associations, Professional Chambers
	B1.2.1.5. Establishing the "Integrated Building Design Approach" and "Zero-Emission (Sustainable) Building" criteria; integrating them into the BEP Regulation if deemed necessary	2012-2015		Technical report/guide containing Integrated Building Design Approach and Sustainable Building Criteria, publication of revised BEP Regulation in Official Gazette	MEU	MENR, TSE, TUBITAK, Sectoral Associations, Professional Chambers

Figure 4.3. Objectives B1.1 and B.1.2 in Building Sector (Climate Change Action Plan, 2012)

These studies relevant to the climatic changes and the developed strategies for mitigating the unplanned and undesired consequences of climate change, population growth and extensive expansion of urban settlements, bringing excessive consumptions of resources as well, developments, are inevitably important and valuable. These approaches and strategies cover and focus on different scales of actions from micro to macro level. Nonetheless, for a swifter change and a more stable intervention, certain actions may be put into force.

To illustrate the importance and relevance of this legislative domain as a prior and prerequisite action, the following items are given, as brief examples of required modifications to legal and legislative aspects, together with their significant reasons to negative causes.

- Site selection: if the site is appropriate in terms of consistency of the program and required physical features like topography, sun direction vs. mass orientation, water resource proximity or public transportation. This inappropriateness of the site in terms of its physical features may result in excessive energy requirements and excessive resource consumptions, or furthermore the requirement of additional and excessive infrastructure is also not sustainable at all in terms of environmental impacts. Furthermore, if the site is also inappropriate in terms of contextual and/ or social and cultural features, than the misallocation of program functions may end up with under-utilized and thus unnecessarily energy-intensive building design outputs.
- Set back regulations: excessive shading or sun exposure causing excessive heating / cooling demands and consequently, excessive energy consumption. Furthermore, the negative impacts caused by the insensitive or revised set back executions will create negative impacts on the environmental sustainability, in terms of effecting the existing micro-climate, or damaging the living habitat, or preventing the green density to sustain and thus ending up with excessive solar radiation islands.

- Site orientation and layouts: mis-orienting or having inaccurate layouts in the development leads to underutilization of the site features like physical, or topographical, therefore causing insufficiency or lack of passive systems on the selected site.
- Approvals: the uncoordinated organization and conflicting responsibilities for the approval procedures results in re-works, over-productions or revisions in the design development process. Furthermore, due to obligation of approvals only required in the initial and in the final stages, the wastes caused during the process including the reworks, construction waste management problems or consumption of energy during the construction have not been kept under control.
- Tax issues: fulfillment of individual sustainability concepts related to seven sustainability concepts proposed are not required and therefore, there is no penalty for their absence. Since the consequences have not been rewarded or punished, any output is acceptable.
- Surrounding / Neighboring interference: none of the building designs are responsible or bonded with the close surrounding developments involvement some examples to these lacking items are about noise problems, gas pollution because of dense traffic it requires, security and privacy problems due to introduction of new and unappropriated functions in the context. Anything developed is limited with its own lot-specific constraints and regulations, however contextually, socially and user-perception based building design has severe impacts on the surrounding environment, necessitating involvement and, when necessary, intervention of it in the process.
- Contextual / land use regulations: since the proposed functions and program developments are open to change in the investment stages; the existing infrastructure supply may become insufficient. Therefore, additional infrastructural provision has been required and constructed; in lieu of

utilizing already contaminated of urbanized areas for those functions to be located.

All of the aforementioned topics display the significance and extensive impacts of these legislative grounds on the enhancement of a broader sustainability in the building design development processes in built environments. Due to loosely defined legal and legislative issues, particularly in the Turkish construction industry, building design development outputs were unable to attain continuous and consistent sustainability levels. Moreover, the process has never been considered as a component of the sustainability achievement approach and therefore, has never been the subject of a legal or legislative challenge based on an objection to sustainability fulfillment. Therefore, it is very essential that decision makers who are actively involved in and responsible for the development of policies for sustainable building design development processes take the necessary steps to complete the assigned tasks in order to fulfill significant sustainability concepts assigned.

Since building designs have a close and interdependent relationship with their surroundings throughout their entire lifecycle, it is essential and required that both their sustainable development processes like investment decisions, site selections, and brief, as well as end-of-life processes like demolishment and waste management, must be sustainable. To create such a consistent and continuous, and hence sustainable, process throughout the entire lifecycle of any building design development, accurate legal and legislative regulations are required in any context. Laws and regulations are essential in promoting the widespread and consistent utilization of sustainability achievement approaches in building design development industry.

4.3.1 Highlighting Sustainability Concepts on The Reference of Building Classes

Numerous sustainability research has various points of focus in their approaches for prioritizing different sustainability concepts to increase the outputs' sustainability efficiency to the greatest extent possible. This limited approach, however, causes lack of the desired maximum efficiency of sustainable building design development, as the desired level of efficiency in the broader achievement of sustainable building design processes can only be achieved through the integration of interrelated and interdependent layers, hidden in the individual components and impacts of the developed urban environment. Therefore, the purpose of this research study has intended to provide a comprehensive re-understanding to enhance and improve sustainable building design development processes as well as the outputs of these processes. Since the outputs of these processes have emerged in the form of the urban built environments in which we live, it is preferrable to construct the approach beginning with the fundamental component of these built environments, namely the buildings. However, it is obvious that there have been numerous in terms of typology, scale, content, program, context, significance and design for each different building entity within the urban environment. Consequently, when raising and defining the essential aspects of determined sustainability concepts and their validity in terms of developed building design processes; these differences play a significant role in terms of their impacts, privileges and limitations. In order to understand the impacts of these different aspects of the buildings, a grounding classification domain has been determined. Since typology and related programs or functional / spatial requirements of that typology of buildings are the major determinants and impacts; both in the early stages for the decisions and also on the impacts of that significant building over the longer term in use-stages; this grounding domain has been defined as being related with their typological references, specifically the function-mix based classification.

In order to define specific priorities and significances with respect to different sustainability concepts raised in previous sections, the building classification approach of CAT[18] (Turkish Chamber of Architects) and the Ministry of Environment, Urbanization and Climate Change has been used as a point of reference. In this classification, buildings have been categorized into 5 main divisions, each of which having their sub-divisions as A, B, C or D, where different typologies, specifications, program features, as well as some limitations like height, content or capacity have been determined to define their complexity in terms of giving reference to the process of design development. Certain minimum criteria must be met when using this classification approach as a reference for this research study, as one of the main criteria is to improve the efficiency of sustainable building design development processes and their outputs, and as there is a required complexity level in these specific building designs. In general, these criteria include and focus on the buildings with a certain degree of complexity that require a multidisciplinary collaboration process of design development by multiple actors with associated interrelated concerns and priorities for the enhancement of sustainable building design achievement. Although some typologies may be repeated or exist under many classifications; they differ or are defined differently, in terms of their needed content, program complexity or technical and systematical features. To expand further and illustrate; it can be mentioned that residential building typology occur under both 3B and 4A and even in 5A, depending on the buildings' heights, maximum allowable gross built area or program complexity of adding other supplementary functions facilities in its mix. A further characteristic of this classification is its relevance and compliance with the economic features of that specific building design. These classes also establish the construction costs per

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[18] The detailed translation of Building Classes with their detailed explanations of each class and sub- class have been given in the Appendix C. The original classification exists on https://www.resmigazete.gov.tr/eskiler/2021/03/20210324-3.htm accessed on 19th Jan. 2022

square meter as a reference, which serves as a foundation for the initial investment, cost control, system and material selections as well as the overall project and construction services. Therefore, referring this classification has been considered to promote the validity, applicability and improvement of proposed sustainability concepts within an appropriate approach and division criteria. Figure 4.4 displays the English translation of the building classes of CAT, which have been adapted as a reference for any kind of building design development process in agreement by different actors in Turkish building industry context.

Class II_Buildings	**Class III_Buildings**
A Group	A Group
1. Towers, Water Towers	1. School And District Sports Halls
2. Shear Walls, Retaining Walls	2. Multi-Storey Garages
3. Boathouse	3. Retail Buildings (Including Max. Three Storeys, Without Elevator)
4. Similar Structures Like Defined In This Category	4. Shopping Malls
	5. Printing & Press Houses
B Group	6. Cold Storages
1. Pneumatic Structures	7. Residentials (Including Max Three Storeys, Without Elevator)
2. Single-Story Offices, Stores Or Simple Workshops	8. Gas Stations
3. Small District Parks, Playgrounds	9. Campings
4. Agricultural Industrial Structures (Single-Storey, Prefabricated, RC, Steel..Etc.)	10. Post-offices
5. Boat Maintenance Ateliers , Sledges	11. Small Scale Industrial Buildings
6. Geological And Botanical Parks	12. Childcare , Play Schools
7. Slaughterhouse	13. Similar Structures Like Defined In This Category
8. Similar Structures Like Defined In This Category	
	B Group
C Group	1. Integrated Agricultural Industrial Buildings, Large Scale Farms
1. Warehouses, Hangars (Small Planes, Helicopters, Agricultural Planes, Maintenance Ateliers)	2. Residential Buildings Up To 21.50 Hmax In Max.
2. Industrial Buildings (Single-Storey With Basement And/ Or Mezzanine Only)	3. Restaurants , Cafeteria
3. Similar Structures Like Defined In This Category	4. Small Library Or Similar Cultural Buildings
	5. Schools
	6. Police Offices
	7. Health Centers
	8. Retail Buildings Up To 21.20 Hmax In Max.
	9. Prisons (Up To 150 People)
	10. Convention Centers
	11. Exhibition Halls
	12. Youth Centers, Community Centers
	13. Marina Structures
	14. Night Clubs
	15. Guesthouses, Pensions
	16. Similar Structures Like Defined In This Category

Class IV _Buildings	**Class V_Buildings**
A Group	A Group
1. Specialized school and educational campus buildings	1. Embassy buildings, private houses having a GBA of 600sqm
2. Health centers, outpatient clinic	2. Military buildings
3. Port buildings	3. TV, Radio stations
4. Administrative buildings	4. Stock exchange buildings
5. District municipality buildings	5. University campus buildings
6. Prisons more than 150 people of users	6. Business centers (having more than 30.50 hmax)
7. Thermal houses, spa centers	7. Buildings having heights of more than 51.50 hmax
8. Places for worshipping up to 1500 people	8. Shopping malls (including multiple uses like cinema, exhibition…etc.)
9. Aqua parks	9. Similar structures like defined in this category
10. Integrated industrial buildings	
11. Sports centers	B Group
12. Nursing home, nursery, dispensary	1. Congress and convention centers
13. Grand Shopping Malls	2. Olympic sports centers, hippodromes
14. Residential buildings up to 30.50 hmax	3. Scientific research, R&D centers
15. Hotels (2*)	4. Hospitals
16. Similar structures like defined in this category	5. Worshipping buildings serving for more than 1500 user in total)
	6. Airports
B Group	7. Hotels (4*)
1. Research centers, laboratories, health centers	8. Similar structures like defined in this category
2. City / greater municipality buildings	9. Airport maintenance ateliers, warehouses
3. City / governmental public buildings	
4. Metro stations	C Group
5. Large scale post offices	1. Hotels and holiday villages (5*)
6. Entertainment centers	2. Museum and library complexes
7. Stadiums, sports halls and swimming pools	3. Similar structures like defined in this category
8. Bus stations	
9. Bank office buildings	D Group
10. Radio and TV , broadcasting buildings	1. Opera houses , theatres, concert hall centers
11. Private housing , villas, (up to 600sqm of GFA)	2. Renovations, restorations of historical buildings
12. Similar structures like defined in this category	3. Similar structures like defined in this category
13. Common shelters	
C Group	
1. Large scale library or cultural buildings	
2. Ministry buildings	
3. Dormitories	
4. Archive buildings	
5. Radioactive secured storages	
6. Court houses	
7. Hotels (3*)	
8. Rehabilitation and treatment centers	
9. Greater municipality buildings	

Figure 4.4. English translation of Building Classes of CAT (Chamber of Architects of Turkey) for Building Design Services

The main aim of this section of the research on the basis of building classes, is to discuss the differing effects and impacts of each sustainability concept on the basis of various typologies, that are grouped under specific building classes of CAT as a base reference and to determine if these various sustainability concepts have common and mutual significances on them effecting on the efficiency of sustainable building design developments. Furthermore, the intention was to lay the grounding for the development of the comprehensive re-understanding by revealing the implications of these commons, from which relevant check points, concerns and priorities would have been created.

Therefore, specific case studies have been conducted for different building classes, where the determined and applicable sustainability concepts have been tested for their significance and achievement degrees at different levels of efficiency, in terms of impacts, concerns and/ or priorities. In order to facilitate comparison, two or three different, constructed real-world building design examples have been determined for each selected building type, all of which have similar typologies, scales and contexts. The details of the analyses, the applied criteria to each and every example of the case studies as well as the outcoming evaluations of the findings of these case studies have been discussed in the next sections.

4.3.2 Case Studies Searching for Sustainability Concepts Based on Building Classes

The importance and the necessity of sustainable building design in the built environment has steadily grown over the recent decades. The AEC industry has prioritized not only the ways to search and achieve more efficient sustainable building designs, as an outcome and product, but also the ways of sustaining much more sustainable built environments in the existing urban context with the achievement of more and more sustainable designs. Different actors representing different fields of the industry have actively participated and also promoted achievement of sustainability in the building design projects, in which they have been involved. Due to the fact that, depending on the concern and position of a particular actor, the privileges differ in terms of systems or tools used to arrive at the intended sustainable building design as well as the proceeded approaches on the ways of executing and achieving sustainable building design processes, the extent to which sustainability could have been fulfilled has also been a matter of discussion. Therefore, case studies have been conducted in order to determine the presence or absence of various sustainability concepts in built environments. The selection criteria for the case studies were set with reference to both the limitations of the research and also the multidisciplinary and complex character potentials of the real-life examples. In regard to the limits imposed on this thesis, the case study examples have all been selected from the Turkish context of building industry, representing complex and significant examples of their own typologies. The other criteria related to the multidisciplinary and complexity of the projects have been determined since most of the wastes and undesired consequences and impacts are observed in such examples of the built environment. Consequently, case study examples have been chosen from the 4^{th} and 5^{th} Building class groups of the CAT building classification, with subdivisions of each class. As the main objective of improving the building design development processes to end up with more efficient sustainable lifecycles have been directly affected from the processes of such complex and multidisciplinary design development processes, the validity of the proposed additional sustainability concepts has also been investigated through the analyses of case studies. Another concern on the selection criteria of the examples were the variety of program, scale and context, as these aspects also play significant roles in the achievement and efficiency of a broader sustainability.

Through the analyses, objective approaches on similar sustainability concepts have been followed for each case in order to reveal their presence or absence, or to highlight their effects or consequential impacts on the built outputs from a broader perspective.

Specifically, the main objectives of the case studies were to search, analyze and reveal the following aspects:

- if the real-life building design examples comply with or satisfy these newly proposed sustainability concepts
- if these sustainability concepts are valid and applicable to different scale and context of similar typology-based building design projects while still keeping their integrity
- if the fulfillment or absence of each concept has an impact on the other concepts

Therefore, the objective research approach on the case studies may be summarized as the search to display on the bases of sustainability concepts, like given in the following.

i. first whether they have been applied,
ii. second to what extend they have been applied (in terms of process and efficiency) and what are the relevant consequences
iii. third the potentials, lacks and enhancements of the components leading to these specific concepts

The key comparison tables for each selected sample building design with reference to its building class and side-by-side comparisons are shown in the figures below (Figure 4.5, Figure 4.6, Figure 4.7).

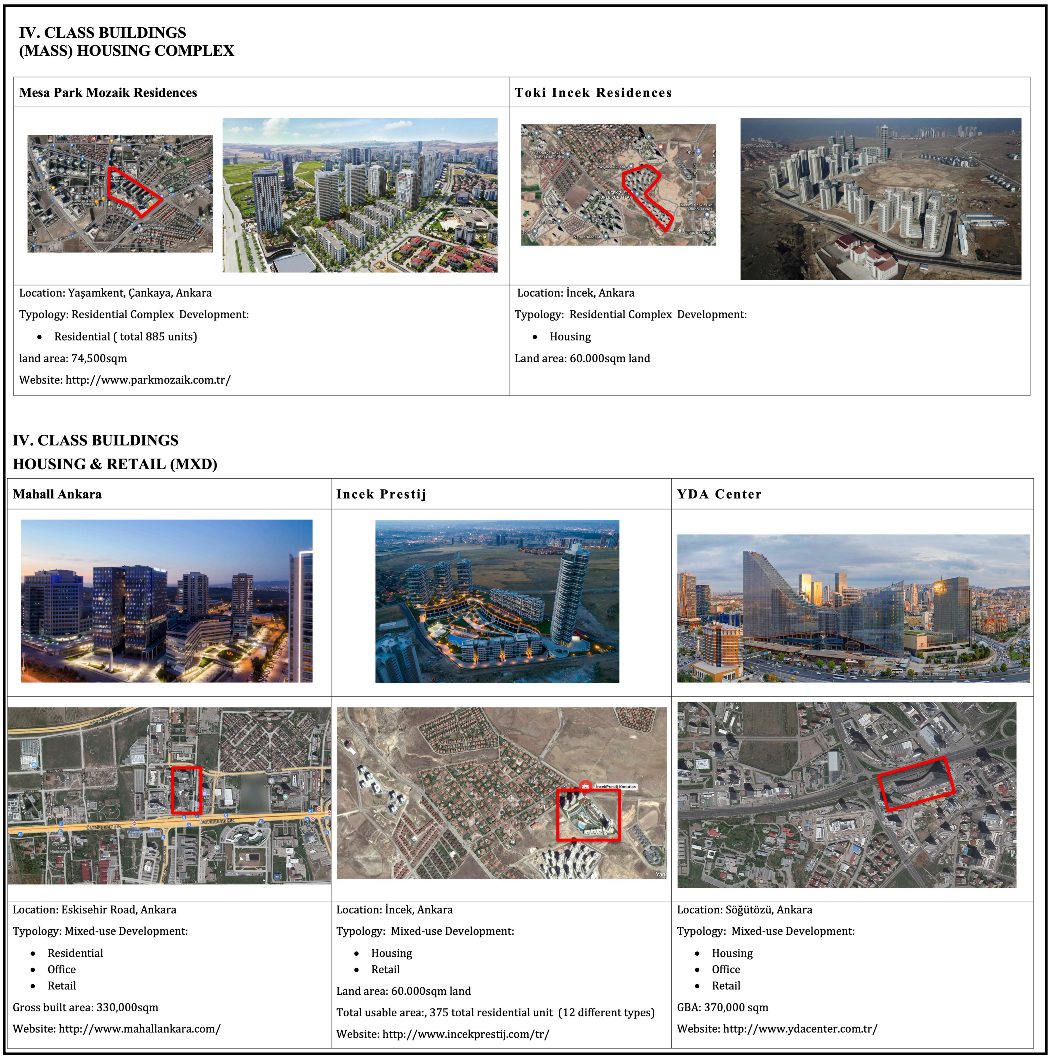


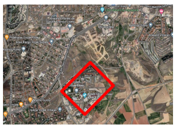
Figure 4.5. Comparison Of Selected Building Designs for Building Class IV for Residential Building Typology

IV / C CLASS BUILDINGS
GOVERNMENTAL OFFICE (ADMINISTRATIVE) BUILDINGS

ILBANK_Atasehir Headquarters	Ministry Of Environment Urbanization and Climate Change Headquarters	Disaster and emergency Management Presidency Headquarters
		
		
Location: Ataşehir, İstanbul Typology: Office Complex, Governmental Office Headquarters : • Office GBA: 12,600 sqm Website: https://www.arkiv.com.tr/proje/ilbank-as-istanbul-bolge-mudurlugu-yeni-idare-binasi/5469	Location: Eskişehir Road, Ankara Typology: Office Complex, Governmental Office Headquarters : • Office GBA: 142.166 sqm Website: https://yapiisleri.csb.gov.tr/cevre-ve-sehircilik-bakanligi-hizmet-binasi-insaati-haber-6255	Location: Söğütözü, Ankara Typology: Office Complex, Governmental Office Headquarters : • Office GBA: 46.000 sqm Website: http://www.yapi.com.tr/haberler/toki-afada-hizmet-binasi-yapacak-_110759.html

Figure 4.6. Comparison of Selected Building Designs for Building Class IV_C

V / A CLASS BUILDINGS
UNIVERSITY CAMPUS DEVELOPMENTS

Atılım University Campus	Çankaya University _ Main Campus
 	 
Location: İncek, Ankara Typology: University Campus, educational buildings Total campus area: 280.000 sqm Website: https://www.atilim.edu.tr/tr	Location: Eskisehir Road Ankara Typology: University Campus, educational buildings Total campus area: 470.000 sqm Website: https://www.cankaya.edu.tr/

V / C CLASS BUILDINGS
HOSPITAL BUILDINGS

Losente Hospital Complex	Ankara City Hospital
 	 
Location: İncek, Ankara Typology: Healthcare / Hospital Complex Total campus area: app 30.000 sqm Website: https://www.losente.com.tr	Location: Bilkent , Eskisehir Road Ankara Typology: University Campus, educational buildings Total campus area: app 325.000 sqm Website: https://www.cankaya.edu.tr/

Figure 4.7. Comparison of Selected Building Designs for Building Class V

As illustrated, the selected real-world examples have been considered to have a specific minimum level of complexity against which various sustainability concepts might have been evaluated and tested for their accomplishments as well as the final impacts due to their provision or absence. As the complexity of any building design increases, so do the considerations, concerns, privileges and limitations, as well as the resulting impacts on the surrounding built environment. Therefore, it was determined that case studies would concentrate primarily on 4th and 5th class of buildings, with two or three examples from each class selected. Similar sustainability concepts have been applied in the analyses of each case study to display, first, whether they have been applied, second, to what extent they have been applied in terms of process and efficiency, and third, the potentials, deficiencies and enhancements of the components of that specific sustainability concept.

In general, each example of a case study has been analyzed, utilizing three main approaches as the set of sustainability concept tests. These three main analysis approaches focus on different but significant aspects of each and every project.

i. The first analysis focuses on the site layout decisions and contextual references in general, the second on volumetric mass articulations, systematical and technical utilizations as well as spatial relations, and the third on more specific design solutions such as floor plan layout decisions and/ or section-wise spatial provisions. In more detail; on the basis of the site's layout and contextual relationships; the initial evaluations have focused primarily on the environmental sustainability and contextual sustainability. The building design complexes have been analyzed in terms of their contextual references, compatibility and suitability not only in terms of function and program mix, but also simultaneously mass articulations and orientations, passive system and microclimatic feature utilizations. In addition to this first set of analyses; infrastructure related aspects like roads, approaches, traffic and urban facility proximity or land-use aspects, have been searched for and displayed. Other sustainability concepts included in this first set of analyses were economical sustainability, social & cultural sustainability, where extensive analysis on parts and whole, as well as decomposition of the complex components was treated according to multiple criteria.

ii. The second analyses conducted on the case studies were significantly much more focused on spatial qualities, microclimatic and controlled outdoor space provisioning, and section-wise elaborations enhancing efficiency of indoor program allocations. Specifically in this second set of analyses, same sustainability concepts with the first set including environmental, contextual, economical, social and cultural sustainability have also been tested, with an addition of physical sustainability concept.

iii. As the final focus of analyses, the case study samples were exposed to considerably more in-depth and specialized examinations, such as the analysis on floor plans, sections or details of the system / building materials specifications. Similarly, in this final set, common and mostly applicable sustainability concepts have been taken into consideration such as contextual, economical and physical sustainability.

Appendix A provides a comprehensive depiction of the case study analyses conducted on chosen building design development examples.

The results of the case studies revealed that very similar consequences can be observed in various building design examples, those of which are existing independently from their typologies or context and resulting insufficient accomplishments of sustainability. Most of these problems were observed as being resulted from the similar factors, some of which have been given in the following:

i. inadequate approaches followed throughout the lifecycles of those specific building design developments, not considering the full lifecycle as already defined in previous sections.

ii. limited approaches focusing on a single part of the sustainability, so ignoring and lacking the broader accomplishment as a whole, but rather only integrating some building performance related aspects to the building ignoring the broader aspects.

iii. mis implementation or inaccurate modifications on the legal and legislative domains, causing interdependent impacts in the surrounding such as the changes in the plan notes, set back and / or height regulations effecting the nearby developments.

iv. ignorance of the potential or disadvantages of the contextual and local situations, resulting to demands for extra facilities to reach for optimized use, or underutilization of provided facilities and stay as idle.

v. no concern or enthusiasm to increase the overall sustainability levels in a multifaceted manner to fulfill as many sustainability concepts as possible with the improvement of the output by utilization of passive systems, due to the lack of legal or legislative incentives or promotions.

vi. no multidimensional approach to consider and fulfill other sustainability concepts to improve and achieve sustainability in the overall building design development processes in the entire lifecycle.

4.3.3 Building Class Based Sustainability Concept Significance Correspondence Tables

With reference to the case studies analyzed in previous section, this research study has also developed and proposed a further study where revealing the different degrees of significances for determined sustainability concepts in relation to different building classes has been developed. The main aim on developing such a comparative analysis on the base of building classes and sustainability concepts is to search and reveal if the significance of sustainability concepts is independent from the typology of the building design and if they are valid inevitably in each and even in the least complex design development example. The analyses have been constituted in the format of a matrix combining the building classes in one side and sustainability concepts on the other, with an additional sub-divisions of problem task and significance of the sustainability concept applied.

This matrix includes a secondary division approach for each classification based on whether the developments or investments belong to public or private entities, as priorities and significances may vary in terms of their potentials and/ or necessities for satisfying each specific sustainability concept for their individual significance. Furthermore, since this classification has also been used in practice as a basis for the cost estimations of these building designs to be constructed, they have inevitable impacts on the achievement of a broader sustainability, as well as on the processes involved in their realization. The reason for sub-dividing each building class classification into two topics of public vs. private was also necessary for revealing the different priorities and concerns that the same typology and / or scale of building may have, depending on whether it is publicly used or operated or privately invested and operated with a much more long-term sustainability approach. Or similarly, because some sustainability concepts may have stronger impacts on a specific typology when they belong to governmental authority, effecting and being a role model for public, or have different intentions of operation and feasibility for belonging to private owners. Not only in terms of initial decision-making stages, but also from the perspective and involvement of different actors in the sustainable building design development, this revealing of interrelationships between building classes and their utmost importance significance in terms of specific sustainability concepts becomes essential.

As a result of such studies, the sustainability concept relevance vs. building class tables have been developed and displayed in separated tables below, segregated by specific building classes (Table 4.2, Table 4.3 and Table 4.4). The tables function in two ways; according to the significance of the impact of each specific sustainability concept on each specific building category, different degrees have been assigned to each cell. It has been determined that the ranking category of impact will display a scale from zero to five, depending on the importance and significance of that specific sustainability concept: with zero (0) indicating no or minimal effect, on (1) being negligible, two (2) being significant and five (5) being extremely significant. The relative importance levels for each building class have been determined based on the sustainability concepts in Chapter 2, in terms of their priorities, domains of effective, their impacts and relationships and the situations examined on the cases analyzed in previous section.

As it can be seen from the tables, as the building class and the complexity level increases, the significance of the relevant sustainability level increases as well. However, it is also evident that even in the lowest class of building classification especially for public investments most of the sustainability concepts should be concerned and fulfilled to the possible extent.

Table 4.2 Building Class (2nd class and 3rd Class) vs. Sustainability Concepts _ Significance Level Differentiation acc. to Public/ Private Building Design Differentiation

		Sustainability concepts						
2nd Class (small scale single-story facilities, warehouse, industry buildings)		**Economical**	**Environmental**	**Social And Cultural**	**Contextual**	**Physical (building performance and energy efficiency)**	**Occupancy-based (Operational)**	**Process-Based (Managerial)**
		2	**1**	**0**	**0**	**1**	**0**	**0**
Private	**Problem / criteria**	• investment concerns,	• infrastructural impacts and waste exhaust	• interference on cultural and social continuity	• impact on built environment due to context changeability	• certain limitations on materials and systems	• low operational complexity • fewer user variety and fewer quantity	• less degree of complexity (correspondence - exchanges…etc.)
	Significance	• Functional performance in terms of RoI (Return of Investment)	• Small scale – less impact comparatively	• No typological relation	• No regulatory or administrative effect or authority	• Functional determinacy and consequential impacts	• No considerable impact due to low user impact	• No considerable impact
		Economical	**Environmental**	**Social And Cultural**	**Contextual**	**Physical (building performance and energy efficiency)**	**Occupancy-based (Operational)**	**Process-Based (Managerial)**
		2	**1**	**1**	**1**	**2**	**0**	**0**
Public	**Problem / criteria**	• Public responsibility in terms of funding / cost concerns	• Environmental impacts	• impact on social and cultural development of the environment	• impact on built environment due to context changeability	• Being bounded with certain regulations on materials and systems	• low operational complexity • fewer user variety and fewer quantity	• less degree of complexity (correspondence - exchanges…etc.)
	Significance	• long term control of feasibility continuity	• Small scale – less impact comparatively	• decision- authority for long term changeability of context	• Regulatory / administrative authority	• Functional and energy bounded determinacy	• No considerable impact due to low user impact	• No considerable impact
3rd Class (medium scale public buildings accommodating crowds of people, facilities for common use)		**Economical**	**Environmental**	**Social And Cultural**	**Contextual**	**Physical (building performance and energy efficiency)**	**Occupancy-based (Operational)**	**Process-Based (Managerial)**
		3	**3**	**4**	**2**	**3**	**4**	**4**
Private	**Problem / criteria**	• Greater scale Investment concerns • Process (project development & construction.) cost concerns	• interacting complex typologies- multiple wastes • consumption of multiple resources	• variety of facilities provided: conflicting- supporting – overlapping usages	• large impacts on built environment due to contextual impact and changeability	• large scale impact on energy consumption, • efficiency on building performance, decisions on material and systems	• large quantity and variety of users – high impact on efficiency and performance perception • reputational continuity concerns	• high level of multidisciplinary collaboration • optimization of process
	Significance	• Multiple aspect RoI concern • Management & planning required	• Optimization and management of consuming and exhausting	• Long term feasibility requirement on the continuity social and cultural usage	• Flexibility on adaptive re-use, function change	• management of passive systems • Optimization, efficiency simulations	• Pre- during and post review of user expectation vs. perception for maximum efficiency	• Management of complex and dense exchange interactions required • Planning and management of the process for minimizing pr. wastes
		Economical	**Environmental**	**Social And Cultural**	**Contextual**	**Physical (building performance and energy efficiency)**	**(Occupancy-based (Operational)**	**Process-Based (Managerial)**
		3	**3**	**3**	**3**	**3**	**2**	**3**
Public	**Problem / criteria**	• Public responsibility in terms of funding / cost concerns	• Special infrastructural requirement • Excessive waste production	• variety of facilities provided: conflicting- supporting – overlapping usages	• Impacts on larger scale of built environment	• large scale impact on energy consumption, • efficiency on building performance, decisions on material and systems	• Served for public- no control of user, post occupancy • Continuation of under efficiency in long term similar project development	• Standardized process ignorance of increase in complexity
	Significance	• Optimization required and prioritized in multidisciplinary project superimpositions	• Optimization and management of consuming resources and exhausting (wastes)	• Long term feasibility requirement on the continuity social and cultural usage for public benefit	• Authority on contextual / planning regulations and changeability	• management of passive systems • Optimization, efficiency simulations	• Pre- during and post review of user expectation vs. perception for maximum efficiency	• Management of complex and dense exchange interactions required • Planning and management of the process for minimizing project wastes

Table 4.3 Building Class (4th class) vs. Sustainability Concepts _ Significance Level Differentiation acc. to Public/ Private Building Design Differentiation

4th Class (large scale and complex public buildings; research centers, administrative, industrial , cultural, educational …etc.		**Economical**	**Environmental**	**Social And Cultural**	**Contextual**	**Physical (building performance and energy efficiency)**	**Occupancy-based (Operational)**	**Process-Based (Managerial)**
		5	**5**	**3**	**4**	**5**	**5**	**5**
Private	**Problem / criteria**	• Greater Investment concerns • Multi-leveled initial investment – turnover ratios	• interacting complex typologies-multiple wastes • excessive consumption of multiple resources • excessive use of energy • excessive exhaust of waste • higher impact due to special infrastructural requirements	• short- and long-term impacts and functional continuity concerns • efficient use and flow of community	• short- and long-term impacts on built environment • higher impact due to special infrastructural requirements	• excessive use of energy • excessive exhaust of waste • excessive use of resources • great impact on infrastructure	• large quantity and variety of users – high impact on efficiency and performance perception • reputational continuity concerns • operational cost concerns due to efficient management of building performance vs. user expectation	• high level of multidisciplinary collaboration • optimization of process • conflicting demands and concerns of multidisciplinary project stakeholders
	Significance	• higher and multisided RoI concern • feasibility studies required • Management & planning required • Demand – supply balance required	• Environmental feasibilities required • Reduction of waste and consumption of resources required • Flexibility for adaptive reuse options to be searched	• Feasibility studies required • Flexibility on possible re-use options • Optimization on spatial planning and management	• Feasibility studies required • Urban specific studies related concerns required • Flexibility for adaptive reuse options to be searched	• Search and provision of passive systems for energy efficiency • Recyclable – reused materials and system selections and utilization required • Pre-during and post calculations of building performance required	• Pre- during and post review of user expectation vs. perception for maximum efficiency • Optimization and scenario development for various use patterns	• Early decisions and involvement of design team required • Management of complex and dense exchange interactions required • Planning and management of the process for minimizing project and process wastes
		Economical	**Environmental**	**Social And Cultural**	**Contextual**	**Physical (building performance and energy efficiency)**	**Occupancy-based (Operational)**	**Process-Based (Managerial)**
		4	**4**	**3**	**4**	**4**	**4**	**3**
Public	**Problem / criteria**	• Public responsibility in terms of funding / cost concerns	• Larger footprints in scale, larger impact on environment • Excessive waste and consumptions • Excessive use of energy and resources	• efficient use and flow of community	• Impacts on larger scale of built environment • higher impact due to special infrastructural requirements	• excessive use of energy • excessive exhaust of waste • excessive use of resources • great impact on infrastructure • Economic concerns on selection of materials and systems for reduction of initial costs	• Economic concerns on operational costs, rather than efficiency of the building performances • Less concern on user comfort-excessive consumption	• Excessive project and construction costs due to lack-king interaction and collaboration of multidisciplinary project stakeholders
	Significance	• Optimization required and prioritized in multidisciplinary project superimpositions	• Environmental feasibilities required • Reduction of waste and consumption of resources required • Regulatory authority required	• Optimization on spatial planning and management	• Authority on contextual / planning regulations and changeability	• Search and provision of passive systems for energy efficiency • Pre-during and post calculations of building performance required	• Optimization and scenario development for various use patterns • Pre- during and post review of user expectation vs. perception for maximum efficiency	• Management of complex and dense exchange interactions required • Planning and management of the process for minimizing project and process wastes

Table 4.4 Building Class (5th class) vs. Sustainability Concepts _ Significance Level Differentiation acc. to Public/ Private Building Design Differentiation

5th Class (Special buildings; airports, hospitals, campus, museum…etc.)		**Economical**	**Environmental**	**Social And Cultural**	**Contextual**	**Physical (building performance and energy efficiency)**	**Occupancy-based (Operational)**	**Process-Based (Managerial)**
		5	**5**	**5**	**5**	**5**	**5**	**5**
Private	**Problem / criteria**	• Greater Investment concerns • Multi-leveled initial investment – turnover ratios • Special systems – higher investment requirements	• More specific spatial typologies- for crowds / public / community use- • Larger (destroy of) footprints – land use more areas effected • excessive consumption of multiple resources & energy • excessive exhaust of waste • higher impact due to special infrastructural requirements	• More specific spatial typologies- for crowds / public / community use- • short- and long-term impacts and functional continuity concerns • efficient use and flow of community	• specific – special facilities having higher impacts on the transformation of built environment • short- and long-term impacts on built environment • higher impact due to special infrastructural requirements	• Special systems – more complex technical supply- provision requirements • excessive use of energy • excessive exhaust of waste • excessive use of resources • great impact on infrastructure	• large quantity and variety of users – high impact on efficiency and performance perception • reputational continuity concerns • operational cost concerns due to efficient management of building performance vs. user expectation	• high level of multidisciplinary collaboration • optimization of process • conflicting demands and concerns of multidisciplinary project stakeholders
Private	**Significance**	• higher and multisided RoI concern • feasibility studies required • Management & planning required • Demand – supply balance required • Regulation update / review required	• More Detailed / multiple-leveled Environmental feasibilities required • Reduction of waste and consumption of resources required • Flexibility for adaptive reuse options to be searched	• Analysis / feasibility on Cross-relations and mutual interactions of crowds / public required • Long term feasibility requirement on the continuity social and cultural usage • Flexibility on adaptive re-use, function change	• Long term (urban) approaches and contextual continuity-based analysis and planning required • Regulation review required • Flexibility on adaptive re-use, function change	• management of passive systems • Optimization, efficiency simulations • Search and provision of passive systems for energy efficiency • Recyclable – reused materials and system selections and utilization required • Pre-during and post calculations of building performance required	• Pre- during and post review of user expectation vs. perception for maximum efficiency • Optimization and scenario development for various use patterns	• Early decisions and involvement of design team required • Regulation update / review required • Management of complex and dense exchange interactions required • Planning and management of the process for minimizing project and process wastes
5th Class (Special buildings; airports, hospitals, campus, museum…etc.)		**Economical**	**Environmental**	**Social And Cultural**	**Contextual**	**Physical (building performance and energy efficiency)**	**Occupancy-based (Operational)**	**Process-Based (Managerial)**
		4	**4**	**4**	**1**	**2**	**0**	**0**
Public	**Problem / criteria**	• Public responsibility in terms of funding / cost concerns • Special systems – higher investment requirements	• Larger footprints in scale, larger impact on environment • Excessive waste and consumptions • Excessive use of energy and resources	• efficient use and flow of community • short- & long-term continuity of facilities for public use	• Impacts on larger scale of built environment • higher impact due to special infrastructural requirements	• excessive use of energy • excessive exhaust of waste • excessive use of resources • great impact on infrastructure • Economic concerns on selection of materials and systems for reduction of initial costs	• Economic concerns on operational costs, rather than efficiency of the building performances • Less concern on user comfort- excessive consumption	• Excessive project and construction costs due to lack-king interaction and collaboration of multidisciplinary project stakeholders
Public	**Significance**	• Optimization required and prioritized in multidisciplinary project superimpositions and systems selections	• Environmental (impact) feasibilities required • Reduction of waste and consumption of resources required • Regulatory authority on determination and control required	• Optimization on spatial planning and management • public use efficiency and continuity prioritized	• Authority on contextual / planning regulations and changeability • Regulations review required	• Search and provision of passive systems for energy efficiency • Pre-during and post calculations of building performance required • Regulatory authority required for measuring and improving building performances	• Optimization and scenario development for various use patterns • Pre- during and post review of user expectation vs. perception for maximum efficiency • Regulatory authority required for maximum comfort, perception of users and efficiency of buildings	• Management of complex and dense exchange interactions required • Planning and management of the process for minimizing project and process wastes • Regulatory authority on process (approval, submission, content, quality…etc.) required

4.4 Operational Checklist Proposals for Sustainable Design Developments

The new approach discussed through this PhD research has been developed in order to have a broader sustainability enhancement in any sustainable building design development process. This new approach and re-understanding of the processes and the relevant lifecycles of sustainable building designs however may also be illustrated in different formats in order to be operational and in order to demonstrate their ease of utilization in different scenarios and by different actors. In order to be able to do that, some operational checklist proposals have been developed for the further reference of actors involved. This checklist approach has also its own uniqueness, thus enables all actors for an alternative and wide-spread utilizations of them.

One of the uniqueness is its multidimensionality, where different actors involved in any sustainable building design development process, with different priorities or in different scenarios may utilize it from their individual approaches.

Another uniqueness exists in the multilayered structure, in which the actors of the building design development process may find different ways to use the checklists on different dimensions, for the fulfillment of different priorities of different sustainability concepts in different stages of the lifecycle. Continuing with this second uniqueness, the main significance of the checklist approach has been developed on the basis of its constitution, where each and every step within a sustainable building design development process has been identified in detail, defined in cross relational perspective and then their potential for feedbacking each other has been also determined within the required process of proceeding within the process. Consequently, when compared to the existing traditional and intended integrated sustainable design development processes, this new approach of multidimensional and cross-relational network of defining the process has revealed the primary significance of developing this new understanding.

Within these concerns and in order to simplify the utilization potentials of this checklist approach, as in each and every scenario the primary impact is by / from or via people; the user groups have been identified as to be the primary reference point. Thus, the checklists have been organized to have sub-divisions for the primary utilization of specific user groups, with some user groups using more than one division based on their role, task or position in the process of sustainable building design development. In reference to previous discussions, where actors were defined as one of the primary factors , having impacts or being effected by the consequences or guiding the process in full authority on decision-making processes, three user groups of actors have also been continued as the reference in this division approach. The details of these divisions and related references have been given in the next section of this chapter.

4.4.1 User Associated Approach on the Checklist Proposals

To accomplish a sustainable building design process, it is unavoidable that the process must be conducted with a broader approach, considering many different interconnected and integrated concerns, priorities and overlaps. In order to avoid overlooking any essential aspects for a building design development to be sustainable, certain priorities and criteria related to specific tasks associated with some specific parties involved should be set prior and in advance before the process. Several stages should serve as check valves for the process via which these essential aspects must be followed, analyzed, considered, checked, monitored, revised if needed and completed in relation to the specific significances of sustainability concerns. The checklists proposed thus, has been developed within this concern, to have a multidimensional approach, where multiple conflicting priorities or overlapping commons and challenging concerns of each component of the sustainable building design process, either the task itself or party responsible to fulfill that task, have been re-structured and re-composed within a new form or a process flow table. Furthermore, since according to the differentiation of parties involved in the process has different impacts on the process and the output based on their specifications and responsibilities, the checklists have also been developed in three different modules, where specific actors may use one or more of them based on their involvement in the process.

These different user groups have been categorized basically according to their involvements, degrees of impacts and responsibility associations on the building design development process. Therefore, the classification has been determined as following:

A. Decision makers: This group consists of the first group of actors utilizing the checklists, who are responsible for the majority of decisions from very early-stage decisions to investment and feasibility studies as well as official and authorization approvals, even until the very late post-design stages of the process for decisions on reuse, recycling or demolition and waste management. Consequently, certain users may be defined as associates of investor companies, developers, owners, governmental authorities, institutions, non-governmental organizations or policy makers.

B. Building Design Development / Execution Professionals: This group is comprised of all building design team participants, who actively take part in all sustainable building design development processes, including design development, project execution, engineering studies, consultancies, supervision, construction, management, cost and quality controls. Architects, engineers, consultants, specialists, project managers, quality managers, contractors, sub-constructor teams, supervisors of governmental, technical, auditing all belong to this group and were considered prior to implementing this division of the checklist.

C. Post–process & Occupancy related Parties: This final group of division has been developed specifically for the actors involved in the sustainable building design development processes and primarily impacted throughout the middle-end portion of the lifecycle of the building design. Where the design and construction studies are about to be finalized, especially the users of the building design as well as the facility managers and / or operational management parties have been considered to interfere with the building design and the current process in order to sustain the building design developments and their intended long-term sustainability efficiency throughout its whole lifecycle. Further opportunities for adaptive reuse, revitalization, refunctioning, or even the very final decision to demolish depend on the involvement, contribution, advice and guidance of this final group of actors.

As defined, these three primary groups not only identify different user groups but also constitute a foundation for the determination of important aspects, criteria and check valves to be fulfilled in order to improve the overall sustainability achievement processes in building design development approaches. With the help of this smaller sub-breakdown method, it is also possible to reveal and highlight the multidimensional interactions and exchanges between individual actors in terms of crucial concepts in reference to certain building stages for the fulfillment of essential priorities, conflicts or commons that are overlapping.

Table 4.5 User group of Actors _1: Decision-Makers' Significance of Sustainability Table Within Building Stages

User Group: DECISION MAKERS Stage	Criteria	Task	Significance Of Sustainability
Site selection	provide max. efficiency of site utilization with respect to multiple criteria	Check the utilization of topography for max. efficiency and utilization of site	Environmental sustainability: in terms of utilization of site constraints and potentials
	provide max. efficiency of site with respect to its proximities to necessary facilities in the surrounding for the sustainability of selected program and project	Check the sites potential and sufficiency to develop the program and to fulfill the requirements of the project.	Environmental sustainability: in terms of the impacts on the built environment after the realization of this program with the contribution and utilization of sites features.
	Search for utilization of passive (energy) systems and usages of self-sustainable systems for max utilization of site features	Check the possibility or potential of utilization of any passive systems appropriate with the selected site	Environmental sustainability: in terms of prevention of carbon footprints or hazardous impacts or wastes …etc.
Project requirements	Provide maximum efficiency of the selected program in terms of its social, cultural, environmental and occupancy related sustainability aspects	Check if the selected program and its project requirements are appropriate with the climate and site features	Environmental sustainability to sustain the selected program and its related requirements on terms of its contribution to social and cultural sustainability concepts as well as post-occupancy user perception-based sustainability enhancement
	Search supply of required supporting functions in optimum utilization or shared utilization to fulfill project requirements	Check the specific requirements of the program for any required supporting functions in optimum utilization or shared utilization to fulfill project requirements	Environmental sustainability in terms of prevention of any waste for just support of the project requirements Contextual sustainability in terms of prevention of any supporting facilities as excessively constructed instead of sharing or re-utilizing
Program development	Prevention of excessive development of similar or related functions / facilities in built environment	Check any similar usage in close surrounding effective on the project typology / program	Contextual sustainability: in terms of prevention of excessive or competitive facilities to occupy built environment and produce excessive wastes in multiple levels
	Provision of a longer lifecycle with possibilities of future revisions, adaptive reuse opportunities, functioning alternatives in the future usage	Check the program's flexibility to be revised, (re) functioned, re-adapted…etc. in the long term for different occasions / scenarios	Contextual sustainability in terms of potential to be (re)utilized in longer lifecycle durations
Feasibility studies	Search for maximum efficiency of multi-sided and multi-leveled sustainability enhancement on the feasibility of integration of the project-program on the economic ground	Check different feasibility studies (economical, turnover, investment, supply-demand, realized market value) …etc.	Economical sustainability: in terms of achieving right (early) decisions on the site-program and project requirement compatibilities
	Search for maximum efficiency of multi-sided and multi-leveled sustainability enhancement on the feasibility of integration of the project-program with the site on environmental and contextual ground	Check conflicting, challenging or competitive functions in the context, which can be revealed in feasibility studies	Contextual sustainability: in terms of preventing competitive or challenging situations preventing the programs enhancement of sustainability in the surrounding context within its estimated lifecycle
Approvals	Determine necessary milestones for approvals to prevent over production, idle waiting hours, re-works (any wastes of the process)	Set check valves for control and approval of the building design Determined the Soft and Hard gates for the building design development to proceed	Economical sustainability: in terms of preventing revisions causing extra cost Process- based sustainability: in terms of organizing planning and managing the process with necessary approvals to proceed
	Determine necessary authorities for required approvals and check their special regulations	Check required legal and legislative regulations, for appropriateness of the building design Make necessary correspondences in advance to prevent later revisions causing excessive cost and effort	Economical sustainability: in terms of preventing revisions causing extra cost Process- based sustainability: in terms of organizing planning and managing the process with necessary approvals to proceed to stay in the schedule
	Search the conditions and risks of approval / non-approval before the issuing, developing and/or realization of the building design project	Check on the consistency between approval requirements and program and project features	Process-based sustainability in terms of improving the sustainable building design development process Economical sustainability in terms of not to spend excessive or preventable costs due to lack of early checking of approval requirements

Table 4.4 (cont'd) User Group of Actors_1: Decision-Makers' Significance of Sustainability Table Within Building Stages

Schematic Design Development			
• Design Criteria Determinations	Search for optimization and full efficiency for user, client and professional priorities	Check and approve the design criteria with respect to the intended function / user and budget correlation	Economical sustainability: in terms of cost & efficiency relation Occupancy based sustainability: in terms of
• superimpositions	N/A	N/A	N/A
• program fulfillment	N/A	N/A	N/A
• efficiency calculations	N/A	N/A	N/A
• Budget follow - up	Search for optimization on the budget estimations for the whole lifecycle	Check possible optimizations in the budget estimation for initial investment, construction and post-construction / operational costs	Economical Sustainability in terms of triple leveled of budget determination with the use of optimization & balance on material and system selections as well as integrated design approach
	Search for optimization of operational budget with utilization of passive systems, although they may have higher initial costs	Check the possibility or potential of utilization of any passive systems appropriate with the estimated budget concerns in the long-term lifecycle	Economical sustainability in terms of provision of not only self-sustaining but also integrated systems for the achievement of much more efficient and optimized budget enhancement
Detailed Design Development			
• Design Criteria Determinations	Search for optimization and full efficiency for user, client and professional priorities	Check and approve the design criteria with respect to the intended function / user and budget correlation	Economical sustainability: in terms of cost & efficiency relation Occupancy based sustainability: in terms of
• superimpositions	N/A	N/A	N/A
• program fulfillment	N/A	N/A	N/A
• efficiency calculations	N/A	N/A	N/A
• Budget follow - up	Search for optimization on the budget estimations for the whole lifecycle	Check possible optimizations in the budget estimation for, construction and post-construction / operational costs	Economical Sustainability in terms of triple leveled of budget determination with the use of optimization & balance on material and system selections as well as integrated design approach
	Search for optimization of operational budget with utilization of passive systems, although they may have higher initial costs	Check the possibility or potential of utilization of any passive systems appropriate with the estimated budget concerns in the long-term lifecycle	Economical sustainability in terms of provision of not only self-sustaining but also integrated systems for the achievement of much more efficient and optimized budget enhancement
Construction			
• logistical	To achieve the maximum efficient construction process	Plan, monitor, assign relevant parties and tasks	Economical sustainability: to use the budged in optimization with early planning (to stay in budget) Process-based sustainability: to use the time with efficient planning and management (to stay in schedule)
• supply and material chain & enhancement	To check the estimated building design development is in process and in track	follow up, monitor and interfere if required	Economical sustainability: to use the budged in optimization with early planning (to stay in budget) Process-based sustainability: to use the time with efficient planning and management (to stay in schedule)
• Budget follow-up	To check if the building design still is under the estimated budget	Arrange cash-flows with respect to agreed intervals (milestones)	Economical sustainability: to use the budged in optimization with early planning (to stay in budget) Process-based sustainability: to use the time with efficient planning and management (to stay in schedule)
• waste management	To estimate the possible wastes caused at the end of the construction in order to manage	Finds possible re-use of the wastes (as they are or as recycled)	Economical sustainability: in order to compensate the cost of wastes in return Environmental sustainability: not to produce excessive wastes and find ways to re-use them

Table 4.4 (cont'd) User Group of Actors _1: Decision-Makers' Significance of Sustainability Table Within Building Stages

Post-construction / occupancy			
• Hand over & Occupancy	Search aspects of post-construction period; requirements of (potential) users, building performance after occupancy	Check the estimated concerns of post-occupancy for their consistencies to determine or give related early decisions in pre-project phases	Occupancy-based sustainability in terms of building performance and user conformity
	Search requirements of hand-over policies and procedures for optimization of resources, budget and construction planning	Check the requirements of hand-over policies and procedures in order to achieve a sustainable process for optimized and efficient use and planning of tasks, resources and process.	Occupancy-based sustainability in terms of achieving a sustainable process in post-construction and occupancy periods as well.
• Program fulfillment	Search for the maximum fulfillment of the program	Check if any update required for maximum utilization of the intended program and use for sustainability in long term use	Occupancy-based sustainability in terms of achieving a sustainable process in post-construction and occupancy periods as well.
• Efficiency / cost calculations	Check for optimum operational costs (comparable to investment cost and plannings for operation / facility management)	Check if any updates, revisions required to increase efficiency in operation for long term sustainability Check is investment and RoI are consistent if any update required	Physical Sustainability: for max efficiency in energy consumption and utilization of passive systems
• Reuse / revision / refunctioning possibilities	Search for a longer lifecycle	Check if there is any unsatisfaction; and the investment can be sustained in its lifecycle, with any revision / reuse/ refunctioning possibilities	Economical sustainability: to extend the LCC and RoI for the building design to enhance a broader and long-term sustainability Occupancy based sustainability: to increase / improve satisfaction and experience of the occupants / users
	Search for the maximum user satisfaction (occupants expectations fulfillment)	Check if the context allows and suitable for any adaptive reuse	Contextual sustainability: to create best land use- function mix within the context Social & cultural sustainability: to increase / improve synergies within the environment for the perception and experience of users
• Demolition & Waste management	Search the advantage and disadvantage of demolishment as the end of a sustainable building design development lifecycle	Check if there is a possibility of renovation, revision and rehabilitation of the building design development instead of demolishment	Economical sustainability in terms of balances and compensations of old construction- revision costs and demolishment feasibility
	Search requirements of procedures of demolishment (pre-requisites, approvals, taxes…etc.)	Check the primary and secondary costs of demolishment process	Economical sustainability in terms of cost balances
	Search the occasions, problems and issues to be handled after demolishment	Check the consequences of demolishment in terms of waste management, site re-use, deployment of building components…etc.	Economical sustainability in terms of - sustaining the initial investment costs, demolishment costs, waste management costs…etc.

Table 4.6 User Group of Actors _2 : Building Design Production Professionals' Significance Of Sustainability Table Within Building Stages

USER GROUP: **Building Design Development Execution Professionals** / **Stage**	**Criteria**	**Task**	**Significance Of Sustainability**
Site Selection	Technical / physical features of the site features wholistic understanding (potentials, limitations…etc.)	Check if the selected site if technically appropriate for the utilization of passive systems and for maximum efficiency enhancement using site features (i.e.: topography, site orientation, layout…etc.)	Environmental sustainability: right and appropriate utilization of natural (re)sources in favor of fulfilling the program requirements for transformed into spatial consequences Physical sustainability: in terms of maximum and efficient utilization of site in favor of passive systems and energy efficiency
	Facility – utility and user perception-based features of the site; site vs surrounding built environment relations (impacts, supports for efficient use)	Check if there are supplementary and/ or contradictory facilities in the existing surrounding of the selected site, that may have +/- impacts for user potential and perception of the program selected or +/- impacts on the area determinations of the function mix	Contextual sustainability: prevent excessive or negative supply of inappropriate functions to the existing environment, to enhance a longer use and lifecycle for the building design Social & Cultural sustainability: to create an interactive and interrelated contribution within the users of the context to enhance a longer use and lifecycle for the building design
	Spatial features allowances: Functional requirements vs site provisions consistency; appropriateness	Check if the selected site is appropriate to fulfill the requirements of the program (accesses, topography / level utilizations, orientation according to NS/EW…etc.)	Environmental sustainability: right and appropriate use of the site in favor of provision of required indoor/ outdoor spatial allocations using minimum energy and resources but rather using site layout decisions in an efficient way Physical sustainability: right and appropriate use of the site as well as more appropriate system and material selections for preventing excessive energy consumptions (preventing extra heating cooling loads, shading devices, piling for car park, solar island…etc.)
Project requirements	Developing and determining the necessary project requirements in terms of technical, spatial and functional specifications	Check if the selected program and its project requirements are appropriate and sufficient with the physical specifications and necessities	Physical sustainability to sustain the selected project requirements on terms of its consistency with resources, building performance
	Developing and determining the necessary project requirements in terms of economy in whole lifecycle (initial investment cost vs. turnover. vs. operational costs, land value, RoI …etc.)	Check if the project requirements are appropriate in terms of technical provision and building performance enhancement	Economical sustainability: in terms of achieving / deciding right (early) decisions on the site-program and project requirement compatibilities
Program development	Developing the most efficient and optimized program details with respect to required typology / building design	Check any optimization possibility among different program components,	Economical sustainability: in terms of prevention of excessive or competitive facilities to require more space / cost / resource
	Developing the most efficient and optimized program details with respect to existing context / built environment	Check any program similarity in the surrounding for adaptation / adjustment of program components	Contextual Sustainability: In terms of preventing excessive / idle / under-used allocations of spaces and thus preventing the program's enhancement of sustainability within its estimated lifecycle
Feasibility studies	Check feasibility and project / building design consistency	Check different feasibility studies (economical, turnover, investment, supply-demand, realized market value) …etc. in terms of fulfillment opportunities within the design development processes	Economical sustainability: in terms of achieving right (early) decisions on the site-program and project requirement compatibilities
	Search for maximum efficiency of multi-sided and multi-leveled sustainability enhancement on the feasibility of integration of the project-program with the site on environmental and contextual ground	Check conflicting, challenging or competitive functions in the context, which can be revealed in feasibility studies	Contextual sustainability: in terms of preventing competitive or challenging situations preventing the programs enhancement of sustainability in the surrounding context within its estimated lifecycle

Table 4.5 (cont'd) User Group of Actors _2 : Building Design Production Professionals' Significance Of Sustainability Table Within Building Stages

Approvals	Search the conditions and risks of approval / non-approval before determining project milestones (or work breakdown structure)	Check appropriate work breakdown structure and relevant milestones of approvals	Process-based sustainability in terms of improving the sustainable building design development process and in terms of preventing wastes (i.e.: idle waiting hours, re-works, over processing…etc.)
			Economical sustainability in terms of not to spend excessive or preventable costs due to lack of early controls, reviews, or approval
	Search for the interim approvals within the process, to plan and regulate the sustainable building process with necessary actions to fulfill before proceeding excessively far	Check the requirements of interim and final approvals to synchronize the process and relevant tasks to be completed on time with respect to responsibility distributions.	Process-based sustainability in terms of optimizing the sustainable building design development process in terms of matching of required task on required time
		Develop task- responsibility-schedule integrated matrices)	
		Develop cash flow - task-responsibility- submission integrated matrices	Economical sustainability in terms of not to spend excessive or preventable costs due to unsynchronized task vs. approval processes.
Schematic Design Development			
• Design criteria determinations	Search for the sufficient supply of multidisciplinary design criteria in early stages for decision making	Check if the provided design criteria determinations are sufficient and valid for all of the multidisciplinary collaboration within the sustainable building design development process	Physical sustainability in terms of material / detail solutions', system selections' efficiencies as well as overall building performance related aspects
		Check if there are any conflicting design criteria to enhance maximum efficiency in sustainability	
	Search for optimization and efficient determination of sustainable building design development	Check the provided multidisciplinary design criteria is optimized, consistent with other interdisciplinary approaches and is consistent within the total design approach, correspondingly effective and optimized in terms of shared principles or commons of priorities in the sustainable building design development	Physical sustainability: in terms of optimization and development of cross-related design criteria approaches (for material selections and system determinations)
• superimpositions	Conduct clash detections to prevent conflicts, or overproductions, further revisions of systems or late detections of problems, those are creating project waste	Check for any conflicts, system clashes or overrides within the building design (system / material, detail) solutions preventing optimization, decreasing efficiency or causing excessive use of resources (cost, time, effort)	Process-based sustainability: to optimize the process with necessary check valves within the whole lifecycle; to determine when to superimpose (to catch which conflicts, problems or reveal potentials) and with whom and to who to superimpose (which disciplines ...etc.)
		Check for any availability of virtual superimpose or simulation possibilities to provide further consequences of waste (in terms of material, system revisions re-works…etc.); as well as to highlight potentials to be optimized as common systems within the building design	Physical sustainability: in order to prevent any further conflicts / problems causing excessive cost, time and effort consequences due to late monitoring; as well as poor building performances occurring due to not superimposing and virtually simulating
• Program fulfillment	Fulfillment of program requirements with required sustainability specifications for optimization and efficiency	Check if additional materials, systems or design criteria are applicable to enhance higher sustainability achievements	Physical sustainability: in terms of maximizing sustainability criteria for building design and performances.
• Efficiency calculations	required sustainability specifications for increasing efficiency	Check if additional systems / solutions can be applicable to increase efficiency and long-term sustainability	Environmental sustainability: Environmental sustainability: in terms of utilization of environmental potentials for efficiency and prevention of excessive consumption of sources Physical sustainability: in terms of maximizing building design and performances.
• Budget follow-up	to achieve and sustain the estimated budget range	Control, review and revise building design (project) requirements and/ or specifications to enhance estimated budget for the specific building design in specific frequencies.	Economical sustainability: in terms of not to spend excessive or preventable costs due to not monitoring project development (for system solutions, details, performances) frequently

Table 4.5 (cont'd) User Group of Actors _2 : Building Design Production Professionals' Significance Of Sustainability Table Within Building Stages

Detailed Design Development			
• Design criteria	To achieve planned (intended level of sustainability achievement	Check / control still the design criteria, is valid and effective in terms of enhancement of intended sustainability levels	Physical sustainability: in terms of maximizing building design and performances.
• Superimpositions	To achieve planned (intended level of sustainability achievement	Check / control the multidisciplinary project executions (systems, materials…etc.) if they contribute to each other in optimizing or improving the enhancement of utmost level of sustainability	Physical sustainability: in terms of maximizing building design and performances.
• Efficiency calculations	To achieve planned (intended level of sustainability achievement	Check / control still the design is efficient in terms of planned (intended) sustainability criteria and broader sustainability achievements,	Environmental sustainability: in terms of utilization of environmental potentials for efficiency and prevention of excessive consumption of sources Physical sustainability: in terms of maximizing building design and performances.
• Program fulfillment	To achieve planned sustainable building design development as an output	Check/ control still if the program determined (and fulfillment of details of the program) is still valid, consistent, optimum and sustainable for the executed project development approaches,	Environmental sustainability: in terms of utilization of environmental potentials for efficiency and maximum fulfillment of programmatic (spatial requirements without using excessive sources Physical sustainability: in terms of maximizing building design and performances.
• Budget follow-up	to achieve and sustain the estimated budget range	Control, review and revise building design (project) requirements and/ or specifications to enhance estimated budget for the specific building design in specific frequencies.	Economical sustainability: in terms of not to spend excessive or preventable costs due to not monitoring project development (for system solutions, details, performances) frequently
Construction			
• logistical	To achieve planned sustainable building design development process	Plan – organize efficiently the transfer of goods / labor / materials…etc. to prevent excessive cost and time consumptions	Economical sustainability: in terms of preventing excessive cost and time consumptions
• supply and material chain & enhancement	To prevent excessive demand and/ or use of materials	Check and Plan the further (re)use of the materials for flexibility within the planned building performances	Process-based sustainability: to pre-consider (estimate) additional reuse of the construction materials for other building design possibilities Economical sustainability: to re-gain some of the initial investment (for infrastructural or temporary construction works / materials) by utilizing in other places / re-uses.
• Budget follow-up	to achieve and sustain the estimated budget range	Control, review and revise building design (project) requirements and/ or specifications to enhance estimated budget for the specific building design in specific frequencies.	Economical sustainability: in terms of not to spend excessive or preventable costs due to not monitoring project development (for system solutions, details, performances) frequently
• waste management	To prevent excessive waste disposal to the environment and excessive consumption of sources	Check and Plan the further (re)use of the wastes for other possible building design developments (either as materials or sources…etc.)	Environmental sustainability: to prevent negative impact / damage of the wastes to environment Process-based sustainability: to pre-consider (estimate) additional reuse of the construction materials for other building design possibilities Economical sustainability: to re-gain some of the initial investment (for infrastructural or temporary construction works / materials) by utilizing in other places / re-uses.

Table 4.5 (cont'd) User Group of Actors _2 : Building Design Production Professionals' Significance Of Sustainability Table Within Building Stages

Post design / construction			
• Hand over & occupancy	To achieve full adequacy of building design vs program vs user compatibility	Check if the intended program has been fulfilled with respect to completed building design features and user expectations	occupancy -based sustainability: to provide and increase satisfaction of users
• Program fulfillment	To achieve maximum satisfaction and fulfillment of user perception for a longer lifecycle of the building design	Check if the program has been fulfilled / if any revision – re use of the idle under-utilized space allocations are required	Post occupancy -based sustainability: to provide and increase satisfaction of users
• Efficiency calculations	To achieve planned (intended level of sustainability achievement	Check / control still the design is efficient in terms of planned (intended) sustainability criteria and broader sustainability achievements,	Environmental sustainability: in terms of utilization of environmental potentials for efficiency and prevention of excessive consumption of sources Physical sustainability: in terms of maximizing building design and performances.
• Operational cost calculations	To achieve intended operational cost and optimization of efficiencies for operation (building performance) within the lifecycle of building design	Check if the existing cost of the operation of the building design is under the limits (intended levels) or causing excessive cost – revise improve if required Check if there are idle waiting or under-utilized- or over utilized spaces causing unplanned operational costs within the building design	Occupancy-based sustainability: in terms of optimizing the intended operational costs with respect to user preferences and their consequential costs. Economical sustainability: in terms of adjusting operation budgets
• Revision / reuse possibilities	To achieve longer lifecycles for the building design development	Check / design and propose possible improvements within the existing design or re-use alternatives for some specific space allocations or adaptive reuse opportunities for the whole development	Occupancy-based sustainability: in terms of optimizing the intended operational costs with respect to user preferences and their consequential costs. Economical sustainability: to adjust and optimize RoI by extending the duration of lifecycle of the building design development
• Demolition & waste management	To sustain the responsibility for the management of wastes produced	Check possible re-uses or recycling of the wastes for future building design developments	Environmental sustainability: to reduce waste produced and exposed to the environment Economical sustainability: to reduce excessive cost consumptions, some return of initial cost

Table 4.7 User Group of Actors _3 : Post Process / Occupancy Related Parties' Significance of Sustainability Table Within Building Stages

User-Group: POST–PROCESS & OCCUPANCY RELATED PARTIES: **Stage**	**Criteria**	**Task**	**Significance Of Sustainability**
Site selection	Search for existing or potential users (and their preferences) within the context of the selected site	Hold questionnaires, surveys to reveal expectations, privileges or lacking facilities related with the spatial provisions by maximum utilization of all features of the selected site	Environmental sustainability: in terms of maximum utilization of features of the site Social & Cultural sustainability: in terms of increasing user satisfaction and possible user potential provision
Project requirements	Search for possible users to operate the project as determined after handover	Check the availability of users or competency of the users with respect to estimated / planned or determined project requirements (in terms of technical, spatial and functional operations) due to cause maximum efficient building performance.	Post-occupancy sustainability: competence of users with respect to determined project requirements / specifications especially in terms of executing building operation and performance related requirements.
Program development	Search for potential users to sustain the long-term durability and usage of the determined program within the built environment / selected context	Conduct multiple analyses and surveys among possible and also existing users of the context to search for limitations, potentials and problems of the developed program	Social and cultural sustainability: in terms of involving the users to the project process to reflect their different perspectives, priorities, concerns…etc. to contribute and improve the efficiency and fulfillment of determined program development
	Search for applicability and appropriateness of the selected program to be operated / used by existing or potential users for a long lifecycle	Try to able potential users or ideas of existing users to the development process of the program for increasing fulfillment of expectations and user perception and further appreciations	Post-occupancy sustainability: in terms of involving the users to the project process so able them as responsible to fulfill expectation, increase possibility of appreciation and satisfy higher perception
Feasibility studies	Search for possibilities to conduct pre-occupancy and pre-project phases searches for both problem preventive approaches as well as revealing potentials to be utilized	Conduct feasibility studies to foresee expectations, identify and reveal possible problems as well as highlight potentials to be incorporated (economical, turnover, investment, supply-demand, realized market value) …etc.	Economical sustainability: in terms of achieving right (early) decisions for building design lifecycle Post-occupancy sustainability: in terms of satisfying the expectations and requirements of the building design displayed in feasibilities
Approvals	Check if user expectation is satisfied before the approvals	Check, hold surveys of official feedback requests from the occupants before final approvals and before finalizing the building design development	Process-based sustainability: to prevent any re-works, that may cause cost and waste after the approvals Post-occupancy sustainability: in terms of satisfying the expectations and requirements of the users
Schematic Design Development	N/A	N/A	N/A
Detailed Design Development	N/A	N/A	N/A
Construction	N/A	N/A	N/A

Table 4.6 (cont'd) User Group of Actors _3 : Post Process / Occupancy Related Parties' Significance Of Sustainability Table Within Building Stages

Post – construction / occupancy			
Hand-over & occupancy	To achieve optimum and maximum efficient utilization of the building design development	Teach the occupants how to optimize the efficiency and maximize the building performances To optimize / reduce the operational costs of the building	Physical sustainability: to increase performance of the building which are dependent to user preferences Post-occupancy sustainability: in terms of involving the users to the project process so able them as responsible to fulfill expectation, increase possibility of appreciation and satisfy higher perception Economical sustainability: to decrease operational costs of the building which are dependent to user preferences
Program fulfillment	To achieve maximum satisfaction and fulfillment of user perception for a longer lifecycle of the building design	Check if the program has been fulfilled / if any revision – re use of the idle under-utilized space allocations are required Hold Post occupancy evaluation (POE) surveys to reveal expectations and to fulfill user satisfaction	Post occupancy -based sustainability: to provide and increase satisfaction of users Economical sustainability: to increase lifecycle of the investment (in accordance with estimated RoI)
Efficiency calculations : Facility & performance management	To achieve optimum and maximum operational efficiency of the building design development for a longer lifecycle	Teach the occupants how to optimize the efficiency and maximize the building performances To optimize / reduce the operational costs of the building	Physical sustainability: to increase performance of the building which are dependent to user preferences Post-occupancy sustainability: in terms of involving the users to the project process so able them as responsible to fulfill expectation, increase possibility of appreciation and satisfy higher perception Economical sustainability: to decrease operational costs of the building which are dependent to user preferences
Re-use / revision / refunctioning possibilities	To achieve maximum satisfaction and fulfillment of user perception for a longer lifecycle of the building design	Check if any update / revisions are required by the users / occupants as: adaptive reuse, refunctioning, revisions of any spatial allocation…etc.	Post-occupancy sustainability: in terms of involving the users to the project process so able them as responsible to fulfill expectation, increase possibility of appreciation and satisfy higher perception Economical sustainability: to increase lifecycle of the investment Contextual sustainability: to prevent any new building to be constructed instead of revising this existing one in the surrounding built environment
Demolition & waste management	N/A	N/A	N/A

4.4.2 Abstract Representation of the Multidimensional Checklist Approach for a Sustainable Building Design

As discussed in previous sections, the comprehensive new approach for sustainability achievement is multidimensional and includes many different multileveled aspects to be followed. In addition to proposing a matrix structure for the following up of specific and significant sustainability concepts to be fulfilled with respect to specific building design stages throughout the whole lifecycle of any sustainable building design process; the checklist approach also offers a specific classification of division based on different user groups within the whole actors, according to their involvement in sustainable building design development processes.

This division provides both an ease of use and a comparison within the user preferences and fulfillments of the sustainability approaches; in addition, it facilitates the monitoring and management of the differing privileges and priorities of different concerned actors effecting the entire process by the control and direction of managers in charge of the achievement of a broader sustainability.

Below figures have been developed to display an abstracted and brief representation of each division of these multilayered checklists, that are classified according to different user groups of actors specifically (Figure 4.8). As it is evident from the figures, the significance of the sustainability concept varies according to the building stages and the preference/ priority/ concern or privileges of the user group. These figures have been designated as a “reminder wall of sustainability” for each user to follow and be guided through each and every stage of the process without any additional limitation.

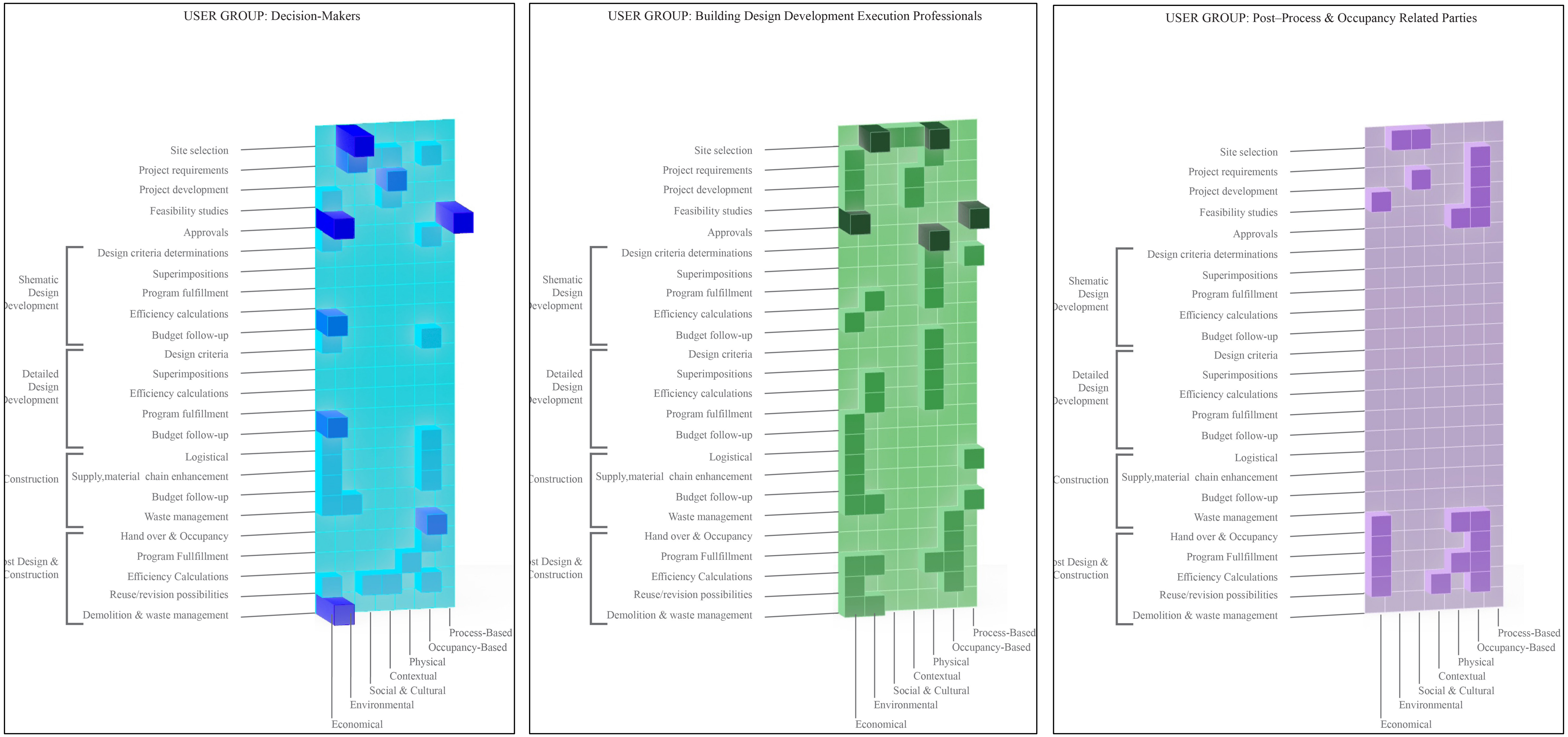


Figure 4.8. “Reminder Wall of Sustainability” Representations for Different User groups

CHAPTER 5

CONCLUSION

5.1 A Comprehensive Understanding of Sustainability

Building design developments are one of the most responsible parties causing and effecting the built environment, as it is predominantly the end product of the building design and building industry. The building industry and its physical output as the environment, are significantly effective on two interrelated domains: first, the excessive productions of output and of waste, and second, the increased consumptions of natural resources nonrenewable energy sources. As discussed in Chapter 2, the increasing population and resulting demands for growing urban settlements resulted with a risk of an uncontrolled expansion into rural areas. In addition, this expansion rates of the production and associated outputs significantly exceed both the regeneration rates of the sources and the recycling rates of the produced and left-over wastes. Therefore, building design industry has a major responsibility in the improvement of this undesirable environmental problems. Solutions concerning environmental problems cannot be found by focusing on reduced problematic areas, disregarding the multidimensionality of the problem. Majority of the research focus on building performances, energy efficiencies and system utilizations as the basic solutions to environmental and sustainability related problems, where further concerns related to other additional dimensions of sustainability have been underestimated. A reduced concept of sustainability, where environmental and economic concerns are highlighted, disregards a multidimensional understanding, which is inclusive of contextual, social and cultural concerns as well as process and occupancy based sustainability goals.

Such a comprehensive understanding is not limited with the design process of a building, but also establishes a critical ground questioning the necessity of the construction as well as searching for alternative solutions, which minimize the construction area and considering the re-evaluation and re-use of existing stock. In this manner, it is possible to bring solutions for decreasing the demand for excessive construction.

The improvements on sustainability achievement in any building design development domain must be considered from micro to macro levels of implications with a multidimensional concern throughout the entire lifecycle. Furthermore, the shift that sustainability perception has performed over the past decades from solely environmental concerns and improvements to a much broader approach of economic, social and cultural implementations, also supports the necessity of such a change in the understanding and achievement approaches of a broader sustainability.

This multidimensional approach to sustainability also requires a wider perception of the lifecycle, where pre-design and post-design stages have been considered, planned and integrated beginning with the very early stages of the building design development processes. Significant concerns and responsibilities especially related to the contribution and integration of different factors should have been implemented to the process, including all decision-making stages, execution periods, construction, post construction and even demolition and waste management, in order to reach a wider understanding of sustainability. To cover and be effective at each of these different but interconnected stages of the process, it is essential to re-define and re-structure the impacts and interdependencies of the key factors. Human-beings as actors, process as all exchanges, tasks and responsibilities and sustainability concepts as accomplishments, particular or broader achievements and fulfillments, have been categorized as three significant and highly connected determinants of the sustainable understanding in any building design, as discussed in Chapter 3. These three pillars of determinants based on actors, exchanges and sustainability concepts should have been incorporated within a multidimensional approach, where the whole process is executed synchronously. This concurrent and multi-layered integration requires a breakdown of interdependent responsibilities for specific involvements of various actors, which guides the necessary follow-ups of assigned tasks due to significant sustainability concepts through the determined building design stages.

In this study, to establish a comprehensive understanding, the impacts of different stages on one another, together with their corresponding actors involved and their effective inputs, have been considered concurrently. Together with this three partite yet interdependent relationship, the design process has been handled as a multi-layered approach, with the establishment of a critical framework to first identify and then eliminate the problems caused by the fragmented nature of conventional and traditional design development processes.

In summary, this study basically has established an approach to comprehend the building design process, which involves multiple inputs and numerous feedbacking opportunities not only throughout the design development process but also during the pre-design and post-design development processes as well. This multidimensional approach incorporates interdependent layers and cross-related components of the sustainability, while setting a definitive ground for the guidance of the designer. Furthermore, at the same time it eliminates the problems and uncertainties caused by the design's misunderstanding of sustainability due to its prioritization of the privileges only in terms of building and architecture.

5.2 The Significance of Different Actors for a Sustainable Physical Environment

In the historical evolution of sustainability concept, the main priority was to "meet the basic needs of all people and extending to all the opportunity to satisfy their aspirations for a better life without compromising the ability of future generations to meet their own needs" as defined by the publication 'Our common future'(WCED,1987) and stated in Chapter 2 of this dissertation. This extremely fundamental and introductory definition of sustainability highlights the people factor as a central component. As also explained further in Chapter 3, ensuring the fulfillment of people's needs, securing the health and well-being of future generations and preserving natural resources for the continuation of communities in self-sufficient and sustaining environments are defined as some key aspects highlighted in the development of sustainability concept.

In sustainability discussions, the significance of 'people' occurs in two different domains: i) the effected: is effected and ii) the involved: can effect (Vos, 2003; Ulrich, 1983). In continuation with this general approach, indicating the multiplicity and variety of different actors within the building design development stages enables the design environment to have a multidisciplinary team involvement in a broader scale. Furthermore, this multidisciplinary team interacts at every stage of the building design development through a multitude of concurrent exchanges, conflicts, discussions and agreements that display the differentiations in the individualistic privileges of these various actors. These differentiations may be based on the different involvements of the actors through the following significant situations: i) specific to the disciplinary backgrounds, priorities, concerns and privileges, that the actors have ii) specific to the building design stages, in which the actors have participated iii) specific to the significant sustainability enhancement for which each specific actor will be assigned a task to complete. Consequently, each of these differentiations result in different implications as physical outputs and as built environment. Therefore, in the research of a comprehensive approach for achieving a broader sustainability in building design developments, one of the primary considerations becomes people aspect and the re-structuring the impacts of this people aspect. Re-defining the responsibilities, re-organizing the exchanges, re-regulating the flow of tasks and re-determining the milestones for review, approval, or on-hold, are some examples of the new strategies that must be implemented in a comprehensive sustainability approach.

This new approach and sensitivity to emphasizing different aspects and significances of the involvement of different actors in sustainable design development processes is very crucial. It changes the general perception, which degrades the values of sustainability by limiting them to the domains of design development processes and responsibility of the architect, to a much more comprehensive approach, which integrates the pre-design, design and post-design processes of any building design development, in conjunction with specialized and specified involvements of various actors. This important raise of awareness for the evident and necessary contributions of ‘other’ actors to the process; also results in an ‘integrated whole’ in the building design development processes. By providing feedback to one another and integrating within the whole process of decision making, or execution, or approvals, or operation, actors support the multidimensional aspects of sustainability, wherein many more sustainability concepts could have been fulfilled due to the diverse priorities of these different actors.

Therefore, the scope of the study has been extended to encompass all of the actors, together with their interrelationships and their interdependent effects that occur during the entire development and occupancy process of any building design. This approach, on one hand, questions each actor’s self-responsibility and role in the process, and on the other, attempts to understand the impacts of each actor on the others. As a result, all of the stages have been incorporated as an essential component of one whole: beginning with the site selection, through the program development and briefing of the designers, extending in construction and occupancy phases, and ending with demolition and even with the waste management after the demolition. In order to achieve this aim and to comprehend this whole process in full detail, a comprehensive and effective research has been developed, to reveal the interrelationships of different actors in the conventional production process of any building design.

5.3 A Critical Understanding of Sustainable Environments

The built environment in its surrounding context, inevitably has several negative impacts and consequences on multiple levels and in numerous domains. On the evaluation of any building design, sustainability criteria are usually limited with architectural design aspects. Within this limited approach, in most cases buildings that fulfill the criteria of green building benchmarks may be lacking very crucial sustainability issues. There are also cases, that are nominated or labeled as sustainable examples, whereas in a deeper analysis they also represent a misutilization of the certification concept. In further explanation, such a misrepresentation of sustainability levels, depending upon a reduced criteria domain are mostly based on building performances and insecurity of multidimensional evaluation.

Each building design development have been subjected to a significant number of criteria during this certification process, however, the main emphasizes are always limited with the building design itself and its performances with few additions of concerns related to site, or post design and post occupancy related issues. Therefore, it is necessary to question the process of certification all the multidimensional concerns on various sustainability levels. Furthermore, the process of certification should have been analyzed and cross checked to understand whether they include all required additional dimensions of sustainability during evaluation. There are significant issues neglected and disregarded throughout the popular certification procedures. Some of these significant issues have been grouped under basic topics and given as the following items.

- Context:
  - if the context is compatible for this building design investment economically, socially and culturally
  - if the building design development requires severe impacts on the context in terms of scale or function
  - if the context will require additional infrastructure or user quantity due to this building design development
  - if the neighborhood is effected positively or negatively by this design development,
  - if the building design development creates a self-sufficient system to the existing users within a long-term lifecycle
- Site selection:

- if the site selection decisions are effective on the land values of the region,
- if the selected site has similar functions or typologies existing in the surrounding, which can be re-utilized instead of and as a replacement of this new building design development
- if the site is close to required urban facilities, for a possibility of optimization with nearby facilities for shared and supportive usage
- if the site is appropriate and satisfactory in terms of ease of accessibility,
- if the site is suitable for possible utilization of passive systems like appropriate orientation for solar shadings, or provision for a microclimate

- Infrastructure:
  - if there exists sufficient provision for additional roads or energy supplies,
  - if any disturbance is created to existing nearby surrounding environments / neighborhoods, due to overloaded traffic, accessibility problems in peak times.
- Process:
  - if the building design fits to the original schedule,
  - if any revisions took place during the design development processes
  - if the process was efficient and sustainable in total
  - if any inventory for process is existing for future feedback,
  - if sufficient involvement of the actors within the entire lifecycle is enhanced

- Users:

- if the users are satisfied with the provided outcome in terms of expectancy, satisfaction and comfort.
- if the users are satisfied in terms of provided functions' compatibility, achievability or accessibility.
- if the building is serving alternative modes of utilization for different of user groups in equal comfort levels, such as crowds, groups, children, elderly.

The global benchmarks and the sustainability approaches on which they are based, should have been extended to multidimensional levels with the incorporation of different and additional sustainability concepts in a comprehensive manner. The evaluation of these benchmarks can only be fulfilled in a comprehensive manner when the building output is comprehended and analyzed not only in its single entity within its own scale but also with its contextual integrity within the urban settlement.

When these broader impacts on the entire domain are considered, it becomes even more crucial that the sustainability approach should be carried out to an upper level of verification. This necessity to be perceived as a much comprehensive domain necessitates the verification of the initial decisions on why, what in specific and how to build are evaluated. Majority of the building design development processes remains insufficient due to their failure to; first, verifying the answers to these questions in multiple aspects of sustainability, and then second, due to their lacking fulfillment of more than one or two sustainability concepts simultaneously as a broader accomplishment. One of the reasons for this lack of compatibility and insensitivity to sustainability is the industry's urge to build new outputs in an increasing rate of construction with an ignorance of comprehensive sustainability concern.

According to United Nations studies and projections, globally it has been expected that by the year 2050, 66%of world population will be living in urban environments[19]. Figure 5.1. shows the general distribution and expansion of urban growth in percentage and the respective city population distributions in these urban regions. This display highlights the importance of this uncontrolled expansion and the consequences that should be expected if no preventive action is taken.

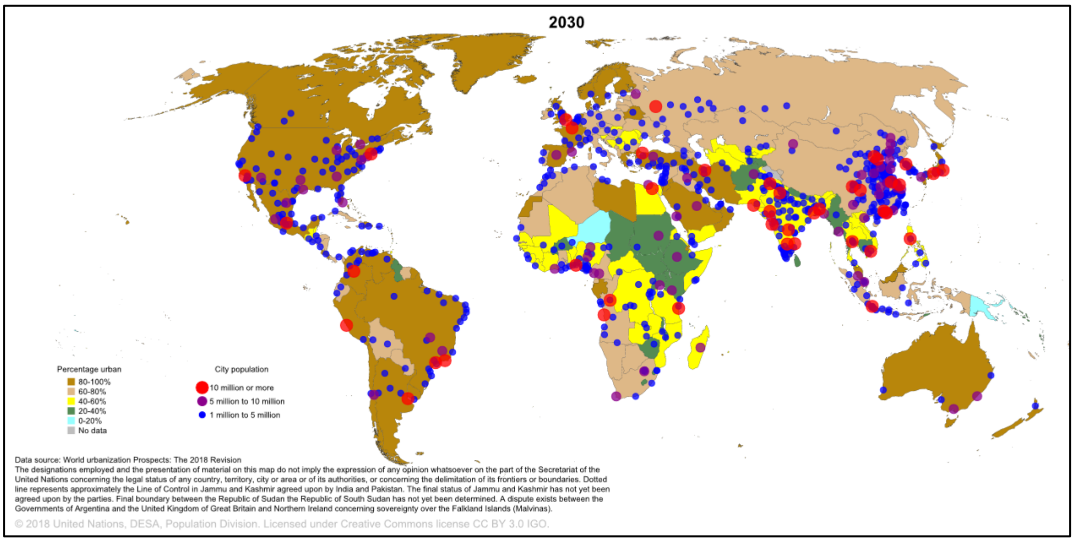


Figure 5.1. “general distribution and expansion of urban growth in urban regions (source: world urbanization prospects: 2018 Revision. https://population.un.org/wup/Maps/ accessed on June 15, 2022)

Likewise for Turkish context, a similar scenario has been estimated as by year 2018, 92,5% of Turkish population is living in cities or within an urban environment (Gökçe et. Al, 2018). This revealed situation, highlights how serious and essential this uncontrolled urban expansion is and why a comprehensive and urgent strategy

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[19] 2014 Revisions Of The Worlds Urbanization Prospects , UN Department of Economic and Social Affairs https://www.un.org/en/development/desa/publications/2014-revision-world-urbanization-prospects.html#:~:text=The%202014%20revision%20of%20the,population%20between%202014%20and%202050. Accessed on June 15, 2022)

should have been developed for a broader sustainability achievement in especially built urban environment domains of Turkey.

This shift in the distribution and balance of urban vs. rural population and the urban expansion as its consequence; brings not only the extra need for new constructions or additional infrastructures, but also the expectation that all of the community life will be effected from this uncontrolled growth; in terms of scale, spatial perception, community life or the continuity and existence of cultural and social patterns. Furthermore, the consequences of such and uncontrolled expansion is not only in the built environments in terms of increase in building stock, but also through the increase in the scale of building design developments, which requires excessive system infrastructures. The increasing level of commodification in the building design industry, forces the building designs individually to face with unavoidable complexities and necessities of the context such as electrical power demands, infrastructural provisions and an increase in the wastes produced inevitably. This problematic situation of underestimating the urgent and crucial aspect of broader sustainability achievement within the building industry might be prevented by the re-understanding of these complex multidisciplinary building design environments and with the utilization of a multi-layered design approach within the proposed sustainable lifecycles.

Continuing with the sustainability approaches in Turkish building industry, an important progress is observed with the development 2030 Agenda for Sustainable Development. Through the achievement of NSDG[20] mentioned in the Report on Turkey's Initial Steps towards the Implementation of the 2030 Agenda for Sustainable Development, Turkey has defined a roadmap including many steps, which starts with the 'completion of the inventory study'. This inventory study is

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[20] National Sustainable Development Goals, quoted from the Report on Turkey's Initial Steps towards the Implementation of the 2030 Agenda for Sustainable Development, Ministry of Development, July 2016, Ankara.

crucial to highlight the importance of strategies on evaluating the existing stock. Furthermore, one of the Paris Agreement compatible benchmarks also highlights the requirement of an increase in the retrofitting of the existing stock (CAT, 2019). The report of Climate Action Tracker (CAT, 2019) highlights the requirement for an increase in the renovation rates with an annual rate of 1,5% -2.1% with an efficiency improvement of 45% from 2020, to be perceived as best in class level. Therefore, utilization of the existing stock, within the context of Turkey is significantly important for a much efficient and sustainable urban environment. such a concern of revealing the existing building inventory , with the main target of re-using that stock in favor of a broader sustainability achievement, may be the grounding factor and fundamental catalyst in the 'building less'.

The strategy to achieve this sensitivity and the accomplishment of a broader sustainability; might be based on a general intention for "building less". Building less approach should cover however, all manners and all stages of building design development in the building industry. In further explanation, 'building less' approach should constitute its strategy on a significant change of perception for the decisions and relevant determinations related to building design developments. Examples to some approaches for these decision-making processes and relevant determinations are given as the following.

- the site selection decisions: if similar functions exist in the context, no need for new buildings but instead consider adaptive reuse, improvement / upgrading of the existing, additional re functioning possibilities
- program determinations: if no complementary function exists, then new buildings might be under-utilized booth due to potential users and/ or due to insufficient infrastructural provision. Thus, result is either overdesign or excessive or unnecessary utilization of resources
- contextual surveys: if the new building design will disturb the existing context in terms of privacy, public balances, or urban facility consequences, then no need for a new building in that specific context or built environment.

- environmental surveys: if the site allows the utilization of passive systems required and appropriate in terms of program and functional requirements.
- occupancy surveys: if there is really a potential or a demand of users for this new building design development, what about the possibilities of adaptive reuses of the existing building stock in the surrounding to be served to possible occupants.
- performance surveys: the decisions and selective criteria on the optimization and efficiency of any building design development. If the required energy loads could have been minimized by the utilization of passive systems, or utilization of resource-generative systems
- waste management: the decision of new building design development should have been justified with the answers to following questions in advance: what will happen to the wastes produced at the end of this new construction. Is it possible to reutilize the wastes of former constructions demolished? Will there be a sustainable strategy to allocate the wastes for further long-term uses of other purposes?

After reviewing and evaluating these concerns and situations, only if the corresponding overall evaluation does not comply or is not satisfied with the reuse opportunity of the existing stock, then the new building design development approach should have been considered. Therefore, the revised new roadmap of sustainable building design development process, specifically the comprehensive re-understanding for sustainable building design lifecycles, should have been implemented on this ground. The alternative checklists proposed might then also support and guide all of the actors through relevant action plans and associated responsibilities within each specific building design stage. The significance of this new approach and its relevant strategies is basically the raised awareness of the actors for an integrative approach within a multidisciplinary team. Due to this multidimensional understanding, the actors are offered to follow a multi-layered design approach. This multi-layered design approach is also elaborated further to serve alternative utilization possibilities. This further development is basically in order to display the operability of such a multi-layered design approach within the practice of design and construction. This operationalized format of the design approach is in the format of alternative checklists, which is utilized by all actors within their associated groups of references synchronously and with simultaneous actions held by other actors at the same time.

The concurrent mindset of this multi-layered design approach will contribute to the fulfillment of the incorporation of all determinants. The further contribution and improvement of this new re-understanding of the multidisciplinary building design processes towards the concept of sustainability, will at the same time prevent the excessive or undesired wastes, generated by the process such as revisions to miscommunication, reworks due to the lack of design data exchange, idle waiting hours due to insufficient concurrent planning of interrelated actions or overproduction due to the disassociation of actors to relevant interdependent tasks and their exchange flows.

5.4 Implications for Further Studies

Based on the research conducted, discussions raised and the new approaches developed; as a conclusion there are inevitably numerous actions to be taken. Some of these actions are ready to be activated rapidly, whereas some may need further research to achieve their best and most efficient way of activation. Regarding the primary objective of this dissertation research, the grounding and framing fundamentals of this new approach have been constituted in order to achieve a new re-understanding through multidimensional building design development processes. Such a re-understanding, when developed and integrated towards the sustainability concept and proposed as a multi-layered design approach, also opens and defines different paths for several further research. These potential domains for further development may be mainly focusing on the improvement of these sustainable processes to be integrated with other approaches in the study of sustainability. These further development studies extend in a wide-ranged domain since the subject covers various disciplines and study topics that are interdependent to one another. Some alternative further study approaches are given in the following topics:

- Studies on certification systems and benchmarks: to search for ways and new approaches to integrate already set framework of these systems with a totalitarian approach, in which the whole process is subjected to certain evaluation criteria integrating the seven proposed sustainability concepts within itself.
- Studies on legal and legislative domains: to search for the effective and positive utilization of new regulations of the government to promote more sustainable building design development achievements by developing and rearranging the authorization process, in terms of specifications or tender methodologies, required milestones of submissions for validations of sustainability, distribution of responsibilities or breakdowns of approvals.
- Studies on economic grounds: to search for the ways to use economical aspects in the evaluation of the fulfillments of multidimensional sustainability in building design developments, either by promoting or penalizing with incentives, support, tax and duty regulations by the government.
- Studies on user involvements: to search for more effective user involvement and contribution within the entire building design development lifecycles, to achieve and improve advanced sustainability levels; to search for the advanced training of the users in terms of maintaining, reviewing and evaluating the existing building and if required to derive possible ways of updating, revising it, to extend the lifecycle; to search on how to integrate continuing education center approach in favor of sustaining sustainable building design occupancy from user perspective.
- Studies on technological tools: to search for better and comprehensive integration of the technological tools for achieving multidimensional sustainability; to search on how these seven sustainability concepts can be integrated with the existing software interfaces, or tools to assess their

efficiencies and thus to simulate their performances in a comprehensive manner.

Considering that, any production and construction alters the natural environment in an irreversible way, it is vital to minimize the unnecessary production and construction, and search for alternative solutions such as reuse, recycle and rehabilitation as a cultural convention. In this sense, the concept of sustainability is open to be carried to the domain of multiple disciplinary discissions that are not limited with physical and environmental issues.

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A. Case Studies

PHYSICAL SUSTAINABILITY

(+/-) shadow casting within the development layout

(+) max higher blocks located on the northern edge to minimize shadow impact within the complex for medium- lower blocks and recreational areas

(-) excessive provision of total number of residential units, compared to existing developments

(+) no excessive surface floor / roof area exposed (for car park or other fa-cilities) no surface sun radiation or solar island effect

(-)green outdoor area for recreation utilization for outdoor comfort control (for user comfort or environmental micro-climatic system provisions)

(+) for medium blocks facade treatment for passive systems provided, for higher blocks curtain wall and no specific side oriented facade treatment

(-) high-rise block located on the north-west and south east sides---> less shadow on the settlemnts itself, however excessive shadow casting to the surrounding

ECONOMICAL SUSTAINABILITY

(+) competetive design and outout for the existing market conditions so increade in land value and high RoI

(-) so many units decreases the RoI rapidness and durations of completion of sales

SOCIAL AND CULTURAL SUSTAINABILITY

(+) Social interaction possibility with respect torich outdoor recreation areas

(-) social, cultural, retail and educational facilities existing in the sur-rounding

CONTEXTUAL SUSTAINABILITY

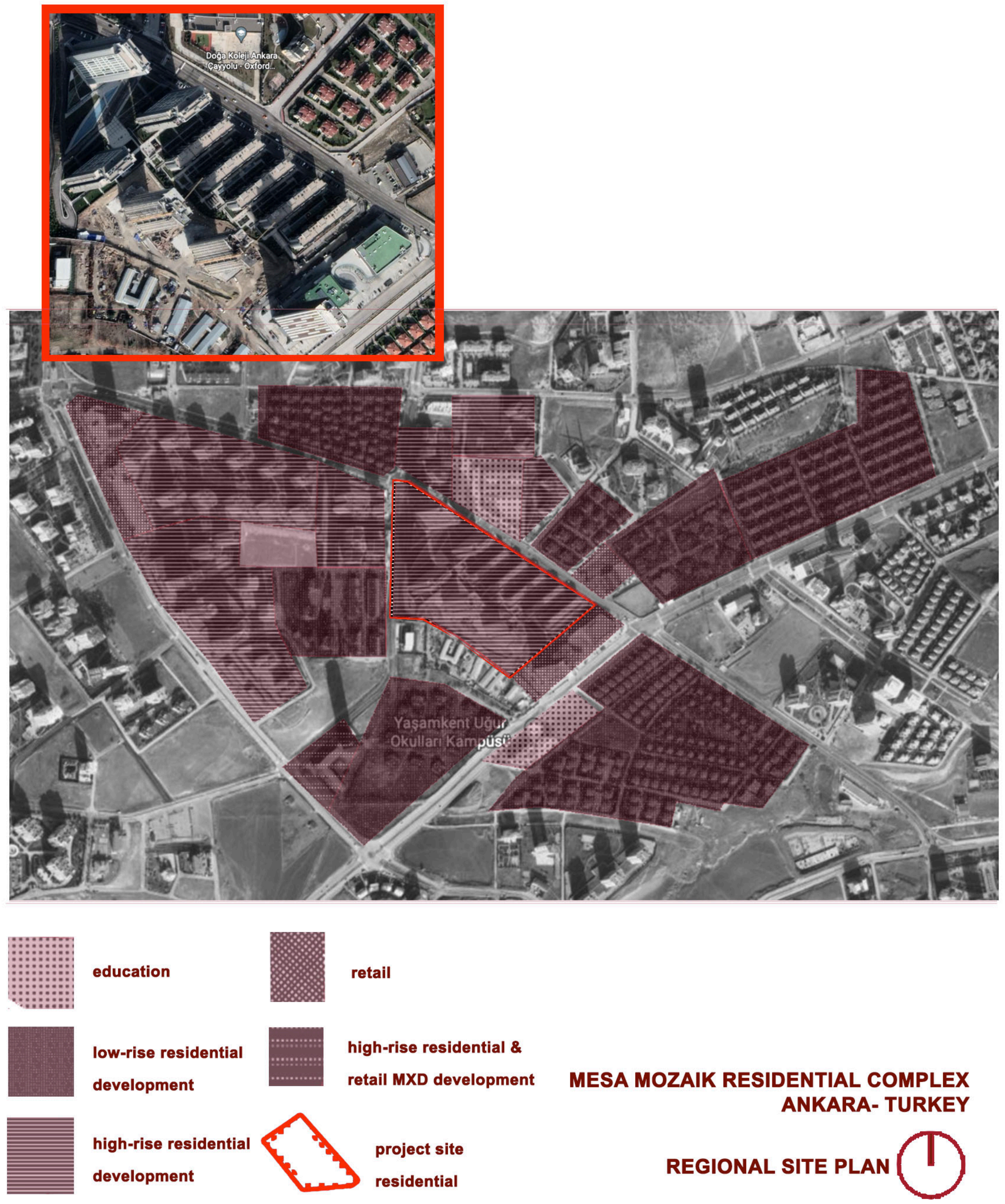
(+) project has been developed and constrcuted in a residential district, with various scale and typologies

(+) sufficient infrastructural provision before the project

(+) sufficient setbacks and regulative concerns within the design and orientation

(+) no revision made on the existing plan notes, regulations, urban plan-ning strategies (contextual)

(+) no addiitonal / exessive function supply provided repeadetly wthin the development, utilization of surrionding fucntions instead (schools, retail)



A.1. Mesa Mozaik Residential Complex_A1_ Analyses Set

PHYSICAL SUSTAINABILITY

(+/-) shadow casting within the development layout

(+) max higher blocks located on the northern edge to minimize shadow impact within the complex for medium- lower blocks and recreational areas

(-) excessive provision of total number of residential units, compared to existing developments

(+) no excessive surface floor / roof area exposed (for car park or other facilities) no surface sun radiation or solar island effect

(-)green outdoor area for recreation utilization for outdoor comfort control (for user comfort or environmental micro-climatic system provisions)

(+) for medium blocks facade treatment for passive systems provided, for higher blocks curtain wall and no specific side oriented facade treatment

(-) high-rise block located on the north-west and south east sides---> less shadow on the settlemnts itself, however excessive shadow casting to the surrounding

ECONOMICAL SUSTAINABILITY

(+) competetive design and outout for the existing market conditions so increade in land value and high RoI

(-) so many units decreases the RoI rapidness and durations of completion of sales

SOCIAL AND CULTURAL SUSTAINABILITY

(+) Social interaction possibility with respect torich outdoor recreation areas

(-) social, cultural, retail and educational facilities existing in the surrounding

CONTEXTUAL SUSTAINABILITY

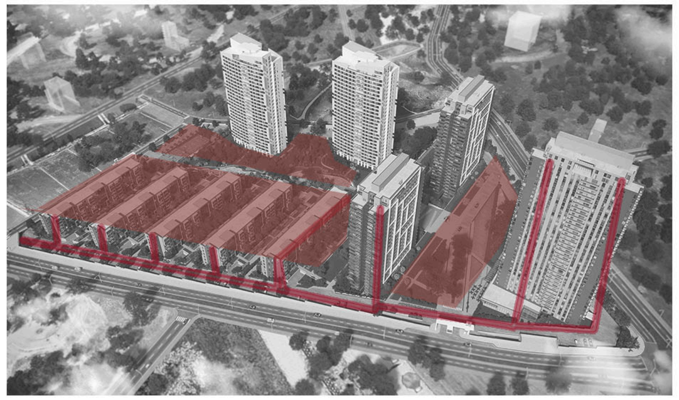
(+) project has been developed and constrcuted in a residential district, with various scale and typologies

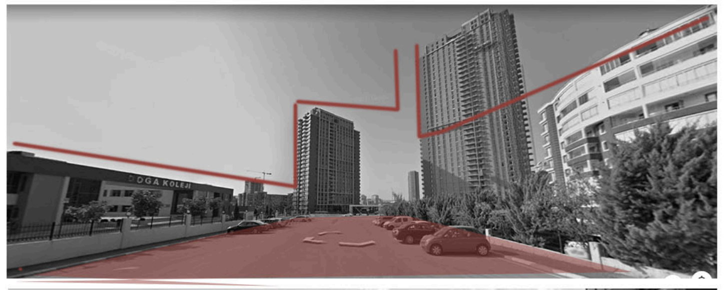
(+) sufficient infrastructural provision before the project

(+) sufficient setbacks and regulative concerns within the design and orientation

(+) no revision made on the existing plan notes, regulations, urban planning strategies (contextual)

(+) no addiitonal / exessive function supply provided repeadetly wthin the development, utilization of surrionding fucntions instead (schools, retail)





ENVIRONMENTAL SUSTAINABILITY

(-)Excessive shadow casting to nearby surrounding

(-)Excessive solar (heat) island effect and solar reflection on the gross footprint / floor area of multi-storey car parking block

(-)No micro-climatic control or environmental systems provision in the cetral open air courtyard

(-)High-rise block located on the north-west and south east sides ---> less shadow on the settlemnts itself, however excessive shadow casting to the surrounding

(-) Central open-air court has no environmental precaution, treatment for user comfort

(+) sports areas and pool in the open air orientation is correct in terms of sun light achievement

MESA MOZAIK RESIDENTIAL COMPLEX
ANKARA- TURKEY

GENERAL VIEW

A.2. Mesa Mozaik Residential Complex_A2_ Analyses Set

PHYSICAL SUSTAINABILITY

(+/-) shadow casting within the development layout

(+) max higher blocks located on the northern edge to minimize shadow impact within the complex for medium- lower blocks and recreational areas

(-) excessive provision of total number of residential units, compared to existing developments

(+) no excessive surface floor / roof area exposed (for car park or other facilities) no surface sun radiation or solar island effect

(-)green outdoor area for recreation utilization for outdoor comfort control (for user comfort or environmental micro-climatic system provisions)

(+) for medium blocks facade treatment for passive systems provided, for higher blocks curtain wall and no specific side oriented facade treatment

(-) high-rise block located on the north-west and south east sides---> less shadow on the settlemnts itself, however excessive shadow casting to the surrounding

ECONOMICAL SUSTAINABILITY

(+) competetive design and outout for the existing market conditions so increade in land value and high RoI

(-) so many units decreases the RoI rapidness and durations of completion of sales

SOCIAL AND CULTURAL SUSTAINABILITY

(+) Social interaction possibility with respect torich outdoor recreation areas

(-) social, cultural, retail and educational facilities existing in the surrounding

CONTEXTUAL SUSTAINABILITY

(+) project has been developed and constrcuted in a residential district, with various scale and typologies

(+) sufficient infrastructural provision before the project

(+) sufficient setbacks and regulative concerns within the design and orientation

(+) no revision made on the existing plan notes, regulations, urban planning strategies (contextual)

(+) no addiitonal / exessive function supply provided repeadetly wthin the development, utilization of surrionding fucntions instead (schools, retail)

ENVIRONMENTAL SUSTAINABILITY

(-)linear / single side oriented residential units (no cross ventilation possibility)

(-) no specific side selection, different orientations for same unit types and for different facilites within the unit (bedroom - vs living room)

(-) no direct air / sunlight provision for wet spaces---mechanic ventilation obligation and excessive resource consumption

(+)micro-climatic control or environmental systems provision in the cetral open air courtyard

(-)high-rise block located on the north-west and south east sides---> less shadow on the settlemnts itself, however more shadow casting to the surrounding

(+)controlled, protected outdoor recreation areas

(+)sports areas and pool in the open air orientation is correct in terms of sun light achievement

(+)controlled shadow casting to nearby

(-)for general halls no direct air and sunlight provision

MESA MOZAIK RESIDENTIAL COMPLEX
ANKARA- TURKEY

GENERAL VIEW

A.3. Mesa Mozaik Residential Complex_A3_ Analyses Set

PHYSICAL SUSTAINABILITY

(-) excessive shadow casting to each other within the development as well as to the surrounding settlements / low-rise buildings
(-) excessive amount of block and layout design
(-) no hierarchy of public space or protected outdoor space utilization
(-) no environmental precaution, treatment for user comfort or environmental micro-climatic system provisions
(-)no appropriate / special orientation based layout of blocks

ECONOMICAL SUSTAINABILITY

(+) low cost land and affordable housing property offer to the market
(+) economic / affordable RoI for investors
(+) provision of minimum necessary facilities withi the development to support economic sustainabiltiy of investment

SOCIAL AND CULTURAL SUSTAINABILITY

(-) No Social interaction possibility with respect to site plan organization and general layout
(-) Nopublic social or cultural facility around
(+) religious and educational faicltites included withint he general masterplan

CONTEXTUAL SUSTAINABILITY

(+) project has been developed and constrcuted in a low-rise and low-density residential area
(-) no sufficient infrastructural provision before the project
(too much close proximity of the high-rise buildings with the neighbouring low-rise private villa ara- instead of enhancing required and appropriate set back distances)
(-) irrespectful footprint and uncontextul occupation (i.e: person/ m2 allocation)
(-) necessary infrastructure has not been provided and planned according to such a development density
(+) revision made on the existing plan notes, regulations, urban planning strategies (uncontextual)
(-) negative effect on the context , changing existing typlogy-density-landuse...etc. ; increase in high-rise developments in the surrounding built environment

A.4. TOKI Incek Residential Complex_A1_ Analyses Set

PHYSICAL SUSTAINABILITY

(-) excessive shadow casting to each other within the development as well as to the surrounding settlements / low-rise buildings
(-) excessive amount of block and layout design
(-) no hierarchy of public space or protected outdoor space utilization
(-) no environmental precaution, treatment for user comfort or environmental micro-climatic system provisions
(-)no appropriate / special orientation based layout of blocks

ECONOMICAL SUSTAINABILITY

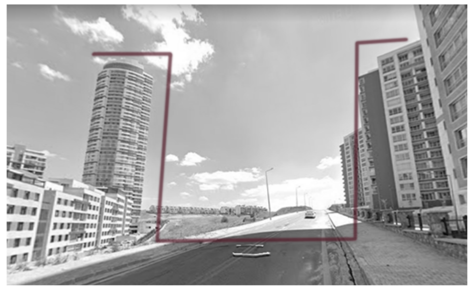
(+) low cost land and affordable housing property offer to the market
(+) economic / affordable RoI for investors
(+) provision of minimum necessary facilities withi the development to support economic sustainabiltiy of investment

SOCIAL AND CULTURAL SUSTAINABILITY

(-) No Social interaction possibility with respect to site plan organization and general layout
(-) Nopublic social or cultural facility around
(+) religious and educational faicltites included withint he general masterplan

CONTEXTUAL SUSTAINABILITY

(+) project has been developed and constrcuted in a low-rise and low-density residential area
(-) no sufficient infrastructural provision before the project
(too much close proximity of the high-rise buildings with the neighbouring low-rise private villa ara- instead of enhancing required and appropriate set back distances)
(-) irrespectful footprint and uncontextul occupation (i.e: person/m2 allocation)
(-) necessary infrastructure has not been provided and planned according to such a development density
(+) revision made on the existing plan notes, regulations, urban planning strategies (uncontextual)
(-) negative effect on the context , changing existing typlogy-density-landuse...etc. ; increase in high-rise developments in the surrounding built environment



ENVIRONMENTAL SUSTAINABILITY

(-)Excessive shadow casting to each other
(-)Excessive mass load , high rise block density - inconsistent with the surrounding low rise development
(-)No micro-climatic control or environmental systems provision in the cetral open air courtyard (no soft landscpae as a voluemtric provision)
(-)High-rise blocks located irrelevant and independently to (sun) oientation
(-)infrastrcutural provision supplied afterwards
(-) inappropriate utilization of topograohy / working as a barrier
(-) high speed road barrier to required facilities (school access not public utilized)

TOKI INCEK HOUSING
ANKARA- TURKEY

GENERAL VIEW

A.5. TOKI Incek Residential Complex_A2_ Analyses Set

PHYSICAL SUSTAINABILITY

(-) excessive shadow casting to each other within the development as well as to the surrounding settlements / low-rise buildings
(-) excessive amount of block and layout design
(-) no hierarchy of public space or protected outdoor space utilization
(-) no environmental precaution, treatment for user comfort or environ-mental micro-climatic system provisions
(-)no appropriate / special orientation based layout of blocks
(-) utilization of two sides only in orientation
(-) no cross ventilation possibility
(-) wet spaces require mechanic ventilation

ECONOMICAL SUSTAINABILITY

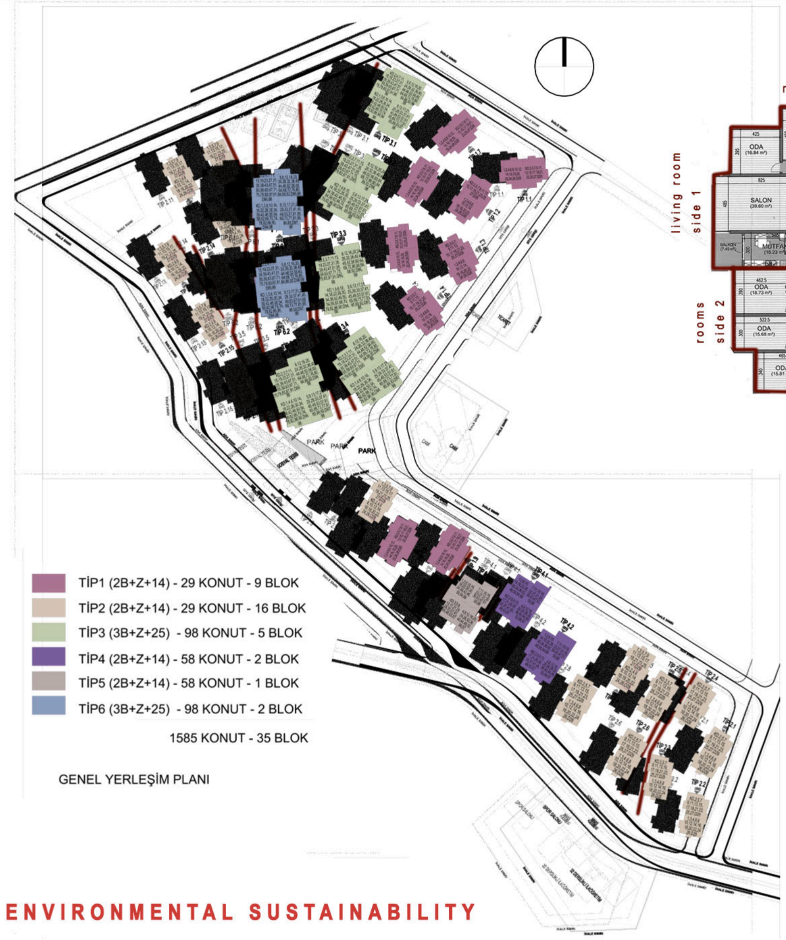
(+) low cost land and affordable housing property offer to the market
(+) economic / affordable RoI for investors
(+) provision of minimum necessary facilities withi the development to support economic sustainabiltiy of investment

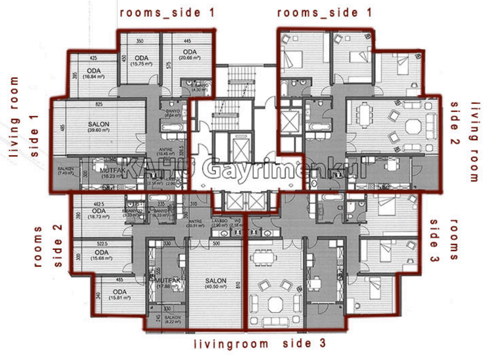
SOCIAL AND CULTURAL SUSTAINABILITY

(-) No Social interaction possibility with respect to site plan organizati-on and general layout
(-) No public social or cultural facility around
(+) religious and educational faicltites included withint he general mas-terplan

CONTEXTUAL SUSTAINABILITY

(+) project has been developed and constrcuted in a low-rise and low-density residential area
(-) no sufficient infrastructural provision before the project
(too much close proximity of the high-rise buildings with the neighbou-ring low-rise private villa ara- instead of enhancing required and ap-propriate set back distances)
(-) irrespectful footprint and uncontextul occupation (i.e: person/ m2 allocation)
(-) necessary infrastructure has not been provided and planned accor-ding to such a development density
(+) revision made on the existing plan notes, regulations, urban plan-ning strategies (uncontextual)
(-) negative effect on the context , changing existing typlogy-den-sity-landuse...etc. ; increase in high-rise developments in the surroun-ding built environment





ENVIRONMENTAL SUSTAINABILITY

(-)Excessive shadow casting to each other
(-)Excessive mass load , high rise block density - inconsistent with the surrounding low rise development
(-)No micro-climatic control or environmental systems provision in the cetral open air courtyard (no soft landscpae as a voluemt-ric provision)
(-)High-rise blocks located irrelevant and independently to (sun) oientation
(-)infrastrcutural provision supplied afterwards
(-) inappropriate utilization of topograohy / working as a barrier
(-) high speed road barrier to required facilities (school access not public utilized)
(-) no possibility for passive systems utilization

TOKI INCEK HOUSING
ANKARA- TURKEY

TECHNICAL / DETAILS

A.6. TOKI Incek Residential Complex_A3_ Analyses Set

PHYSICAL SUSTAINABILITY

(+) all masses have been recessed / set back from Eskisehir Road

(+) housing blocks located far away from Eskisehir rorad- preevnting noise and traffic pollution

(-) all facade treatment similar - independent from orientation (E-W)

(-)insufficient facade treatment for passive system utilization

(-) uniform treatment for all sides (not adjusted for north-east- west)

(-) underutilised roof usage

ECONOMICAL SUSTAINABILITY

(+) previous- similar investments' RoI significance

(+) nearby functions' (offices nearby, mixed use facilities supply) / landuse potential for RoI,

SOCIAL AND CULTURAL SUSTAINABILITY

(+) Social interaction possibility with respect to mixed facilities, public gathering possibilities included.

(-) No cultural facility around

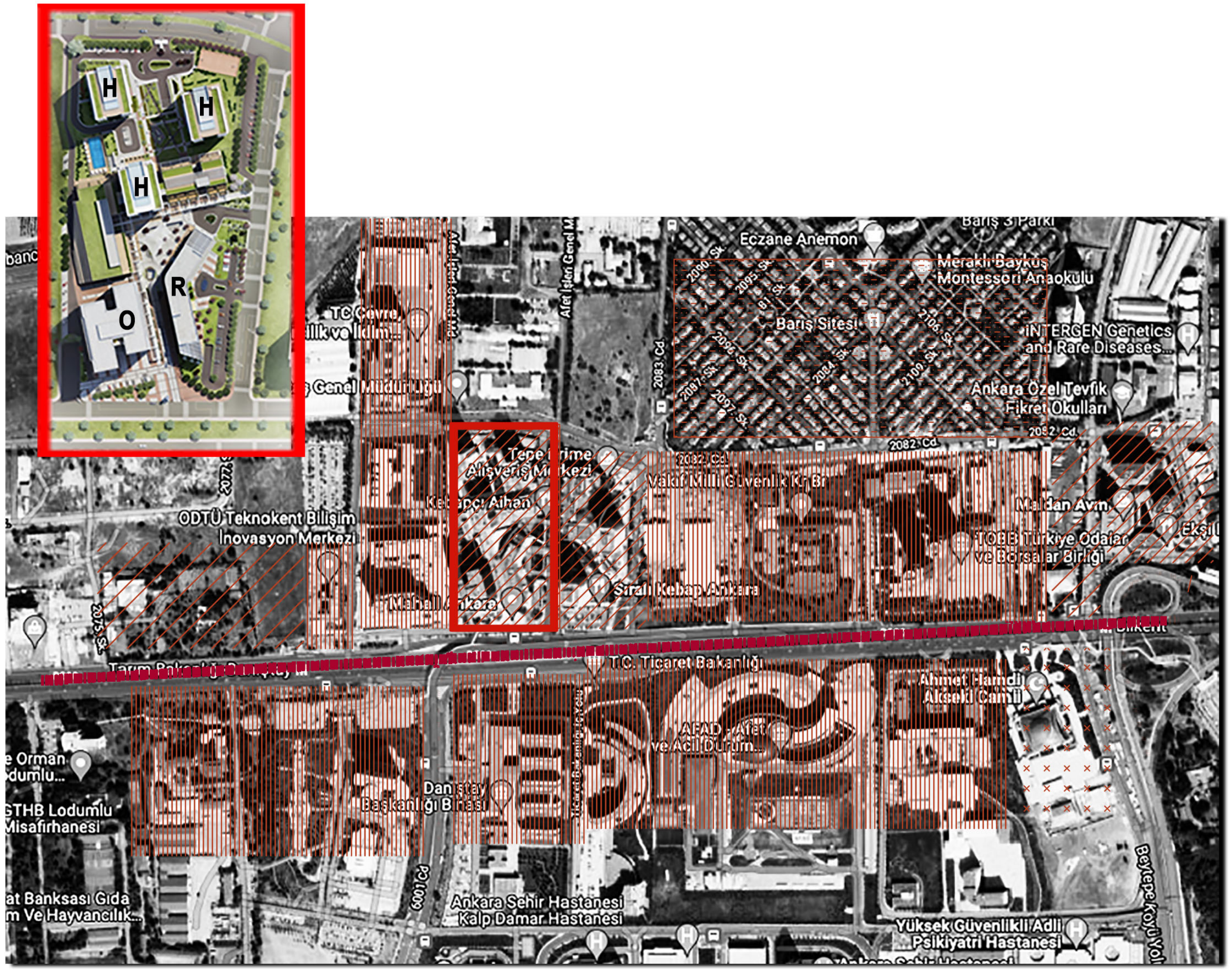
CONTEXTUAL SUSTAINABILITY

(+) project site is in consistency with the context, in terms of

- -continuation of similar typologies,
- -supporting facilities,
- -potential user groups,
- -public use continuity provision

(+) necessary infrastructure has already been provided

(+) consistent with existing plan notes, regulati-ons, urban planning strategies



MXD- completed

MXD- on process

Office complex

Residential settlement

Religious Center / Mosque

Eskisehir Road / main artery

MAHALL ANKARA MIXED USE DEVELOPMENT
ANKARA- TURKEY

REGIONAL SITE PLAN

A.7. Mahall Ankara MXD Complex_A1_ Analyses Set

PHYSICAL SUSTAINABILITY

(+) all masses have been recessed / set back from Eskisehir Road
(+) housing blocks located far away from Eskisehir rorad- preventing noise and traffic pollution
(-) all facade treatment similar - independent from orientation (E-W)
(-)insufficient facade treatment for passive system utilization
(-) uniform treatment for all sides (not adjusted for north-east- west)
(-) underutilised roof usage
(+) air flow / natural ventilation in outdorr spaces

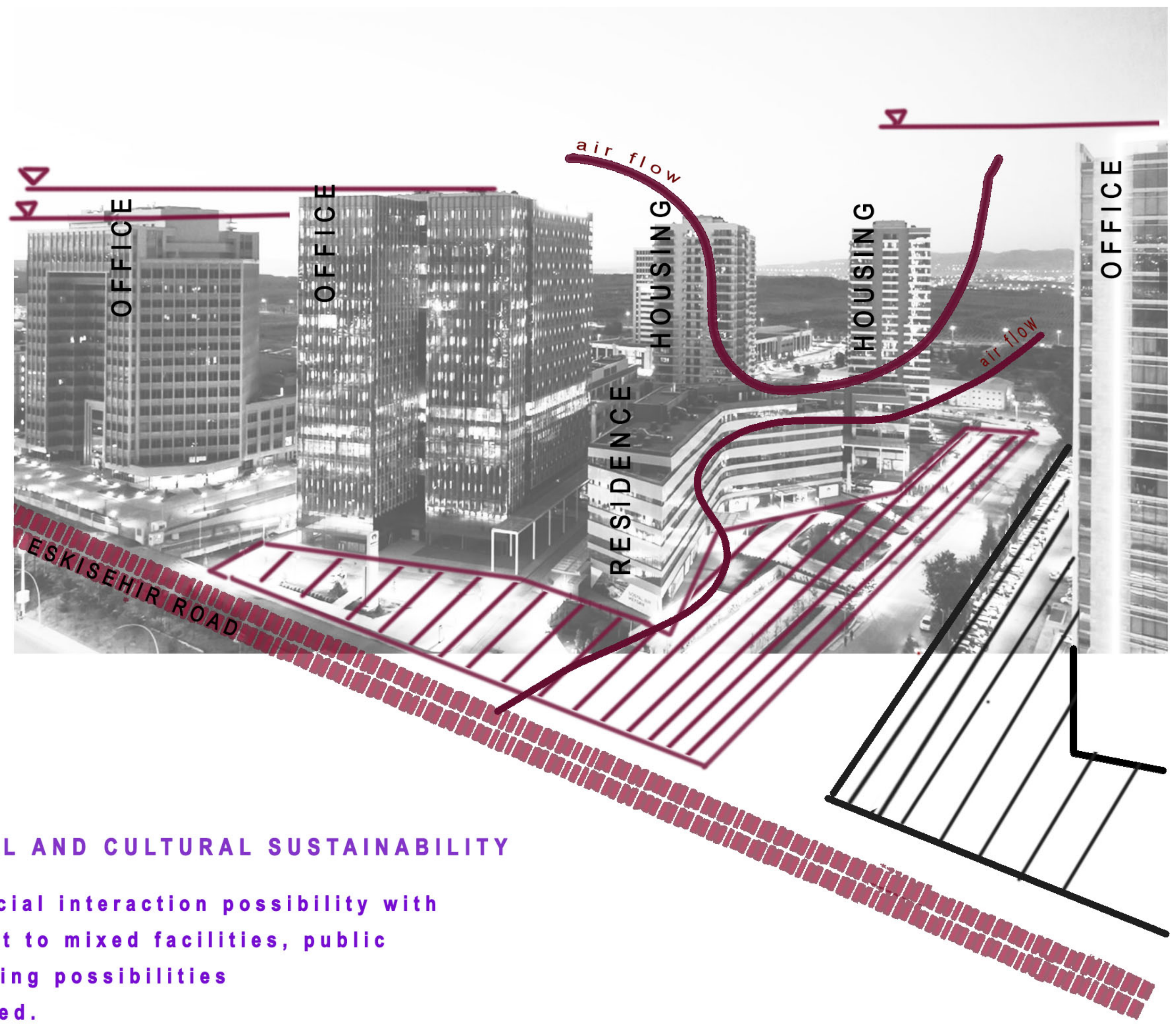
ECONOMICAL SUSTAINABILITY

(+) previous- similar investments' RoI significance
(+) nearby functions' (offices nearby, mixed use facilities supply) / landuse potential for RoI,

CONTEXTUAL SUSTAINABILITY

(+) project site is in consistency with the context, in terms of
- -continuation of similar typologies on the same edge,
- -supporting facilities within the development complex,
- -potential user groups for the synergy and efficient utilization intention
- -public use continuity provision

(+) necessary infrastructure has already been provided
(+) consistent with existing plan notes, regulations, urban planning strategies (hmax consistency...etc.)



SOCIAL AND CULTURAL SUSTAINABILITY

(+) Social interaction possibility with respect to mixed facilities, public gathering possibilities included.
(-) No cultural facility around
(+)provision of the social gathering opportunity in its fucntionmix, which is lacking in the surrounding developments,

MAHALL ANKARA MIXED USE DEVELOPMENT
ANKARA- TURKEY

GENERAL VIEW

A.8. Mahall Ankara MXD Complex_A2_ Analyses Set

PHYSICAL SUSTAINABILITY

(-) in the floor plan / layout of housing blocks
housing units have been located on each of the four different sides / orientations :

*bedroom on East, West and North sides ----> excessive heating cooling necessities

*living rooms on East, West, North and South sides ----> excessive heating cooling necessities

*wet spaces / toilets in the inner core ---->therefore mechnaical ven-tilation- excessive energy consumption

(-) no special facade treatment with respect to different sides / orientation
(-) common floor hall and circulation cores are located at the center of the block -----> mechanical ventlation & excessive energy consumption
(-) balconies located at south and north sides ---->unappropriate utilisation

SOCIAL AND CULTURAL SUSTAINABILITY

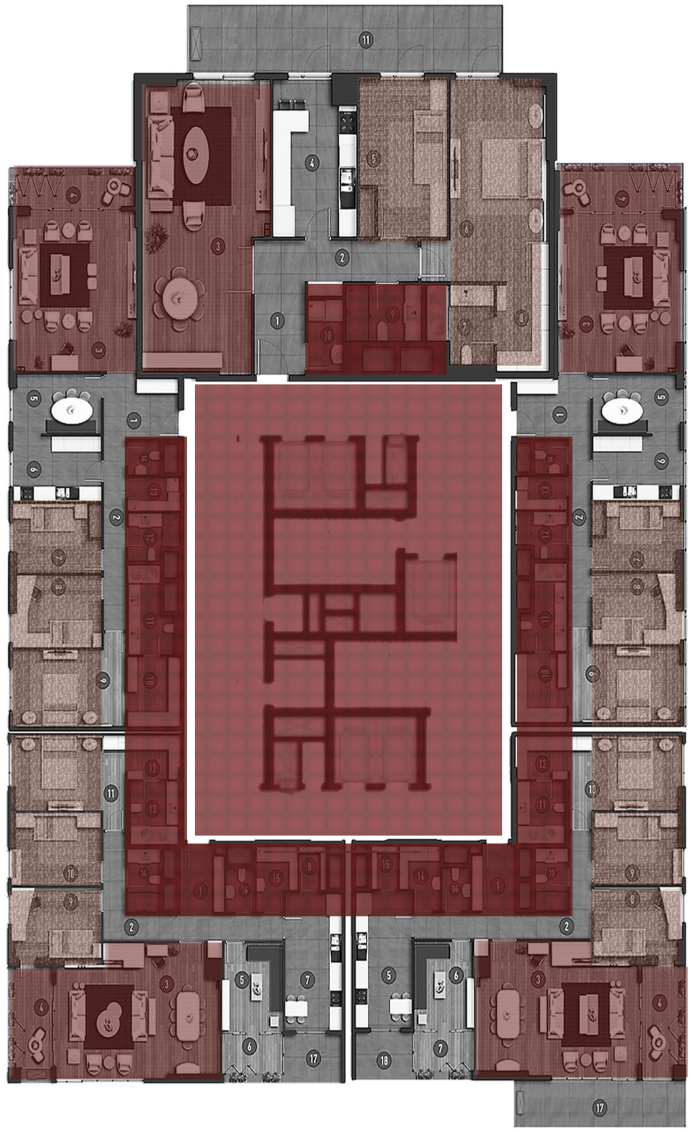
(+) different units (2+1, 3+1, 4+1 ...etc.) located on the same floor plan layout / in the same housing block
-----> social and cultural intyeraction opportunity
(-) all floor plans are same, no different space allocations for public / social gathering
----> no possibility of social or cultural interaction- facility provision within the building

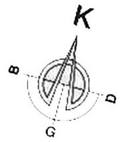
OPERATIONAL SUSTAINABILITY

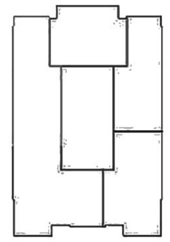
(-)excessive heating cost on north vs. excessive cooling cost on south
(-)no passive system utilizations (louvres / overhangs / shadings ...etc.) to decrease possible operational costs
(-) no daylight in wet spaces -----> excessive electricity / energy consump-tion

ECONOMICAL SUSTAINABILITY

(+) supply of different units ----> decreasing risks of investment
(+) optimisation of net / gross floor area usage ------> investment initial cost advantage







common hall & circulation hall

bedrooms

living rooms

wet spaces

MAHALL ANKARA MIXED USE DEVELOPMENT
ANKARA- TURKEY

GROUND FLOOR PLAN

A.9. Mahall Ankara MXD Complex_A1_ Analyses Set

PHYSICAL SUSTAINABILITY

(-) excessive shadow casting to both within the development as well as to the surrounding settlements / low-rise buildings
(-) excessive footprint / layout of multi-storey carpark
(-) carparks roof has not been utilized for any environmental / passive system
(-)central open-air court has nor environmental precaution, treatment for user comfort or environmental micro-climatic system provisions
(-) high-rise block located on the north-west and south east sides---> less shadow on the settlemnts itself, however excessive shadow casting to the surrounding

ECONOMICAL SUSTAINABILITY

(+) proposal of a new property unit to the market to increase economical demand and potential
(-) retail function provision increases economical feasibility

SOCIAL AND CULTURAL SUSTAINABILITY

(+) Social interaction possibility with respect to mixed facilities, public gathering possibilities included.
(-) No cultural facility around

CONTEXTUAL SUSTAINABILITY

(+) project has been developed and constrcuted in a low-rise and low-density residential area
(-) no sufficient infrastructural provision before the project
(too much close proximity of the high-rise buildings with the neighbouring low-rise private villa ara- instead of enhancing required and appropriate set back distances)
(-) irrespectful footprint and uncontextul occupation (i.e: person/ m2 allocation)
(-) necessary infrastructure has not been provided and planned according to such a development density
(+) revision made on the existing plan notes, regulations, urban planning strategies (uncontextual)
(-) negative effect on the context , changing existing typlogy-density-landuse...etc. ; increase in high-rise developments in the surrounding built environment

A.10. Incek Prestij MXD Complex_A1_ Analyses Set

PHYSICAL SUSTAINABILITY

(-) excessive shadow casting to both within the development as well as to the surrounding settlements / low-rise buildings
(-) excessive footprint / layout of multi-storey carpark
(-) carparks roof has not been utilized for any environmental / passive system
(-) or environmental micro-climatic system provisions
(-) no special treatment with respect t different sides / orientations (SN /EW)
(-) no shading element, overhang, or mass articulative precaution for climatic orientation appropriateness

ECONOMICAL SUSTAINABILITY

(+) proposal of a new property unit to the market to increase economical demand and potential
(-) first supply / provision of retail function (not existing in the surrounding) increases economical potential and feasibility
(+)provision of 12 different residential units, variety in sallable units---- decrease of eceonomical risk of non-sellability

SOCIAL AND CULTURAL SUSTAINABILITY

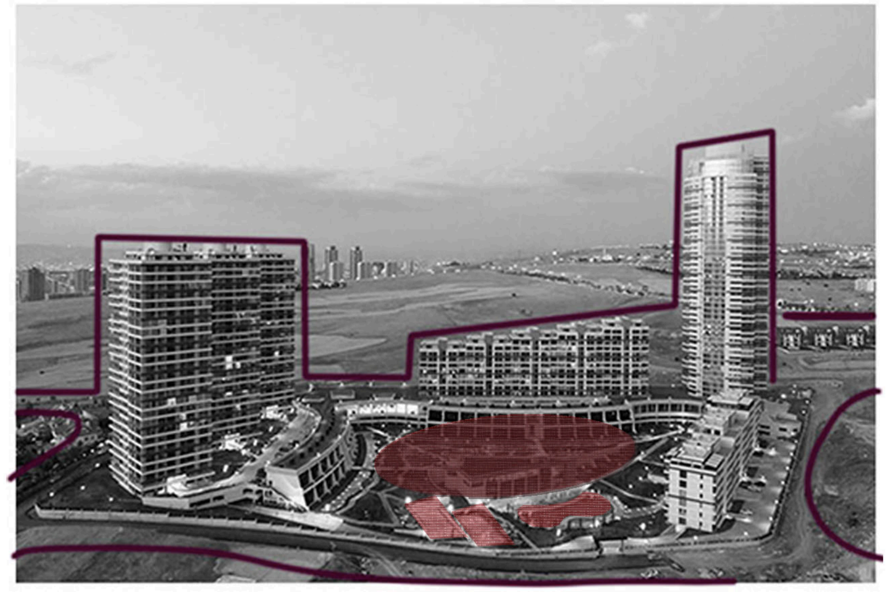
(+) Social interaction possibility with respect to mixed facilities, public gathering possibilities included.
(-) No cultural facility around
(+)provision of 12 different residential units----> variety of user community and interaction potential

CONTEXTUAL SUSTAINABILITY

(-) all low density settlments in the surounding
---> planning / zone status change
(-) all low rise developments in the close surrounding- some mid-rise in the back
(-) no mixed-use development in the surrounding
/ on the contrary all settlements around are housing
----> planning / zone status change
(-) no sufficient infrastructure provision (narrow /one way stabilized roads)
(-) silhoutte changing impact

ENVIRONMENTAL SUSTAINABILITY

(-)Excessive shadow casting to nearby surrounding
(-)Excessive solar (heat) island effect and solar reflection on the gross footprint / floor area of multi-storey car parking block
(-)No micro-climatic control or environmental systems provision in the cetral open air courtyard
(-)High-rise block located on the north-west and south east sides
---> less shadow on the settlemnts itself, however excessive shadow casting to the surrounding
(-) Central open-air court has no environmental precaution, treatment for user comfort
(+) sports areas and pool in the open air orientation is correct in terms of sun light achievement



MAHALL ANKARA MIXED USE DEVELOPMENT
ANKARA- TURKEY

GENERAL VIEW

A.11. Incek Prestij MXD Complex_A2_ Analyses Set

PHYSICAL SUSTAINABILITY

(-) one lineear block having an exessive length with no articulation in edges.
(+) lcocated in north- south orientation
(-) all facade treatment excatly same (for office units and residentials)- independent from orientation
(-) units located to west and east, no solar protection or shading or aother protection treatement from solar radiaton and excessive sun exposure
(-)no facade treatment for passive system utilization
(-) too close and parallel located orientation with Eskisehir road (pollution, noise and pedestrian accessiblity problems)
(+/-) roof utilized with terracing in east-west directions to aco-modate terrace having units , however no shading provision
(-) no landscape or natural element dominated outdoor space provision for users
(-) negative impact on surrounding in terms of wind circulation and sun blockage

ECONOMICAL SUSTAINABILITY

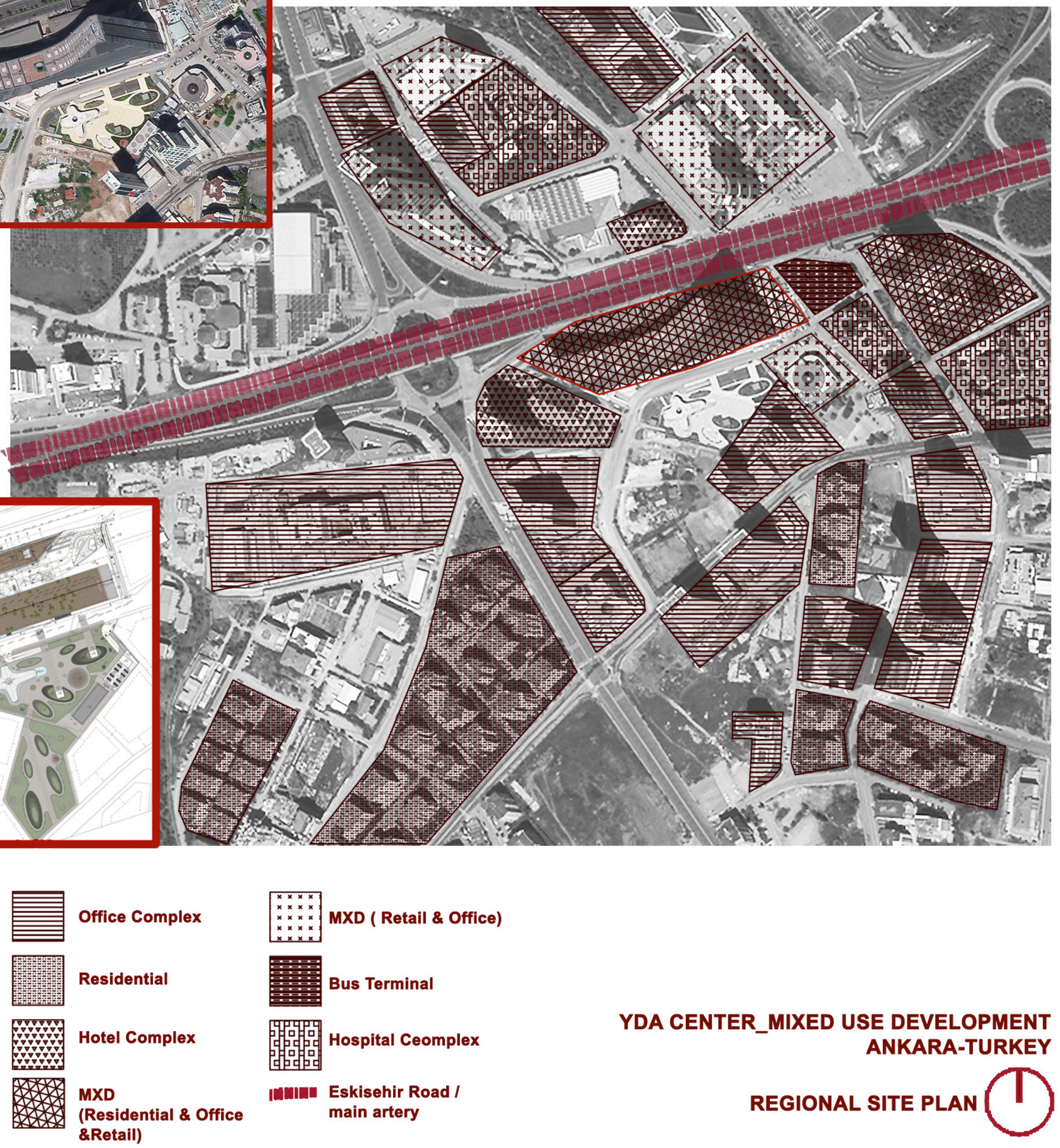
(+) in between many different facilitis, high existing land value- therefore high rates potential in sales
(+) nearby functions' (offices nearby, mixed use facilities supply) / landuse potential for RoI,

SOCIAL AND CULTURAL SUSTAINABILITY

(+) Social interaction possibility with respect to mixed facilities, public gathering possibilities included.
(+) sevral mixed-use functions and varios typoogies with different facilties are exsitng all around

CONTEXTUAL SUSTAINABILITY

(+) project site is in consistency with the context, in terms of
-continuation of similar typologies,
-supporting facilities,
-potential user groups,
-public use continuity provision
(+) necessary infrastructure has already been provided
(-) inconsistency in terms of building mass dimensions and mass articulation approaches



A.12. YDA Center MXD Complex_A1_ Analyses Set

PHYSICAL SUSTAINABILITY

(-) one lineear block having an exessive length with no articulation in edges.
(+) lcocated in north- south orientation
(-) all facade treatment excatly same (for office units and residentials)- independent from orientation
(-) units located to west and east, no solar protection or shading or aother protection treatement from solar radiaton and excessive sun exposure
(-)no facade treatment for passive system utilization
(-) too close and parallel located orientation with Eskisehir road (pollution, noise and pedestrian accessiblity problems)
(+/-) roof utilized with terracing in east-west directions to acomodate terrace having units , however no shading provision
(-) no landscape or natural element dominated outdoor space provision for users
(-) negative impact on surrounding in terms of wind circulation and sun blockage

ECONOMICAL SUSTAINABILITY

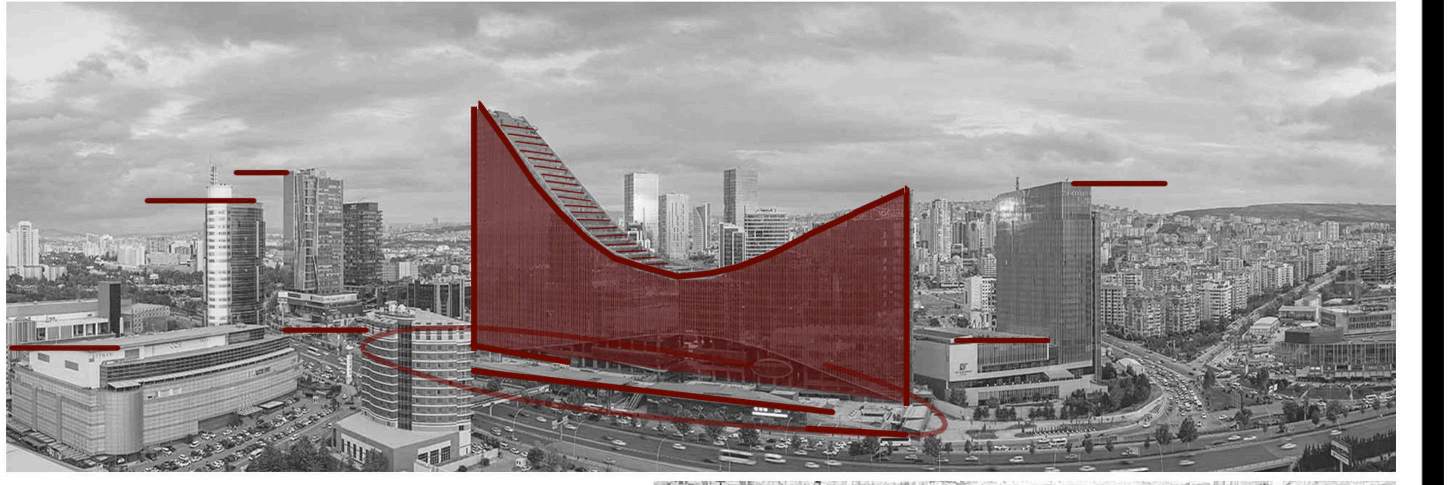
(+) in between many different facilitis, high existing land value- therefore high rates potential in sales
(+) nearby functions' (offices nearby, mixed use facilities supply) / landuse potential for RoI,

SOCIAL AND CULTURAL SUSTAINABILITY

(+) Social interaction possibility with respect to mixed facilities, public gathering possibilities included.
(+) sevral mixed-use functions and varios typoogies with different faciltiies are exsitng all around

CONTEXTUAL SUSTAINABILITY

(+) project site is in consistency with the context, in terms of
-continuation of similar typologies,
-supporting facilities,
-potential user groups,
-public use continuity provision
(+) necessary infrastructure has already been provided
(-) inconsistency in terms of building mass dimensions and mass articulation approaches



ENVIRONMENTAL SUSTAINABILITY

(-) blockage of sun and wind circulation for existing surrounding developments
(-) excessive sun exposure to east west oriented units without any protection
(-) no facade articulation for that much of a continous lineear block
(-) no passive system utilzation on north & south facades
(-) curtain wall selection and application- for the whole facedes on north and south
(-) monolithic and megastructure mass approach- no continuation of fragmented and articulated mass execution
(-) no differentatiaon or specific space allocations and provisions in terms of different functions / facilites located iwthin the complex

YDA CENTER_MIXED USE DEVELOPMENT
ANKARA-TURKEY

GENERAL VIEW

A.13. YDA Center MXD Complex_A2_ Analyses Set

PHYSICAL SUSTAINABILITY

(-) one lineear block having an exessive length with no articulation in edges.

(+) Icocated in north- south orientation

(-) all facade treatment excatly same (for office units and residentials)- independent from orientation

(-) units located to west and east, no solar protection or shading or aother protection treatement from solar radiaton and excessive sun exposure

(-)no facade treatment for passive system utilization

(-) too close and parallel located orientation with Eskisehir road (pollution, noise and pedestrian accessiblity problems)

(+/-) roof utilized with terracing in east-west directions to acomodate terrace having units , however no shading provision

(-) no landscape or natural element dominated outdoor space provision for users

(-) negative impact on surrounding in terms of wind circulation and sun blockage

ECONOMICAL SUSTAINABILITY

(+) in between many different facilitis, high existing land value- therefore high rates potential in sales

(+) nearby functions' (offices nearby, mixed use facilities supply) / landuse potential for RoI,

SOCIAL AND CULTURAL SUSTAINABILITY

(+) Social interaction possibility with respect to mixed facilities, public gathering possibilities included.

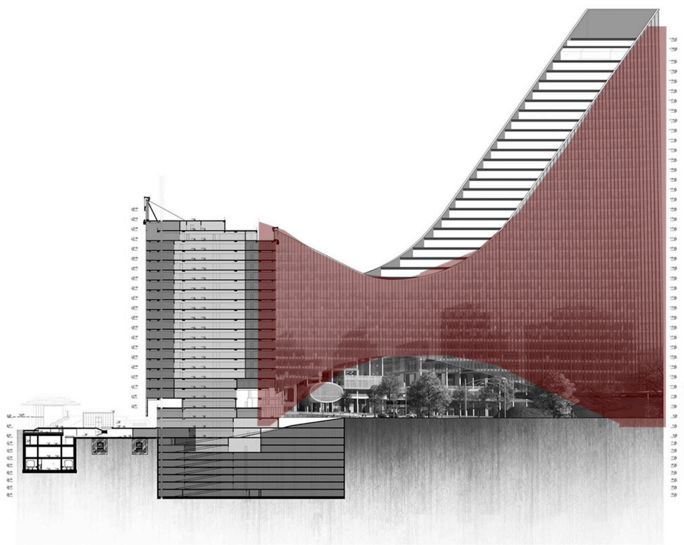
(+) sevral mixed-use functions and varios typoogies with different facilties are exsitng all around

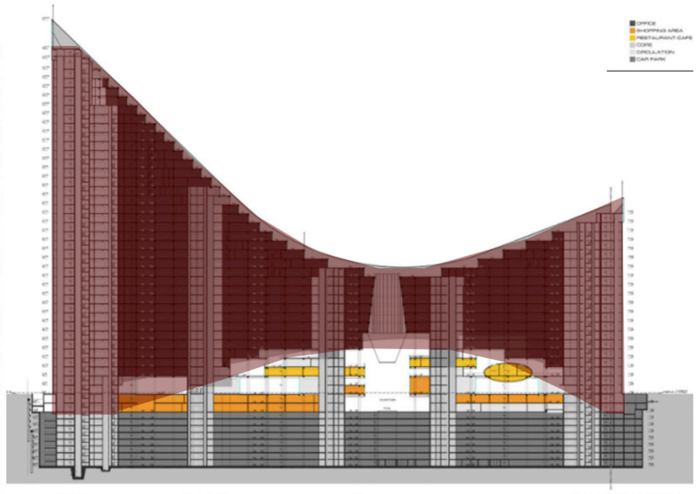
CONTEXTUAL SUSTAINABILITY

(+) project site is in consistency with the context, in terms of
- -continuation of similar typologies,
- -supporting facilities,
- -potential user groups,
- -public use continuity provision

(+) necessary infrastructure has already been provided

(-) inconsistency in terms of building mass dimensions and mass articulation approaches





ENVIRONMENTAL SUSTAINABILITY

(-) blockage of sun and wind circulation for existing surrounding developments

(-) excessive sun exposure to east west oriented units without any protection

(-) no facade articulation for that much of a continous lineear block

(-) no passive system utilzation on north & south facades

(-) curtain wall selection and applicationfor the whole facedes on north and south

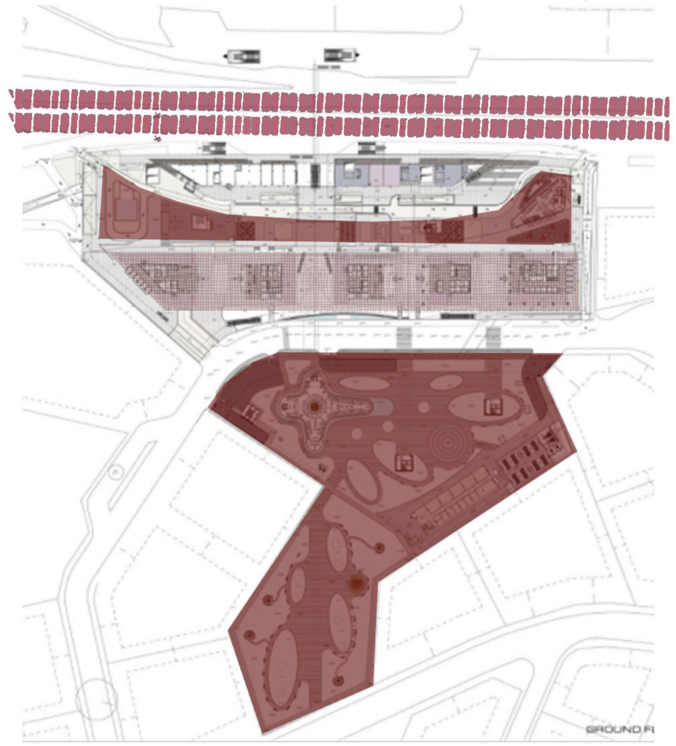
(-) monolithic and megastructure mass approach- no continuation of fragmented and articulated mass execution

(-) no differentatiaon or specific space allocations and provisions in terms of different functions / facilites located iwthin the complex

(+) subway connection for pubiic access.

(+) sufficient closed underground car-parking provision

(+) design and provision of an urban park in southern side of the complex for a buffer zone



YDA CENTER_MIXED USE DEVELOPMENT
ANKARA-TURKEY

GROUND FLOOR PLAN

A.14. YDA Center MXD Complex_A3_ Analyses Set

CONTEXTUAL SUSTAINABILITY

(+/-) project site is in consistency with the context, in terms of

- -continuation of similar typologies,(fnancial center)
- -supporting facilitiesto support the daily patterns of employees / users ,
- -interaction & continuity of user groups,
- -public use continuity provision

(+) necessary infrastructure has already been provided

(+) consistent with existing plan notes, regulations, urban planning strategies

ECONOMICAL SUSTAINABILITY

(+) Nearby functions' (offices & mixed use facilities supply in the suoorunding)

(+) governmental land , therefore no RoI intenti-on----however land value increase

SOCIAL AND CULTURAL SUSTAINABILITY

(+)Social interaction possibility with respect to mixed facilities, public gathering possibilities included.

PHYSICAL SUSTAINABILITY

(+) general mass design approach has been divided into three in vertical and tilted to enhance daylight

(+) all officces and spaces have direct sun & day light and natural ventilation opoorunuties

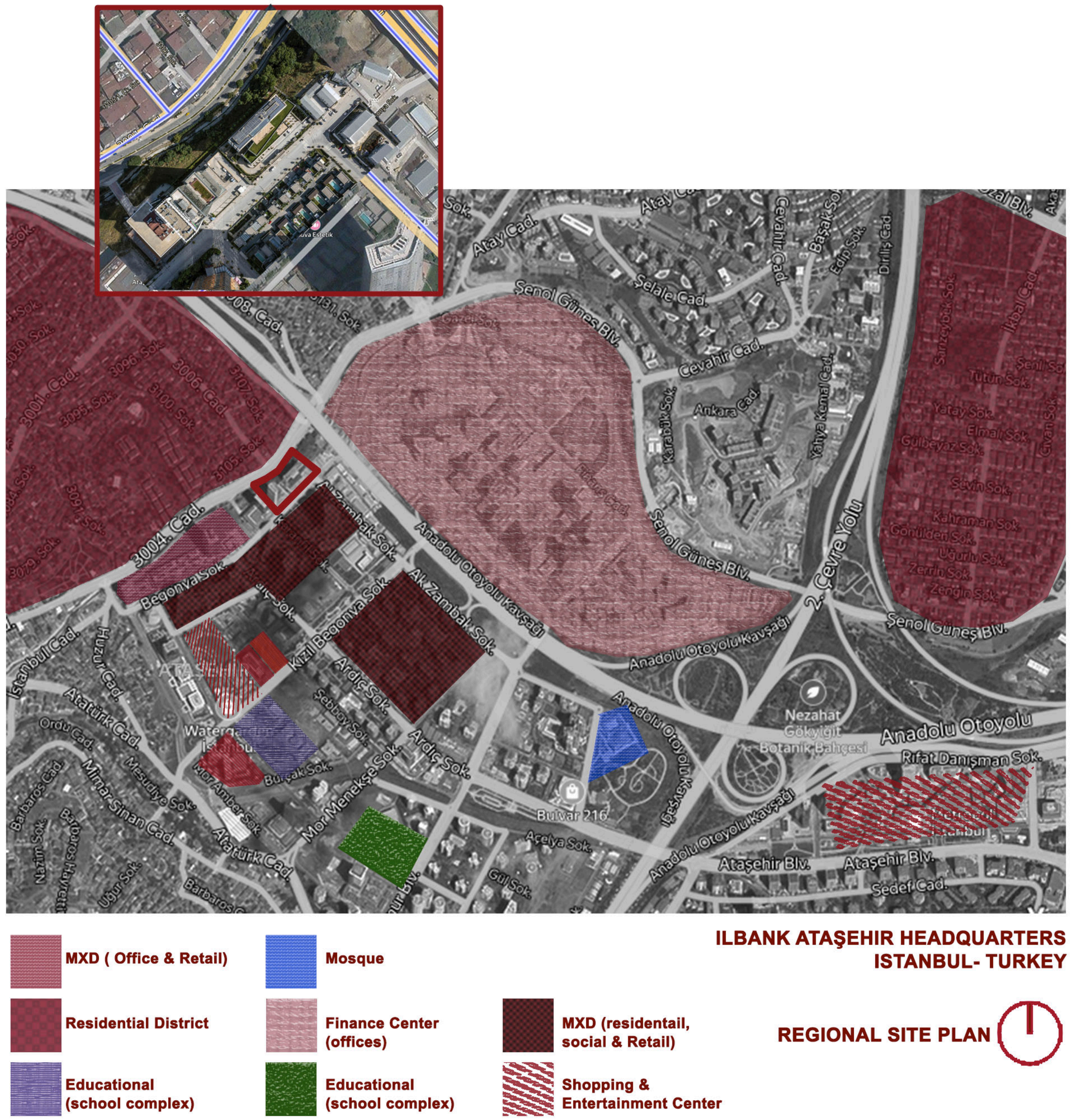
(+) general layout is SE, NW orientation,

(+) best utilization of topography on the north side, with basement floors

i. caroark in burried parts and

occupational areas in exposed parts to have direct sun & daylight & ventilation

(+) all set back roofs in lower grounds are utilizaed as green recreational terraces



A.15. Ilbank HQ _A1_Analyses Set

CONTEXTUAL SUSTAINABILITY

(+/-) project site is in consistency with the context, in terms of

- -continuation of similar typologies,(fnancial center)
- -supporting facilitiesto support the daily patterns of employees / users ,
- -interaction & continuity of user groups,
- -public use continuity provision

(+) necessary infrastructure has already been provided

(+) consistent with existing plan notes, regulations, urban planning strategies

(+) infrastructural appropriateness, road access suffici-cent

ECONOMICAL SUSTAINABILITY

(+) Nearby functions' (offices & mixed use facilities supply in the suoorunding)

(+) governmental land , therefore no RoI intenti-on----however land value increase

SOCIAL AND CULTURAL SUSTAINABILITY

(+)Social interaction possibility with respect to mixed facilities, public gathering possibilities included.

PHYSICAL SUSTAINABILITY

(+) general mass design approach has been divided into three in vertical and tilted to enhance daylight

(+) all officces and spaces have direct sun & day light and natural ventilation opoorunuties

(+) general layout is SE, NW orientation,

(+) best utilization of topography on the north side, with basement floors

i. caroark in burried parts and

occupational areas in exposed parts to have direct sun & daylight & ventilation

(+) all set back roofs in lower grounds are utilizaed as green recreational terraces

ENVIRONMENTAL SUSTAINABILITY

(+)mass articulation- appropriate to indoor-out-door utilization

(+) respectful height allocation within the sur-rounding

(-) disconnecton with backside road access- due to topography

(+) maximum and efficient utilization of harsh topography (by allocation of closed car park and other occupational spaces)

(-)with the surrounding high-rises excessive shadow projection on the mass

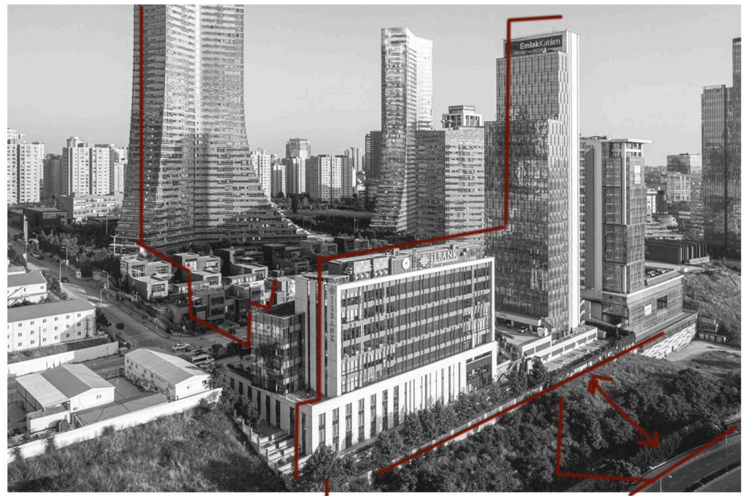
(-)insufficient shading elements on south-east side

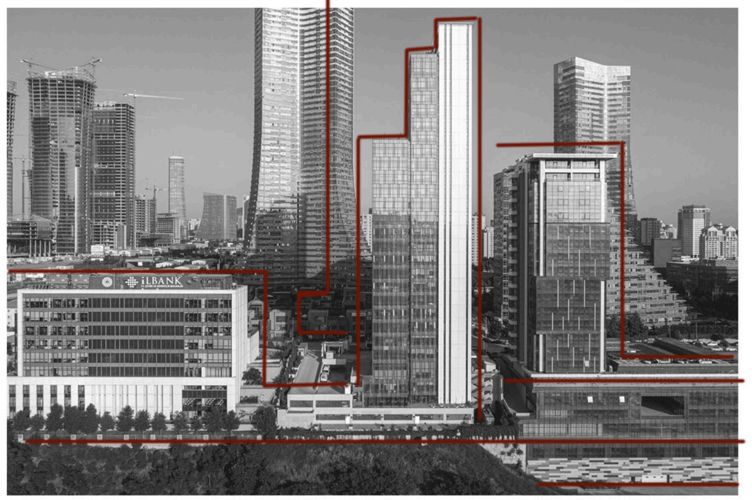
(+) location far away from high rise blocks

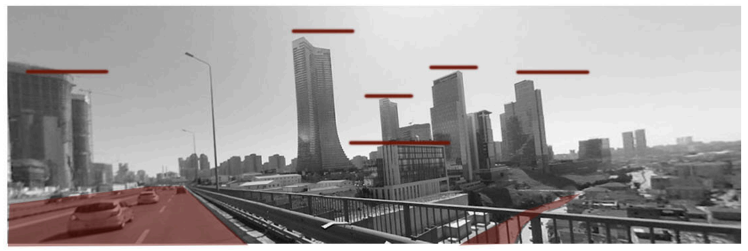
(+)direct day-light and sunlight acheievement and natural ventilation provision to all spaces within the complex

(+) cross ventilation possibility with the atrium inside the building

(+) appropriate division of blocks for different functions, therefore optimization and efficiency of use in different time intervals, durations- in terms of supporting / enhancing sustainability







ILBANK ATAŞEHIR HEADQUARTERS
ISTANBUL- TURKEY

GENERAL VIEW

A.16. Ilbank HQ _A2_Analyses Set

CONTEXTUAL SUSTAINABILITY

(+/-) project site is in consistency with the context, in terms of

- -continuation of similar typologies,(fnancial center)
- -supporting facilitiesto support the daily patterns of employees / users ,
- -interaction & continuity of user groups,
- -public use continuity provision

(+) necessary infrastructure has already been provided

(+) consistent with existing plan notes, regulations, urban planning strategies

(+) infrastructural appropriateness, road access sufficicent

ECONOMICAL SUSTAINABILITY

(+) Nearby functions' (offices & mixed use facilities supply in the suoorunding)

(+) governmental land , therefore no RoI intenti-on----however land value increase

SOCIAL AND CULTURAL SUSTAINABILITY

(+)Social interaction possibility with respect to mixed facilities, public gathering possibilities included.

PHYSICAL SUSTAINABILITY

(+) general mass design approach has been divided into three in vertical and tilted to enhance daylight

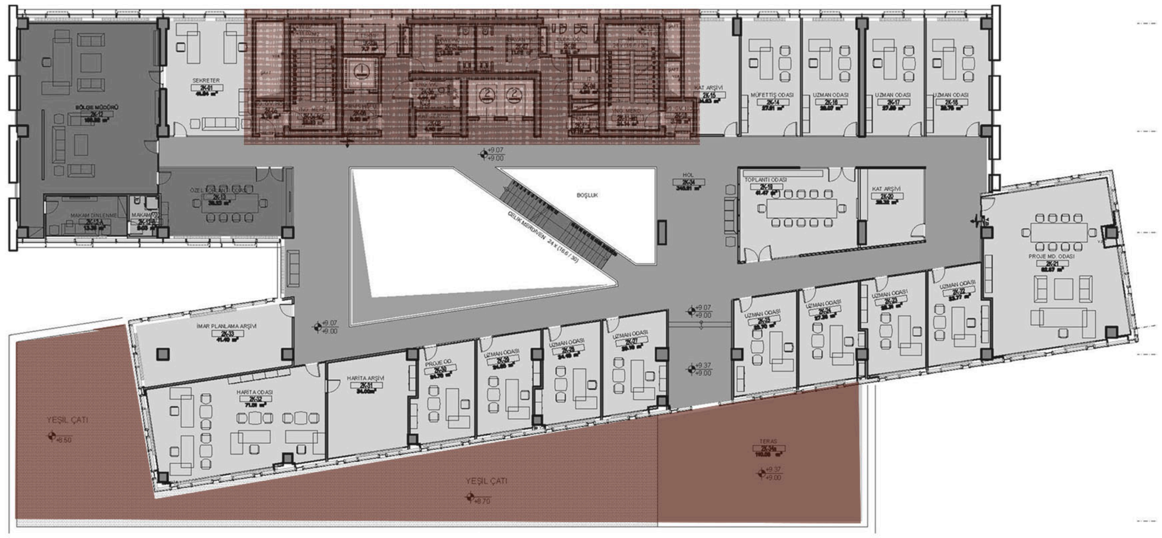
(+) all officces and spaces have direct sun & day light and natural ventilation opoorunuties

(+) general layout is SE, NW orientation,

(+) best utilization of topography on the north side, with basement floors (carpark in burried parts and occupational areas in exposed parts to have direct sun & daylight & ventilation)

(+) all set back roofs in lower grounds are utilizaed as green recreational terraces

(+) service cores and technical rooms located on north



ENVIRONMENTAL SUSTAINABILITY

(+)mass articulation- appropriate to indo-or-outdoor utilization

(+) respectful height allocation within the surrounding

(-) disconnecton with backside road access-due to topography

(+) maximum and efficient utilization of harsh topography (by allocation of closed car park and other occupational spaces)

(-)with the surrounding high-rises excessive shadow projection on the mass

(-)insufficient shading elements on south-east side

(+) location far away from high rise blocks

(+)direct day-light and sunlight acheievement and natural ventilation provision to all spaces within the complex

(+) cross ventilation possibility with the atrium inside the building

(+) appropriate division of blocks for different functions, therefore opti-mization and efficiency of use in different time intervals, durations- in terms of supporting / enhancing sustainability

(+) sports areas and pool in the open air orientation is correct in terms of sun light achievement

ILBANK ATAŞEHIR HEADQUARTERS
ISTANBUL- TURKEY

FLOOR PLAN

A.17. Ilbank HQ _A3_Analyses Set

PHYSICAL SUSTAINABILITY

(+) no setback or outdoor space allocation for outdoor usage- gathering or microclimate

(-)office block is located to east-west drirections inappropriate for office function due to sun exposure

(-)no special facade treatment for passive system utilization

(-) uniform treatment for all sides (not adjusted for north-east- west)

(-) underutilised roof usage

(-) east west orientation for office function requires excessive cooling requirement- unnecessary energy consumption

ECONOMICAL SUSTAINABILITY

(+) government investment- no land value concerns or RoI priority

(+) nearby functions' (offices nearby, mixed use facilities supply) / landuse potential for RoI,

SOCIAL AND CULTURAL SUSTAINABILITY

(+) no Social interaction possibility with respect to lack of public gathering possibilities

(+) No retail , social facilities around

(+) housing and hospitality functons around suporting office function

CONTEXTUAL SUSTAINABILITY

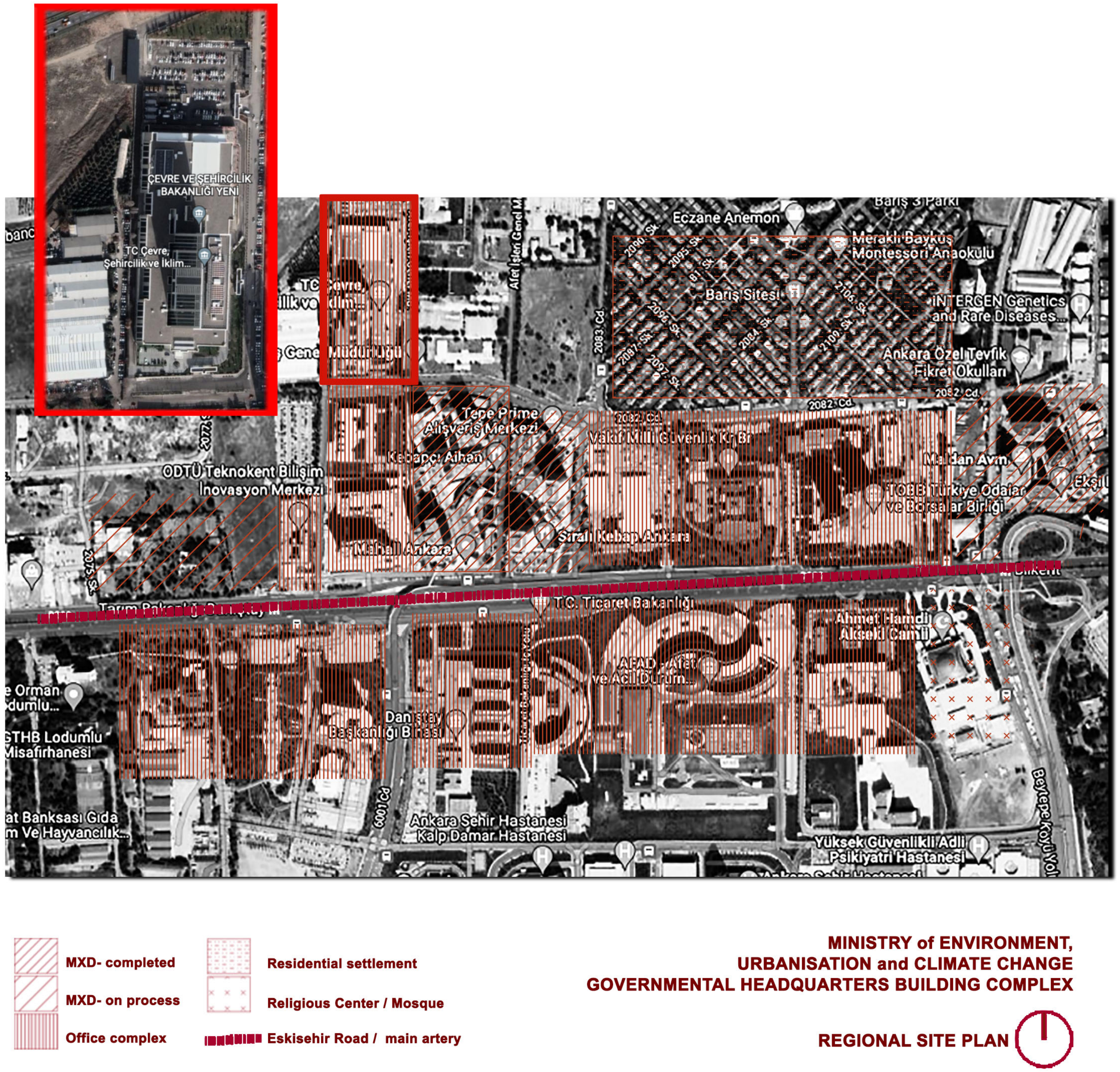
(+) project site is in consistency with the context, in terms of

- -continuation of similar typologies,
- -supporting facilities,
- -potential user groups,
- -public use continuity provision

(+) necessary infrastructure has already been provided

(+) consistent with existing plan notes, regulations, urban planning strategies

(-) no open public use possibility - no neighbourhood dialague , closed gated settlement



A.18. MoE HQ _A1_Analyses Set

PHYSICAL SUSTAINABILITY

(+) no setback or outdoor space allocation for out-door usage- gathering or microclimate

(-)office block is located to east-west drirections inappropriate for office due to sun exposure

(-)no special facade treatment for passive system utilization

(-) uniform treatment for all sides (not adjusted for north-east- west)

(-) underutilised roof usage

(-) east west orientation for office function requi-res excessive cooling requirement- unnecessary energy consumption

ECONOMICAL SUSTAINABILITY

(+) government investment- no land value concerns or RoI priority

(+) nearby functions' (offices nearby, mixed use facilities supply) / landuse potential for RoI,

SOCIAL AND CULTURAL SUSTAINABILITY

(+) no Social interaction possibility with respect to lack of public gathering possibilities

(+) No retail , social faciliies around

(+) housing and hospitality functons around suppor-ting office function

CONTEXTUAL SUSTAINABILITY

(+) project site is in consistency with the context, in terms of

- -continuation of similar typologies,
- -supporting facilities,
- -potential user groups,

(+) necessary infrastructure has already been provided (wide surrounding acess road provision)

(+) consistent with existing plan notes, regulati-ons, urban planning strategies

(-) no open public use possibility - no neighbour-hood dialague , closed gated settlement

(+) road access utility from all sides

ENVIRONMENTAL SUSTAINABILITY

(-)mass articulation- no concerns or sensitivity to surrounding

(+) respectful height allocation within the surroun-ding- set back balances height

(-) disconnecton with suoorunding due to walls-gated settlement

(-) no special space design or provision all massive block design

(+) due to set back no excessive shadow cassting to surrounding

(-)no facade treatment due to sun- wind control

(-)no shading elements on south-east side

(+)same facade treatment in low rise and high rise parts- inapproriate/ incocnsistent from functions al-located

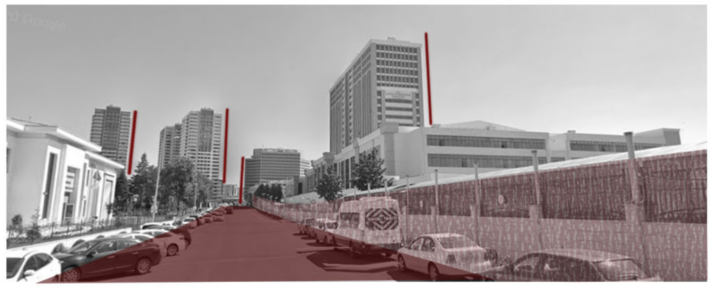
(+)direct day-light and sunlight acheievement and natural ventilation provision to all spaces within the complex

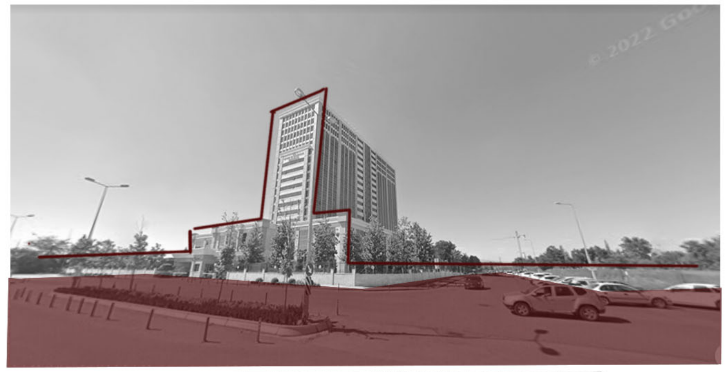
(+) cross ventilation possibility with the atrium inside the building

(-) no roof utilization for Solar panels or green roof on the low rise block

(-) mostly curtain wall cladding in East ans west facade limited openable window wystem for direct fresh air

(-)excessive outdoor surfiliniear car park within the site





MINISTRY of ENVIRONMENT, URBANISATION and CLIMATE CHANGE GOVERNMENTAL HEADQUARTERS BUILDING COMPLEX

GENERAL VIEW

A.19. MoE HQ _A2_Analyses Set

PHYSICAL SUSTAINABILITY

(+) no setback or outdoor space allocation for outdoor usage- gathering or microclimate
(-)office block is located to east-west drirections inappropriate for office function due to sun exposure
(-)no special facade treatment for passive system utilization
(-) uniform treatment for all sides (not adjusted for north-east- west)
(-) underutilised roof usage
(-) east west orientation for office function requires excessive cooling requirement- unnecessary energy consumption

ECONOMICAL SUSTAINABILITY

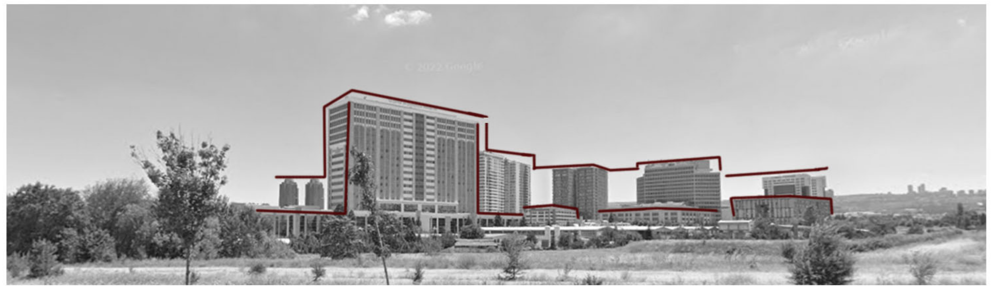
(+) government investment- no land value concerns or RoI priority
(+) nearby functions' (offices nearby, mixed use facilities supply) / landuse potential for RoI,

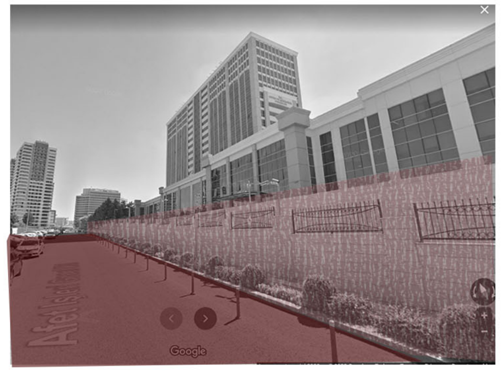
SOCIAL AND CULTURAL SUSTAINABILITY

(+) no Social interaction possibility with respect to lack of public gathering possibilities
(+) No retail , social facilies around
(+) housing and hospitality functons around suporting office function

CONTEXTUAL SUSTAINABILITY

(+) project site is in consistency with the context, in terms of
-continuation of similar typologies,
-supporting facilities,
-potential user groups,
-public use continuity provision
(+) necessary infrastructure has already been provided
(+) consistent with existing plan notes, regulations, urban planning strategies
(-) no open public use possibility - no neighbourhood dialague , closed gated settlement





ENVIRONMENTAL SUSTAINABILITY

(-)mass articulation- no concerns or sensitivity to surrounding
(+) respectful height allocation within the surrounding- set back balances height
(-) disconnecton with suoorunding due to walls- gated settlement
(-) no special space design or provision all massive block design
(+) due to set back no excessive shadow cassting to surrounding
(-)no facade treatment due to sun- wind control
(-)no shading elements on south-east side
(+)same facade treatment in low rise and high rise parts- inapproriate/ incocnsistent from functions allocated
(+)direct day-light and sunlight acheievement and natural ventilation provision to all spaces within the complex
(+) cross ventilation possibility with the atrium inside the building
(-) no roof utilization for Solar panels or green roof on the low rise block
(-) mostly curtain wall cladding in East ans west facade limited openable window wystem for direct fresh air

MINISTRY of ENVIRONMENT,
URBANISATION and CLIMATE CHANGE
GOVERNMENTAL HEADQUARTERS BUILDING COMPLEX

CLOSE UP / DETAILS

A.20. MoE HQ _A3_Analyses Set

CONTEXTUAL SUSTAINABILITY

(+) project site is in consistency with the context, in terms of
- -continuation of similar typologies,
- -supporting facilitiesin the surrounding,
- -potential user groups,
- -public use continuity provision

(+) necessary infrastructure has already been provided

(+) consistent with existing plan notes, regulations, urban planning strategies

ECONOMICAL SUSTAINABILITY

(+) no landvalue concern

fore no RoI intention----however land value increase

SOCIAL AND CULTURAL SUSTAINABILITY

(+)consistency of functional continuity among other governmental and/ or office buildings

(+) due to a high dense main road, ease of accessibility for users

(4) due to provision of MXD centers in the surrounding social and cultural use for users

PHYSICAL SUSTAINABILITY

(+) main mass has been oriented to north (offices) but with a treatment of double skin to protect cold wind - as well as south with some sun hading elements

(+) all offices and spaces have direct sun & day light and natural ventilation opportunities

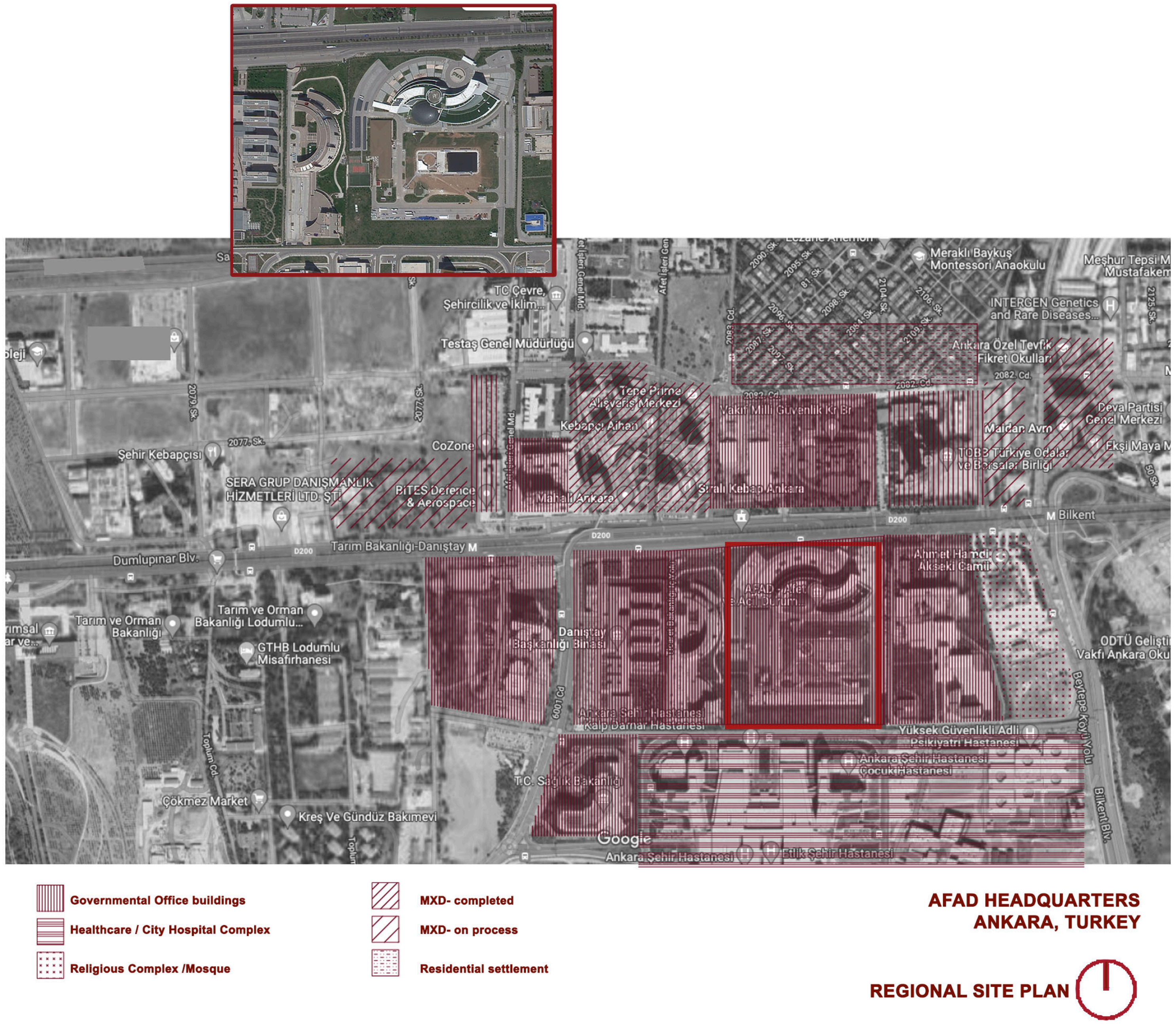
(+) general layout is S-N orientation,

(+) outdoor courtyard for public use oriented to south

(+) green roof on the first floor terraces

(-) a glass dome-roofed geodesic semi sphere space in between of curvilinear masses, oriented to south - excessive sun exposure

(-) no green massive utilization for outdoor climatic control in outdoor spaces



A.21. AFAD HQ _A1_Analyses Set

CONTEXTUAL SUSTAINABILITY

(+) project site is in consistency with the context, in terms of
- continuation of similar typologies,
- supporting facilitiesin the surrounding,
- potential user groups,
- public use continuity provision

(+) necessary infrastructure has already been provided

(+) consistent with existing plan notes, regulations, urban planning strategies

ECONOMICAL SUSTAINABILITY

(+) no land value concern, therefore no RoI intention

(+) efficient utilization of functions by maximum user capacity , therefore optmised utilization of investment

SOCIAL AND CULTURAL SUSTAINABILITY

(+)consistency of functional continuity among other governmental and/ or office buildings

(+) due to a high dense main road, ease of accessibility for users

(+) due to provision of MXD centers in the surrounding social and cultural use for users

PHYSICAL SUSTAINABILITY

(+) main mass has been oriented to north (offices) but with a treatment of double skin to protect cold wind - as well as south with some sun hading elements

(+) all offices and spaces have direct sun & day light and natural ventilation opportunities

(+) general layout is S-N orientation,

(+) outdoor courtyard for public use oriented to south

(+) green roof on the first floor terraces

(-) a glass dome-roofed geodesic semi sphere space in between of curvilinear masses, oriented to south - excessive sun exposure

(-) no green massive utilization for outdoor climatic control in outdoor spaces

ENVIRONMENTAL SUSTAINABILITY

(+) respectful height allocation within the surrounding

(+) different treatments on facades due to different orientations (north vs south facades)

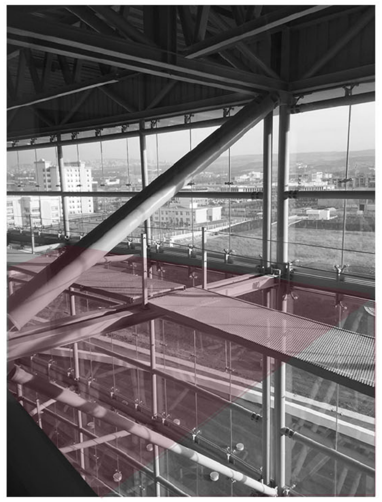
(+)indoor gardens (double skin) utilization to prevent heat loss and cold exposure via direct facades for offices located on north

(+/-)indirect day-light and sunlight acheievement and natural ventilation provision to all spaces within the complex

(+) cross ventilation possibility inside the building

(+) appropriate division for different functions, therefore optimization and efficiency in different time intervals, durations- in terms of supporting / enhancing sustainability

(+) utilization of roof as green terrace (prevent excessive solar radiation)



AFAD HEADQUARTERS
ANKARA- TURKEY

GENERAL VIEW

A.22. AFAD HQ _A2_Analyses Set

CONTEXTUAL SUSTAINABILITY

(+) project site is in consistency with the context, in terms of
- continuation of similar typologies,
- supporting facilitiesin the surrounding,
- potential user groups,
- public use continuity provision

(+) necessary infrastructure has already been provided
(+) consistent with existing plan notes, regulations, urban planning strategies

ECONOMICAL SUSTAINABILITY

(+) no land value concern, therefore no RoI intention
(+) efficient utilization of functions by maximum user capacity , therefore optmised utilization of investment

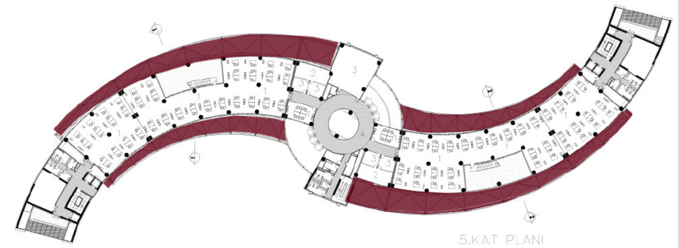
SOCIAL AND CULTURAL SUSTAINABILITY

(+)consistency of functional continuity among other governmental and/ or office buildings
(+) due to a high dense main road, ease of accessibility for users
(+) due to provision of MXD centers in the surrounding social and cultural use for users

PHYSICAL SUSTAINABILITY

(+) main mass has been oriented to north (offices) but with a treatment of double skin to protect cold wind - as well as south with some sun hading elements
(+) all offices and spaces have direct sun & day light and natural ventilation opportunities
(+) general layout is S-N orientation,
(+) outdoor courtyard for public use oriented to south
(+) green roof on the first floor terraces
(-) a glass dome-roofed geodesic semi sphere space in between of curvilinear masses, oriented to south - excessive sun exposure
(-) no green massive utilization for outdoor climatic control in outdoor spaces

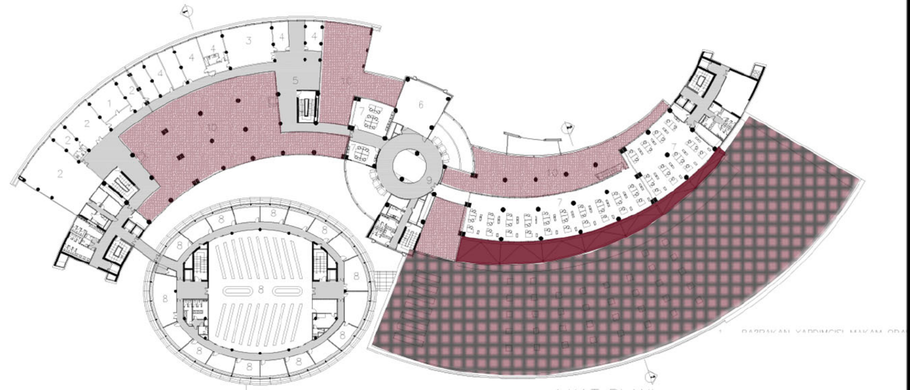
1-1 KESITI



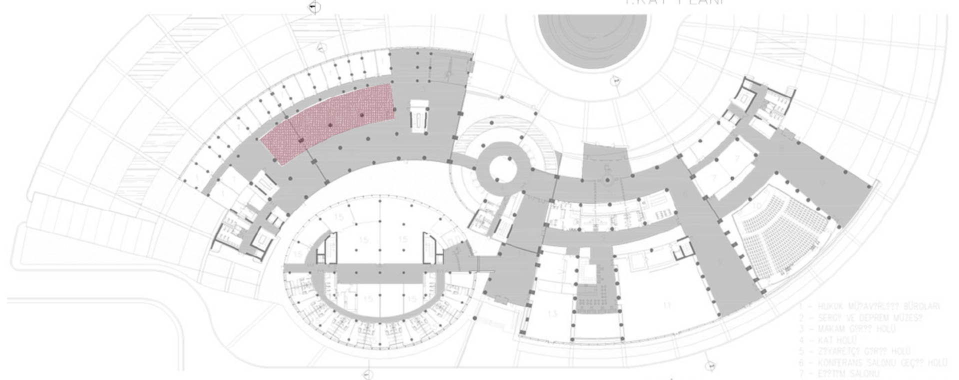
5.KAT PLANI

ENVIRONMENTAL SUSTAINABILITY

(+) respectful height allocation within the surrounding
(+) different treatments on facades due to diffeent orientations (north vs south facades)
(+)indoor gardens (double skin) utilization to prevent heat loss and cold exposure via direct facades for offices located on north
(+/-)indirect day-light and sunlight acheievement and natural ventilation provision to all spaces within the complex
(+) cross ventilation possibility inside the building
(+) appropriate division for different functions, therefore optimization and efficiency in different time intervals, durations- in terms of supporting / enhancing sustainability
(+) utilization of roof as green terrace (prevent excessive solar radiation)



1.KAT PLANI



ZEMIN KAT

AFAD HEADQUARTERS
ANKARA- TURKEY

GROUND FLOOR PLAN

A.23. AFAD HQ _A3_Analyses Set

CONTEXTUAL SUSTAINABILITY

(-) project site is far away from any settlement / urban or suburban development
(-) no contextual / programmatic continuation (on the high speed road with temporary facility allocations rather)
(-) necessary infrastructure has already constrcuted specifically
(+) impact on existing plan notes, regulations, urban planning strategies

ECONOMICAL SUSTAINABILITY

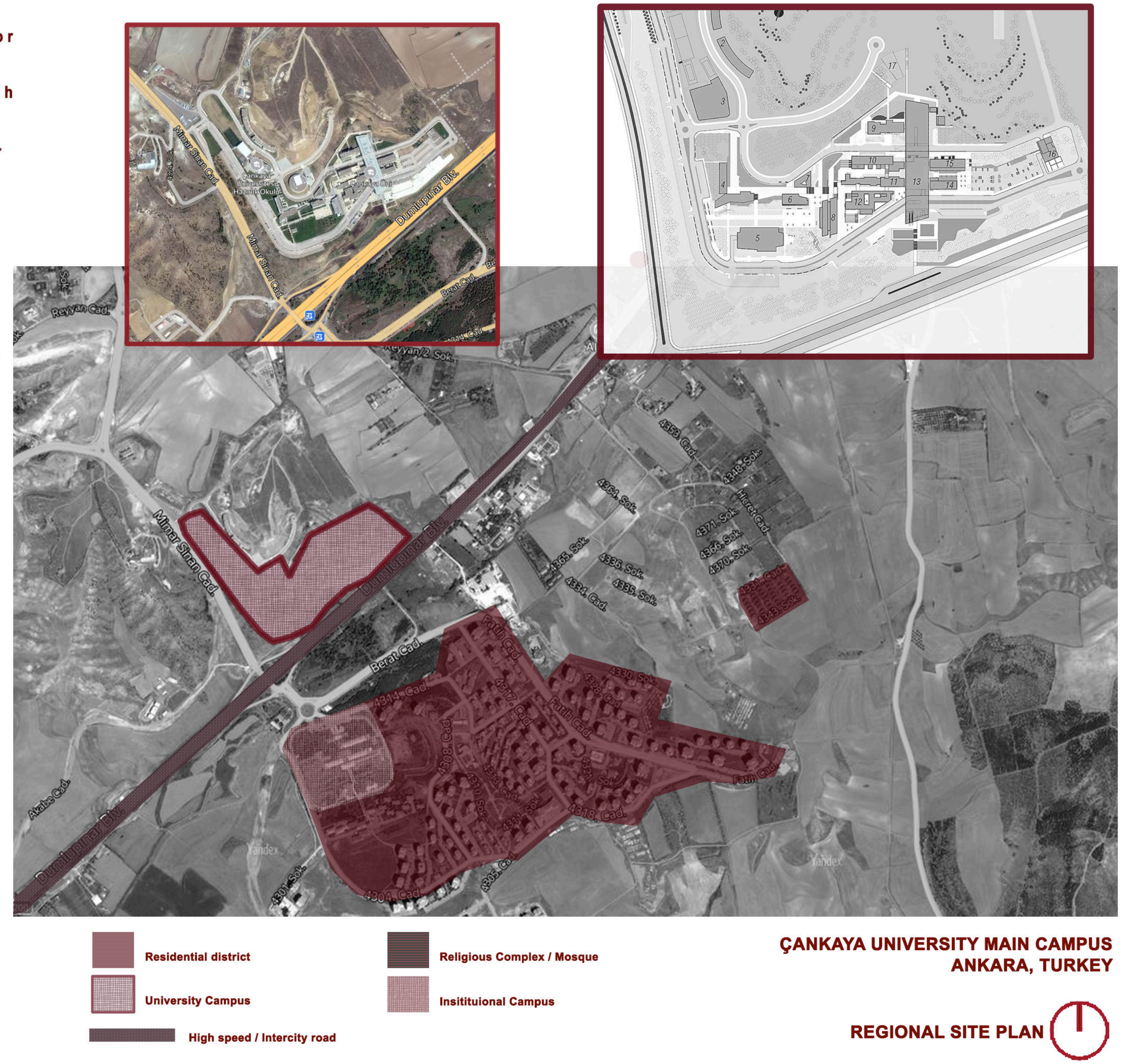
(+) affordable land investment
(+) may raise a land value increase,
(+) catalysing impact on nearby surrounding land values as well
fore no RoI intention----however land value increase

SOCIAL AND CULTURAL SUSTAINABILITY

(-) no supporting or alterntaive use of fuctions for users (students, academic or staff)
(+) due to a high spped main road,no easy access to public transportation, no walkable access
(+/-) recent start of residential district evolutions for accomodation nearby but insufficient

PHYSICAL SUSTAINABILITY

(-) most of the blocks have been oriented to north / south orientation
(-) no access from main artery (Eskisehir road) due to topography- level difference
(-) no protected courtyards for outdoor space utilization
(-) no green / terrace roof utilization
(-) no green massive utilization for outdoor climatic control in outdoor spaces
(-)



A.24. Cankaya University Campus _A1_Analyses Set

CONTEXTUAL SUSTAINABILITY

(-) project site is far away from any settlement / urban or suburban development
(-) no contextual / programmatic continuation (on the high speed road with temporary facility allocations rather)
(-) necessary infrastructure has already constrcuted specifically
(+) impact on existing plan notes, regulations, urban planning strategies

ECONOMICAL SUSTAINABILITY

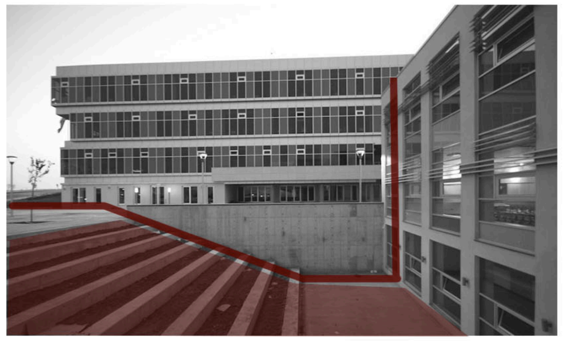
(+) affordable land investment
(+) may raise a land value increase,
(+) catalysing impact on nearby surrounding land values as well

SOCIAL AND CULTURAL SUSTAINABILITY

(-) no supporting or alterntaive use of fuctions for users (students, academic or staff)
(+) due to a high spped main road,no easy access to public transportation, no walkable access
(+/-) recent start of residential district evolutions for accomodation nearby but insufficient

PHYSICAL SUSTAINABILITY

(-) most of the blocks have been oriented to north / south orientation
(-) no access from main artery (Eskisehir road) due to topography- level difference
(-) no protected courtyards for outdoor space utilization
(-) no green / terrace roof utilization
(-) no green massive utilization for outdoor climatic control in outdoor spaces
(+)provision of different outdoor spaces, level utilizations



ENVIRONMENTAL SUSTAINABILITY

(+) harmony with topography & utilization of level difference
(-) most block layouts are on Nourt-south orientation
(-) similar treatments on different facades (no passive energy utilization and treatment)
(+)different outdoor space provisions / opportunity for different space and use allocations inside the building
(-) very few allocation and utilization of green , soft landscape provision
(+)direct day-light and sunlight acheievement and natural ventilation provision to all spaces within the complex
(+) cross ventilation possibility

ÇANKAYA UNIVERSITY MAIN CAMPUS
ANKARA- TURKEY

GENERAL VIEW

A.25. Cankaya University Campus _A2_Analyses Set

CONTEXTUAL SUSTAINABILITY

(-) project site is far away from any settlement / urban or suburban development
(-) no contextual / programmatic continuation (on the high speed road with temporary facility allocations rather)
(-) necessary infrastructure has already constrcuted specifically
(+) impact on existing plan notes, regulations, urban planning strategies

ECONOMICAL SUSTAINABILITY

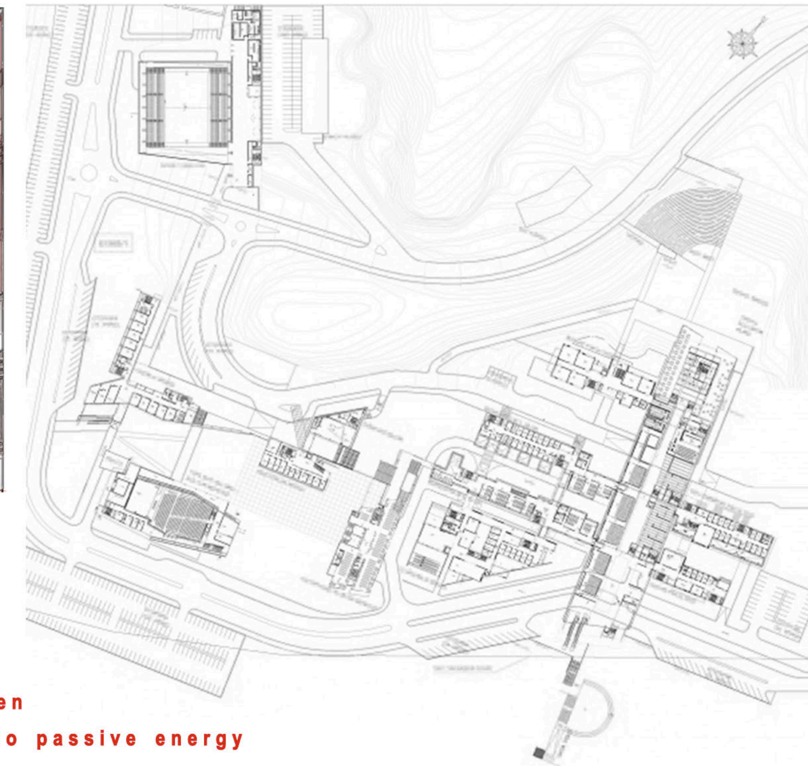
(+) affordable land investment
(+) may raise a land value increase,
(+) catalysing impact on nearby surrounding land values as well

SOCIAL AND CULTURAL SUSTAINABILITY

(-) no supporting or alterntaive use of fuctions for users (students, academic or staff)
(+) due to a high spped main road,no easy access to public transportation, no walkable access
(+/-) recent start of residential district evolutions for accomodation nearby but insufficient

PHYSICAL SUSTAINABILITY

(-) most of the blocks have been oriented to north / south orientation
(-) no access from main artery (Eskisehir road) due to topography- level difference
(-) no protected courtyards for outdoor space utilization
(-) no green / terrace roof utilization
(-) no green massive utilization for outdoor climatic control in outdoor spaces
(+)provision of different outdoor spaces, level utilizations



ENVIRONMENTAL SUSTAINABILITY

(+) harmony with topography & utilization of level difference
(-) most block layouts are on Nourt- south orien
(-) similar treatments on different facades (no passive energy utilization and treatment)
(+)different outdoor space provisions / opportunity for different space and use allocations
(+)direct day-light and sunlight acheievement and natural ventilation provision to all spaces within the complex
(+) cross ventilation possibility inside the building
(-) very few allocation and utilization of green , soft landscape provision

ÇANKAYA UNIVERSITY MAIN CAMPUS
ANKARA- TURKEY
GROUND FLOOR PLAN

A.26. Cankaya University Campus _A3_Analyses Set

CONTEXTUAL SUSTAINABILITY

(-) project site is far away from city center, requires private transportation or only school service

(-) surrounded by residential settlements

(+/-) only one contextual / programmatic continuation

(-) resulted in special infrastucture, massing and zoning layout outputs

(+) no ease of access and activity for students / staff to public amninities / different facilities in the surrounding to catalyse public gathering

ECONOMICAL SUSTAINABILITY

(+) affordable(remote and economic) land value for initial investment investment

(+) causing a raise in land value,

(+) catalysing impact on nearby surrounding land values as well

fore no RoI intention----however land value increase

SOCIAL AND CULTURAL SUSTAINABILITY

(-) no supporting or alternative use of fuctions/ public services or facilities for users (students, academic or staff)

(+) due to suburban location, very few easy access to public transportation, and no walkable access

(+/-) introverted provision of social, recreational facilities for socialising and gathering

(-) no walkable campus design

PHYSICAL SUSTAINABILITY

(-)no consistent orientation, layout strategy for the location and design of blocks

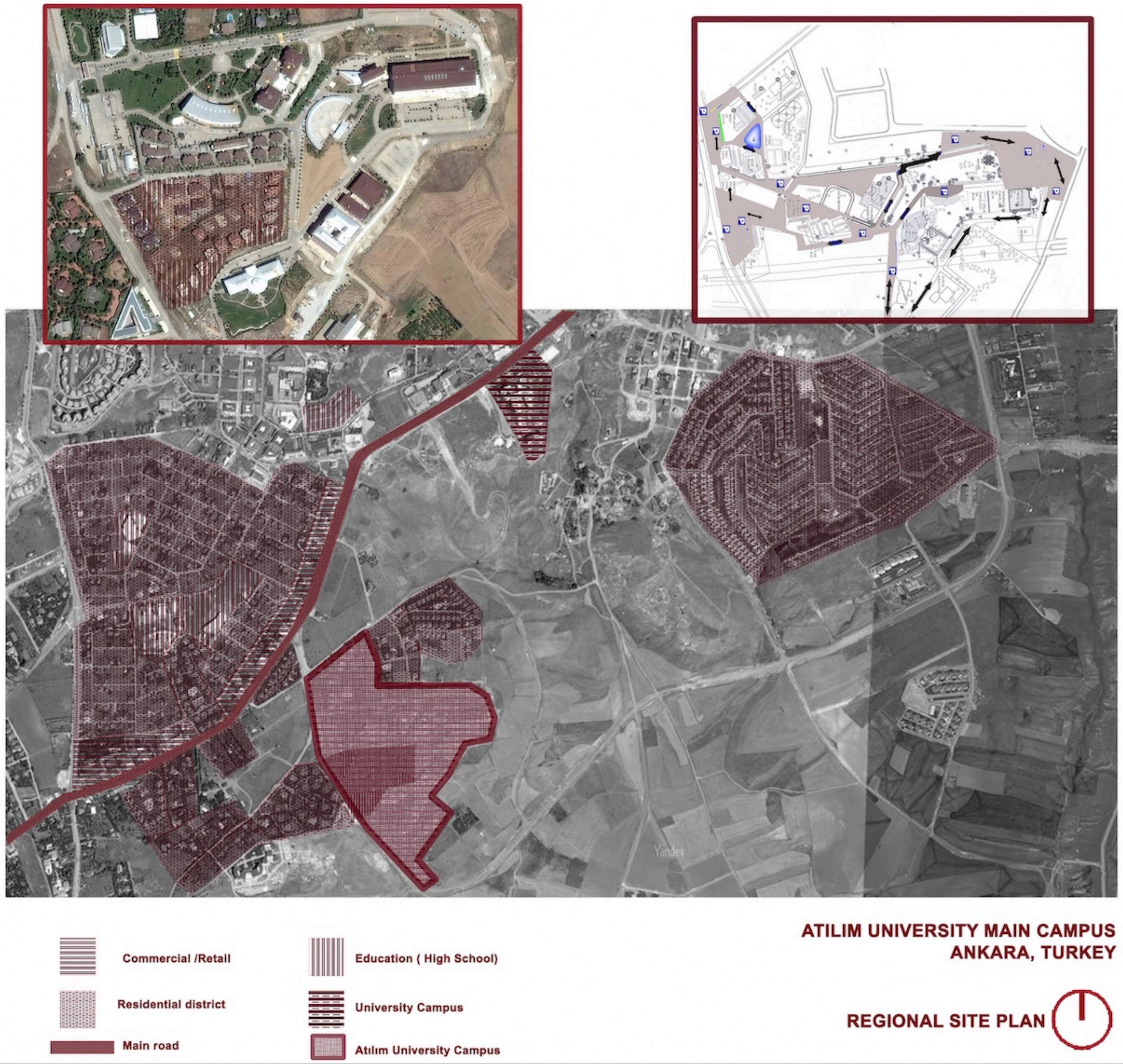
(-) no provision of passive systems or energy efficiency utilization due to main design layout and prıgram criteria

(-) no protected courtyards for outdoor space utilization

(-) no green / terrace roof utilization

(-) no green massive utilization for outdoor climatic control in outdoor spaces

(-) excessive surface car parking areas- resulting solar reflection and solar islands



A.27. Atılım University Campus _A1_Analyses Set

CONTEXTUAL SUSTAINABILITY

(-) project site is far away from city center, requires private transportation or only school service

(-) surrounded by residential settlements

(+/-) only one contextual / programmatic continuation

(-) resulted in special infrastucture, massing and zoning layout outputs

(+) no ease of access and activity for students / staff to public amninities / different facilities in the surrounding to catalyse public gathering

ECONOMICAL SUSTAINABILITY

(+) affordable(remote and economic) land value for initial investment investment

(+) causing a raise in land value,

(+) catalysing impact on nearby surrounding land values as well

fore no RoI intention----however land value increase

SOCIAL AND CULTURAL SUSTAINABILITY

(-) no supporting or alternative use of fuctions/ public services or facilities for users (students, academic or staff)

(+) due to suburban location, very few easy access to public transportation, and no walkable access

(+/-) introverted provision of social, recreational facilities for socialising and gathering

(-) no walkable campus design

PHYSICAL SUSTAINABILITY

(-)no consistent orientation, layout strategy for the location and design of blocks

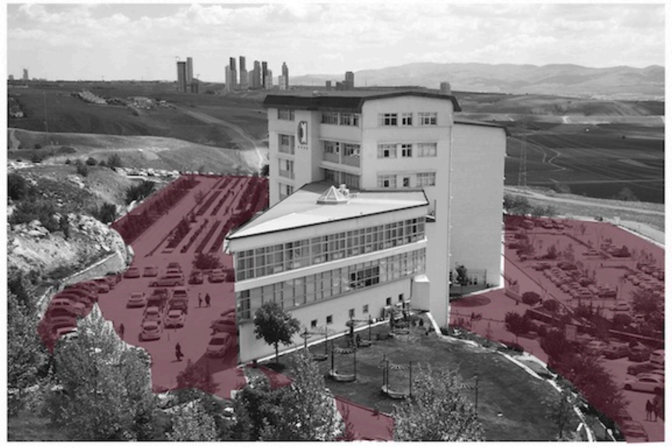
(-) no provision of passive systems or energy efficiency utilization due to main design layout and prıgram criteria

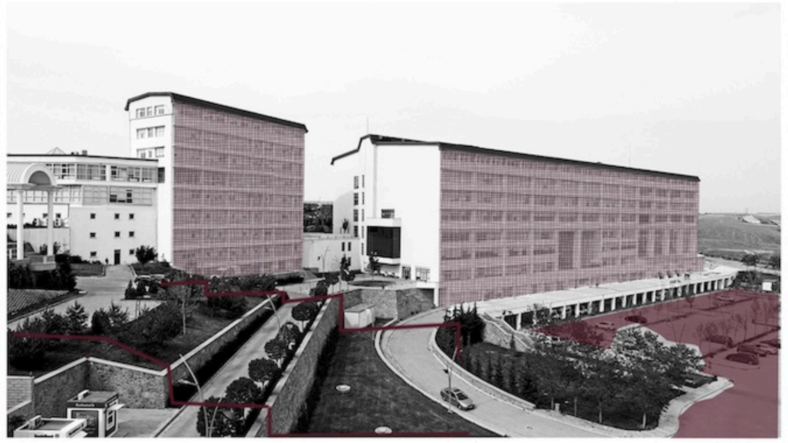
(-) no protected courtyards for outdoor space utilization

(-) no green / terrace roof utilization

(-) no green massive utilization for outdoor climatic control in outdoor spaces

(-) excessive surface car parking areas- resulting solar reflection and solar islands





ENVIRONMENTAL SUSTAINABILITY

(+) harmony with topography & utilization of level difference

(-) most block layouts are on Nourt- south orientation

(-) similar treatments on different facades (no passive energy utilization and treatment)

(+)different outdoor space provisions / opportunity for different space and use allocations inside the building

(-) very few allocation and utilization of green , soft landscape provision

ATILIM UNIVERSITY MAIN CAMPUS
ANKARA- TURKEY

GENERAL VIEW

A.28. Atılım University Campus _A2_Analyses Set

CONTEXTUAL SUSTAINABILITY

(-) project site is inconsistency with the context, in terms of fun-ction/ facility continuation
(-) necessary infrastructure stayed insufficient, thus extra roads, junctions and other infrastructural necessities developed and provided
(-)in terms of waste production as a health complex,too hazarda-ous to be in between of many residential public facilities
(+) creating a synergy in an underdeveloped environment
(-) in a considerably far location- thus hard to be accessed easily and quickly by citizens via public transportation

ECONOMICAL SUSTAINABILITY

(-) causing excessive travel hours due to its far location
(-) creatinga synergy, pull factor for the exsiting underdeveloped settlement
(-) low initial investment cost for the investor- since the plot is in an underdeveloped area

SOCIAL AND CULTURAL SUSTAINABILITY

(+)due to MXD centers nearby, for staff and users, social and com-mercial and cultural facility potential
(-) due to excessive footprint, no interaction among staff and users

PHYSICAL SUSTAINABILITY

(-) too large , excessive footprint area, hard for accesibility inter-nally within different sections
(-) no passive system utilization
(+) differentiation of inpatient rooms blocks from main outpatient center block
(-)no orientation concerns in terms of inpatient rooms block (no sun exposure or wind protection concerns and treatments)
(+/-) closed underground car park provision, however combined and excesivvely large footprint - costly to operate
(+)surrounding roads, drop-off areas and service / public transporta-tion nodes are insufficient
(-) no daylight and naturar air ci large circulation in many rooms of the main block due to excevssive footrpint

A.29. Losente Hospital Complex _A1_Analyses Set

CONTEXTUAL SUSTAINABILITY

(-) project site is inconsistency with the context, in terms of functi-on/ facility continuation
(-) necessary infrastructure stayed insufficient, thus extra roads, junctions and other infrastructural necessities developed and pro-vided
(-)in terms of waste production as a health complex,too hazardaous to be in between of many residential public facilities
(+) creating a synergy in an underdeveloped environment
(-) in a considerably far location- thus hard to be accessed easily and quickly by citizens via public transportation

ECONOMICAL SUSTAINABILITY

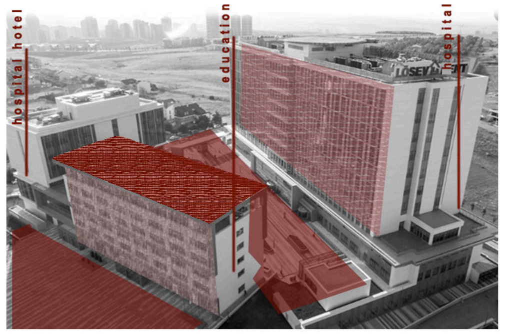
(-) causing excessive travel hours due to its far location
(-) creatinga synergy, pull factor for the exsiting underdeveloped settlement
(-) low initial investment cost for the investor- since the plot is in an underdeveloped area

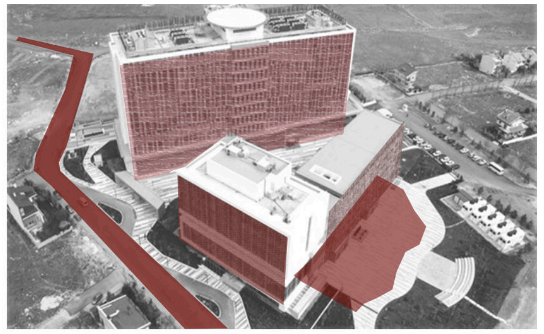
SOCIAL AND CULTURAL SUSTAINABILITY

(+)due to MXD centers nearby, for staff and users, social and com-mercial and cultural facility potential
(-) due to excessive footprint, no interaction among staff and users

PHYSICAL SUSTAINABILITY

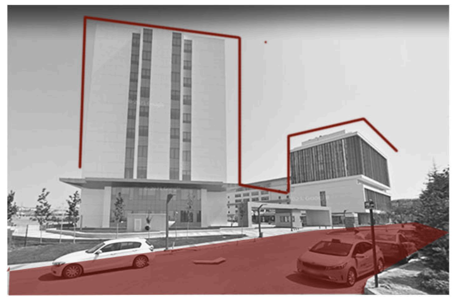
(-) too large , excessive footprint area, hard for accesibility inter-nally within different sections
(-) no passive system utilization
(+) differentiation of inpatient rooms blocks from main outpatient center block
(-)no orientation concerns in terms of inpatient rooms block (no sun exposure or wind protection concerns and treatments)
(+/-) closed underground car park provision, however combined and excesivvely large footprint - costly to operate
(+)surrounding roads, drop-off areas and service / public transporta-tion nodes are insufficient
(-) no daylight and naturar air ci large circulation in many rooms of the main block due to excevssive footrpint
(+) different facade treatments, for either different side/ orientati-





ENVIRONMENTAL SUSTAINABILITY

(+) no excessive solar exposed areas for outdoor usage
(+) more controlled microclimatic outdoor space provision
(-) natural (hazardous) waste production
(-) individual buildinmg blocks for control of different inter-val of usages / users -- energy saving
(+) individual building allcoation for different functions, saves excessive infrastructural requirement /supply
(-) underutilization of roof surfaces / no passive system uti-lization or no green roof
(-) similar facade trements for opposing facade orientation
(-)more soft landscape and volumetric use of trees / green wood could have been utilized especially for south oriented outdoor gathering areas for thermal comfort, and preventing solar radiation
(+) no car access in the campus



LOSENTE HOSPITAL COMPLEX, ANKARA ,TURKEY

GENERAL VIEW

A.30. Losente Hospital Complex _A2_Analyses Set

CONTEXTUAL SUSTAINABILITY

(-) project site is inconsistency with the context, in terms of function/ facility continuation
(-) necessary infrastructure stayed insufficient, thus extra roads, junctions and other infrastructural necessitiesdevelo-ped and provided
(-)in terms of waste production as a health complex,too ha-zardaous to be in between of many public facilities
(-) increasing already dense traffic existence occuring in the surrounding
(-) in a considerably far location- thus hard to be accessed easily and quickly by citizens

ECONOMICAL SUSTAINABILITY

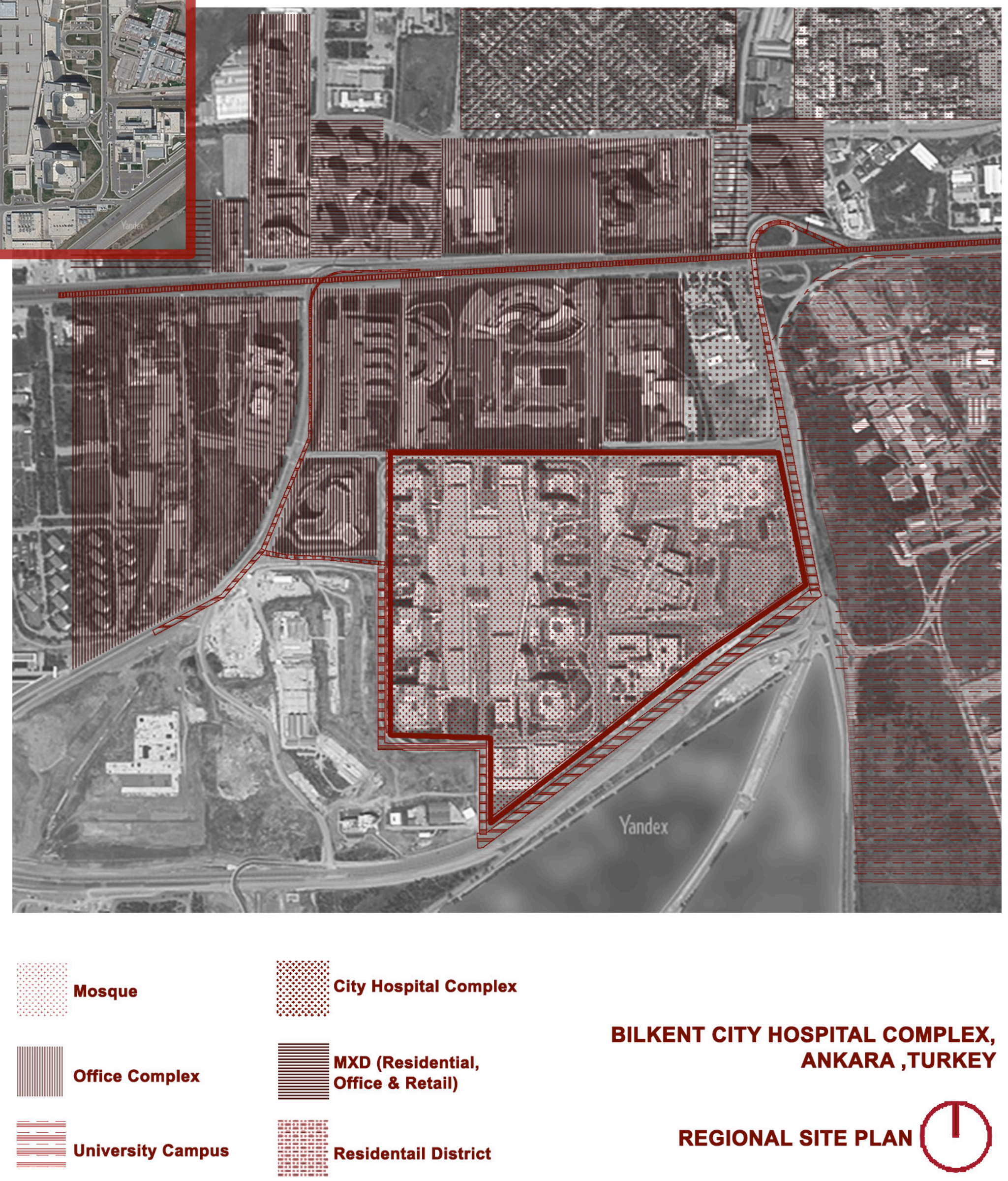
(-) causing excessive travel hours due to its far location
(-) required and resulted in an excessive amount of investment, due to unnecessary TBA, and footprint
(-) excessive operational cost consequences, due to one whole footprint and acvessive TBA , therefore no RoI intenti-on----however land value increase

SOCIAL AND CULTURAL SUSTAINABILITY

(+)due to MXD centers nearby, for staff and users, social and commercial and cultural facility potential
(-) due to excessive footprint, no interaction among staff and users

PHYSICAL SUSTAINABILITY

(-) too large , excessive footprint area, hard for accesibility internally within different sections
(-) no passive system utilization
(+) differentiation of inpatient rooms blocks from main outpatient center block
(-)no orientation concerns in terms of inpatient rooms block (no sun exposure or wind protection concerns and treatments)
(+/-) closed underground car park provision, however combined and excesivvely large footprint - costly to operate
(+)surrounding roads, drop-off areas and service / public transportation nodes are insufficient
(-) no daylight and naturar air ci large circulation in many rooms of the main block due to excevssive footrpint
(-) no outdoor usage or provision to users / staff



A.31. Ankara City Hospital Complex _A1_Analyses Set

CONTEXTUAL SUSTAINABILITY

(-) project site is inconsistency with the context, in terms of function/ facility continuation

(-) necessary infrastructure stayed insufficient, thus extra roads, junctions and other infrastructural necessitiesdeveloped and provided

(-)in terms of waste production as a health complex,too hazardaous to be in between of many public facilities

(-) increasing already dense traffic existence occuring in the surrounding

(-) in a considerably far location- thus hard to be accessed easily and quickly by citizens

ECONOMICAL SUSTAINABILITY

(-) causing excessive travel hours due to its far location

(-) required and resulted in an excessive amount of investment, due to unnecessary TBA, and footprint

(-) excessive operational cost consequences, due to one whole footprint and acvessive TBA , therefore no RoI intention----however land value increase

SOCIAL AND CULTURAL SUSTAINABILITY

(+)due to MXD centers nearby, for staff and users, social and commercial and cultural facility potential

(-) due to excessive footprint, no interaction among staff and users

PHYSICAL SUSTAINABILITY

(-) too large , excessive footprint area, hard for accesibility internally within different sections

(-) no passive system utilization

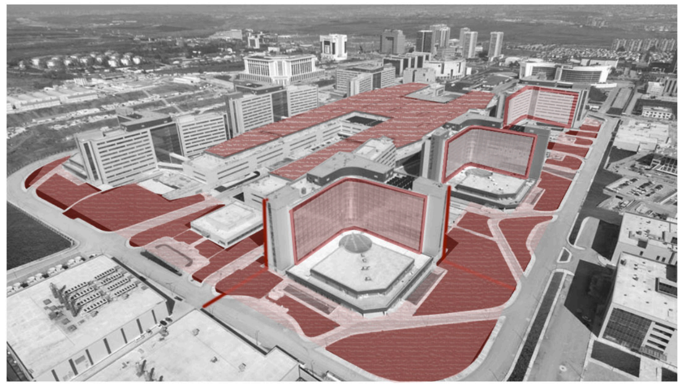
(+) differentiation of inpatient rooms blocks from main outpatient center block

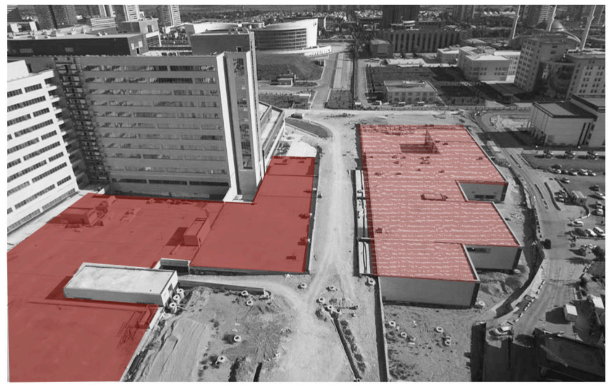
(-)no orientation concerns in terms of inpatient rooms block (no sun exposure or wind protection concerns and treatments due to orientation and solar gain)

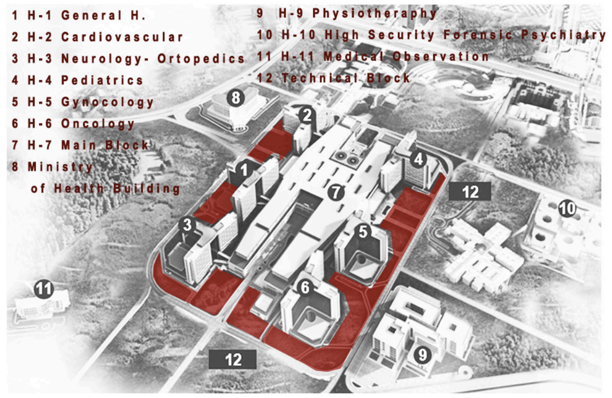
(+/-) closed underground car park provision, however combined and excesively large footprint - costly to operate

(+)surrounding roads, drop-off areas and service / public transportation nodes are insufficient

(-) no daylight and natural air circulation in many rooms of the main block due to excessive footprint







ENVIRONMENTAL SUSTAINABILITY

(-) Excessive solar radiation / solar island effect in the very near surrounding due to uneffective utilization of outdoor green areas.

(-)excessive waste production due to emormous sizes , TBA footprint and necessary facilities of infrastructe relevant provisions

(-) excessive consumption of energy (for operation) due to the approach of monolithic one giant - all connected- enclosed space design with excessive footprints

(-) due to insufficint peripheral vehicular road surrounding, excessive exhaust pollution and dense traffic consequences)

(-) no roof utilization (no green terrace) solar radiation effect increas

(-) extra infrastructural consequences and supply necessities

BILKENT CITY HOSPITAL COMPLEX, ANKARA ,TURKEY

GENERAL VIEW

A.32. Ankara City Hospital Complex _A2_Analyses Set

CONTEXTUAL SUSTAINABILITY

(-) project site is inconsistency with the context, in terms of function/ facility continuation

(-) necessary infrastructure stayed insufficient, thus extra roads, junctions and other infrastructural necessitiesdeveloped and provided

(-)in terms of waste production as a health complex,too hazardaous to be in between of many public facilities

(-) increasing already dense traffic existence occuring in the surrounding

(-) in a considerably far location- thus hard to be accessed easily and quickly by citizens

ECONOMICAL SUSTAINABILITY

(-) causing excessive travel hours due to its far location

(-) required and resulted in an excessive amount of investment, due to unnecessary TBA, and footprint

(-) excessive operational cost consequences, due to one whole footprint and acvessive TBA , therefore no RoI intention----however land value increase

SOCIAL AND CULTURAL SUSTAINABILITY

(+)due to MXD centers nearby, for staff and users, social and commercial and cultural facility potential

(-) due to excessive footprint, no interaction among staff and users

PHYSICAL SUSTAINABILITY

(-) too large , excessive footprint area, hard for accesibility internally within different sections

(-) no passive system utilization

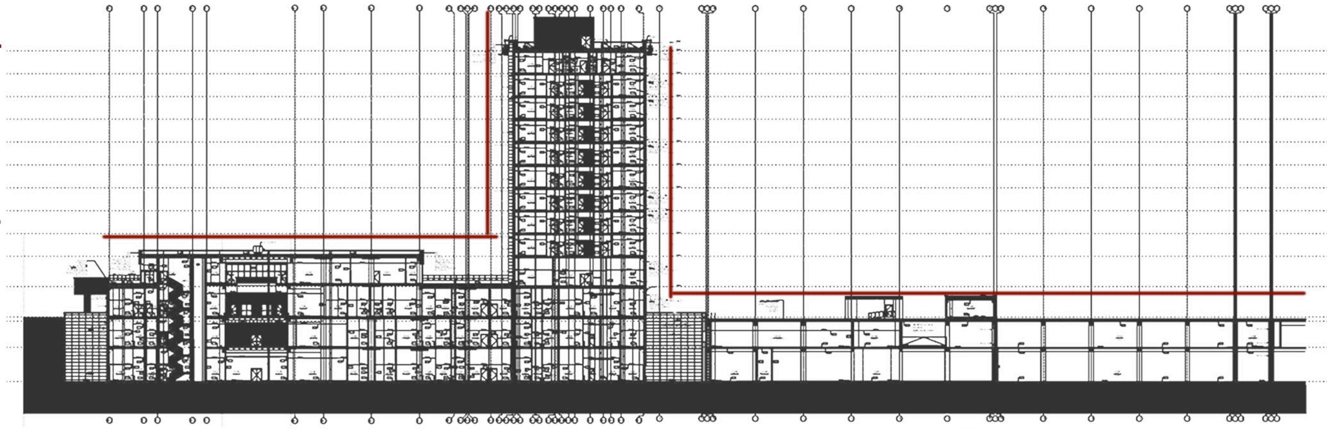
(+) differentiation of inpatient rooms blocks from main outpatient center block

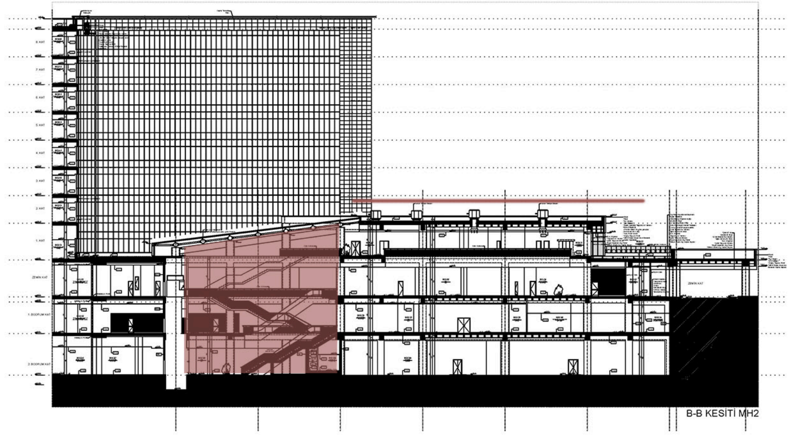
(-)no orientation concerns in terms of inpatient rooms block (no sun exposure or wind protection concerns and treatments due to orientation and solar gain)

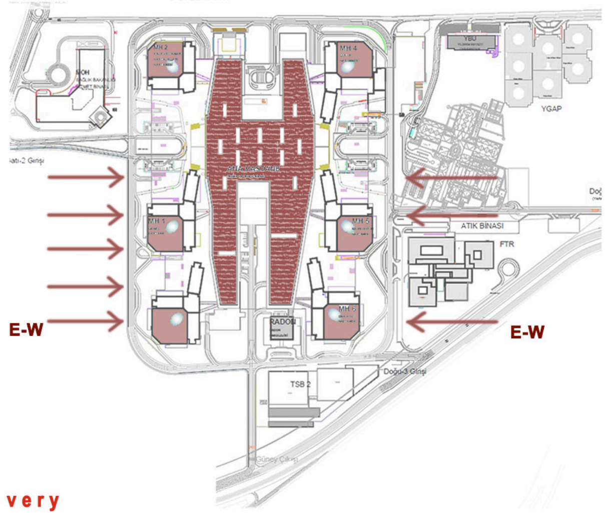
(+/-) closed underground car park provision, however combined and excesively large footprint - costly to operate

(+)surrounding roads, drop-off areas and service / public transportation nodes are insufficient

(-) no daylight and natural air circulation in many rooms of the main block due to excessive footrpint







ENVIRONMENTAL SUSTAINABILITY

(-) Excessive solar radiation / solar island effect in the very near surrounding due to uneffective utilization of outdoor green areas.

(-)excessive waste production due to emormous sizes , TBA footprint and necessary facilities of infrastructe relevant provisions

(-) excessive consumption of energy (for operation) due to the approach of monolithic one giant space design with excessive footprints and atirum space

(-) due to insufficint peripheral vehicular road surrounding, excessive exhaust pollution and dense traffic consequences)

(-) no roof utilization (no green terrace) solar radiation effect increases

BILKENT CITY HOSPITAL COMPLEX, ANKARA ,TURKEY

TECHNICAL DRAWINGS

A.33. Ankara City Hospital Complex _A3_Analyses Set

B. Building (Project) Class Tables

YAPININ MİMARLIK HİZMETLERİNE ESAS OLAN SINIFI	Yapının Birim Maliyeti (BM) TL/m²
I. SINIF YAPILAR	
A GRUBU YAPILAR 1. Kâgir veya betonarme ihata duvarı (3,00 m yüksekliğe kadar) 2. Basit kümes ve basit tarım yapıları 3. Yumuşak plastik örtülü seralar 4. Mevcut yapılar arası bağlantı - geçiş yapıları 5. Geçici kullanımı olan küçük yapılar 6. Kalıcı kullanımı olan yardımcı yapılar 7. Gölgelikler - çardaklar 8. Üstü kapalı yanları açık dinlenme, oyun ve gösteri alanları 9. Depo amaçlı kayadan oyma yapılar 10. Bu gruptakilere benzer yapılar.	425,00
B GRUBU YAPILAR 1. Cam veya sert plastik örtülü seralar 2. Basit padok, büyük ve küçük baş hayvan ağılları 3. Kâgir ve betonarme su depoları 4. İş yeri depoları 5. Bu gruptakilere benzer yapılar.	640,00
II. SINIF YAPILAR	
A GRUBU YAPILAR 1. Kuleler, ayaklı su depoları 2. Palplanj ve ankrajlı perde ve istinat duvarları 3. Kayıkhane 4. Bu gruptakilere benzer yapılar.	1.050,00
B GRUBU YAPILAR 1. Şişirme (Pnömatik) yapılar 2. Tek katlı ofisler, dükkân ve basit atölyeler 3. Semt sahaları, küçük semt parkları, çocuk oyun alanları ve eklentileri 4. Tarımsal endüstri yapıları (Tek katlı, prefabrik beton, betonarme veya çelik depo ve atölyeler, tesisat ağırlıklı ağıllar, fidan yetiştirme ve bekletme tesisleri) 5. Yat bakım ve onarım atölyeleri, çekek yerleri 6. Jeoloji, botanik ve tema parkları 7. Mezbahalar 8. Bu gruptakilere benzer yapılar.	1.550,00
II. SINIF YAPILAR	
C GRUBU YAPILAR 1. Hangar yapıları (küçük uçaklar, helikopterler, tarım uçakları park ve bakım onarım yeri) 2. Sanayi yapıları (Tek katlı, bodrum ve asma katı da olabilen) 3. Bu gruptakilere benzer yapılar.	1.700,00
III. SINIF YAPILAR	
A GRUBU YAPILAR 1. Okul ve mahalle spor tesisleri (Temel eğitim okullarının veya işletme ve tesislerin spor salonları, jimnastik salonları, semt salonları) 2. Katlı garajlar 3. Ticari amaçlı binalar (üç kata kadar üç kat dâhil - asansörsüz - 3/7/2017 tarihli ve 30113 sayılı Resmi Gazete'de yayımlanan Planlı Alanlar İmar Yönetmeliğinin 34 üncü maddesinin 1 inci fıkrasına göre asansör yeri bırakılacak) 4. Alışveriş merkezleri (semt pazarları, küçük ve büyük hal binaları, marketler ve benzeri) 5. Basımevleri, matbaalar 6. Soğuk hava depoları 7. Konutlar (üç kata kadar- üç kat dâhil - asansörsüz - 3/7/2017 tarihli ve 30113 sayılı Resmi Gazete'de yayımlanan Planlı Alanlar İmar Yönetmeliğinin 34 üncü maddesinin 1 inci fıkrasına göre asansör yeri bırakılacak) 8. Akaryakıt ve gaz istasyonları 9. Kampingler 10. Semt postaneleri 11. Küçük sanayi tesisleri (Donanımlı atölyeler, imalathane, dökümhane) 12. Kreş ve gündüz bakımevleri, hobi ve oyun salonları 13. Bu gruptakilere benzer yapılar.	2.250,00
B GRUBU YAPILAR 1. Entegre tarımsal endüstri yapıları, büyük çiftlik yapıları 2. Gençlik merkezleri, halk evleri 3. Lokanta, kafeterya ve yemekhaneler 4. Temel eğitim okulları 5. Küçük kitaplık ve benzeri kültür tesisleri 6. Jandarma ve emniyet karakol binaları 7. Sağlık ocakları, kamu sağlık dispanserleri 8. Ticari amaçlı binalar (Yapı yüksekliği 21,50 m'ye kadar olan) 9. 150 kişiye kadar cezaevleri 10. Fuarlar 11. Sergi salonları 12. Konutlar (Yapı yüksekliği 21,50 m'den az yapılar) 13. Marinalar 14. Gece kulübü, diskotekler 15. Misafirhaneler, pansiyonlar 16. Bu gruptakilere benzer yapılar.	3.000,00
IV. SINIF YAPILAR	
A GRUBU YAPILAR 1. Özelliği olan büyük okul yapıları (Spor salonu, konferans salonu ve ek tesisleri olan eğitim yapıları) 2. Poliklinikler 3. Liman binaları 4. İdari binalar (ilçe tipi hükümet konakları, vergi daireleri ve benzeri) 5. İlçe belediyeleri 6. 150 kişiyi geçen cezaevleri 7. Kaplıcalar, şifa evleri ve benzeri termal tesisleri 8. İbadethaneler (1500 kişiye kadar) 9. Aqua parklar 10. Entegre sanayi tesisleri 11. Müstakil spor köyleri (Yüzme havuzları, spor salonları ve statları bulunan) 12. Yaşlılar huzurevi, kimsesiz çocuk yuvaları, yetiştirme yurtları 13. Büyük alışveriş merkezleri 14. Yüksek okullar ve eğitim enstitüleri 15. Apartman tipi konutlar (Yapı yüksekliği 30,50 m'den az yapılar) 16. Oteller (1 ve 2 yıldızlı) 17. Bu gruptakilere benzer yapılar.	3.200,00
B GRUBU YAPILAR 1. Araştırma binaları, laboratuvarlar ve sağlık merkezleri 2. İl tipi belediyeler 3. İl tipi idari kamu binaları 4. Metro istasyonları 5. Stadyum, spor salonları ve yüzme havuzları 6. Büyük postaneler (merkez postaneleri) 7. Otobüs terminalleri 8. Eğlence amaçlı yapılar (çok amaçlı toplantı, eğlence ve düğün salonları) 9. Banka binaları 10. Normal radyo ve televizyon binaları 11. Özelliği olan genel sığınaklar 12. Müstakil veya ikiz konutlar (Bağımsız bölüm brüt alanı 151 m^2 ~ 600 m^2 villalar, teras evleri, dağ evleri, kaymakam evi ve benzeri) 13. Bu gruptakilere benzer yapılar.	3.800,00
C GRUBU YAPILAR 1. Büyük kütüphaneler ve kültür yapıları 2. Bakanlık binaları 3. Yüksek öğrenim yurtları 4. Arşiv binaları 5. Radyoaktif korumalı depolar 6. Büyük Adliye Sarayları 7. Otel (3 yıldızlı) ve moteller 8. Rehabilitasyon ve tedavi merkezleri 9. İl tipi hükümet konakları ve büyükşehir belediye binaları 10. İş merkezleri (Yapı yüksekliği 21,50 m ile 30,50 m arası - 30,50 m dâhil yapılar) 11. Konutlar (Yapı yüksekliği 30,50 m ile 51,50 m arası - 51,50 m dâhil yapılar) 12. Bu gruptakilere benzer yapılar.	4.100,00
V. SINIF YAPILAR	
A GRUBU YAPILAR 1. Televizyon, Radyo İstasyonları, binaları 2. Orduevleri 3. Büyükelçilik yapıları, vali konakları ve brüt alanı 600 m^2 üzerindeki özel konutlar 4. Borsa binaları 5. Üniversite kampüsleri 6. İş merkezleri (Yapı yüksekliği 30,50 m aşan yapılar) 7. Yapı yüksekliği 51,50 m'yi aşan yapılar (Konutlar dâhil) 8. Alışveriş kompleksleri (İçerisinde sinema, tiyatro, sergi salonu, kafe, restoran, market ve benzeri bulunan) 9. Bu gruptakilere benzer yapılar.	4.950,00
B GRUBU YAPILAR 1. Kongre merkezleri 2. Olimpik spor tesisleri – hipodromlar 3. Bilimsel araştırma merkezleri, AR-GE binaları 4. Hastaneler 5. Havalimanları 6. İbadethaneler (1500 kişinin üzerinde) 7. Oteller (4 yıldızlı) 8. Uçak Bakım, Onarım ve Yenileme Merkezleri 9. Bu gruptakilere benzer yapılar.	6.000,00
C GRUBU YAPILAR 1. Oteller ve tatil köyleri (5 yıldızlı) 2. Müze ve kütüphane kompleksleri 3. Bu gruptakilere benzer yapılar.	6.650,00
D GRUBU YAPILAR 1. Opera, tiyatro ve bale yapıları, konser salonları ve kompleksleri 2. Tarihi eser niteliğinde olup restore edilerek veya yıkılarak aslına uygun olarak yapılan yapılar 3. Bu gruptakilere benzer yapılar.	7.800,00

B.1 Building Class tables[21]

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[21] (**https://www.resmigazete.gov.tr/eskiler/2022/02/20220218-11.htm accessed on 02.07.2022**)

C. National Green Certificate / Example Template

CURRICULUM VITAE

Surname, Name: Duran, Özge Selen

EDUCATION

Degree	**Institution**	**Year of Graduation**
MS	METU Architecture	2001
BS	METU Architecture	1999
High School	TED Ankara College, Ankara	1995

KEY QUALIFICATIONS

- Project Development & Design Process Management
    - Multi-disciplinary project and process management: cross disciplinary data exchanges, schedule and information flow management, design communication, project delivery methodologies
    - Feasibility & market research analysis: Feasibility studies, investment & market research due to time & cost efficiencies.
    - Proposal and tender process managements
    - Contract & conciliation management: customer relations, documentation, (reporting & recording) & contract execution (costs, LOP & bidding process management)
    - Project Design: Contribution & effective process management to all phases of design from conceptual design to construction design& till tender processes
    - Tender Documentation: Execution of tender documents arrangements comprising BOQ's and Technical Specifications for the designed projects.
    - Team management: Project team & work schedules organization and efficient synchronization for many simultaneously ongoing projects, determination of the deliverables & scope of works due to hierarchical organization of the team.

- Architectural Design
  - Architect specializing in various architectural projects, particularly MXD's, Hotel & Touristic Structures, University Campus Masterplan Designs, R & D Centers and the design of other public & private structures (including Culture & Congress Centers, Shopping & Entertainment Centers as well as Business Plazas) with the architectural team.
  - Phases involved are:
    - Masterplan Development
    - Schematic Design and Concept Design Development
    - Design Development
    - Construction Drawings
    - Detailed Design
    - BOQ & Specifications
- International BREEAM Assessor
  - Qualified and certified International BREEAM Assessor in the assessment of all types & scales of buildings everywhere outside of UK. (including all Europe and Gulf Regions) *(where BREEAM, BRE Environmental Assessment Method is a leading certification system accepted in all around the world for the evaluation of an environmental friendly building)*

ACADEMIC EXPERIENCE

More than 20 years of experience in the professional practice of AEC field has started to be reflected on a serious of academic experiences for the last 8 years. Especially the outcomes & know-how knowledge of project development, total-process and project management experiences in architectural design processes have been converted and adapted to be presented in many seminars, lectures and courses. These interactions and contributions in the academic domain can be perceived as to be concentrated on two major subjects / approaches.

The further details of the scope and content of these seminars/ lectures can also be provided upon request.

1. **Courses & Lectures**

1.1. Architectural Design Studio Instructor:

- Instructor At Architectural Design Studio (since 2016 -currently) part-time instructor at 3rd year Architectural Design studio in BİLKENT University, Faculty of Art Design & Architecture (ARCH 301 & ARCH 302)

- Instructor at Architectural Design Studio (2015 - still) part-time instructor at 3rd year Architectural Design studio in ATILIM University, Faculty of Art Design & Architecture (MMR 301 & MMR 302)

- Attendance And Participation To Design Studio Juries (since 2010):
    - Bilkent University, FADA, Department of Architecture
    - METU, Faculty of Architecture, Department of Architecture
    - TEDU, Department of Architecture
    - Eskişehir Osmangazi University, Department of Architecture
    - Atılım University, Department of Architecture

1.2. Multidisciplinary Integrated Design Processes and Project Management Courses_ Instructor

- Instructor of the course ARCH 418_Professional Practice in Bilkent University FADA, Dept. of Arch. (till 2018- still)

- Instructor of the Course ARCH 428_Integrated Design Management in Bilkent University FADA, Dept. of Arch. (till 2020- still)

- Instructor of the Course ARCH 440 _Special topics in architecture- Multidisciplinary Design Process Management" in Bilkent University FADA, Dept. of Arch. (Spring Semester of 2019)

- Instructor of the course MMR 494_Multidisicplinary Projects Management in Atılım University (during Spring Semesters of 2017 and 2019)

1.3. Architectural Design / Project Management Seminars _Lecturer:

- Guest Lecturer at IEU/ Arch 452 Applied Workshop _2016 & 2017 & 2018 & 2019
- Guest Lecturer at METU / Arch 452 Professional Practice_2014
- Guest Lecturer at Başkent Univ./ Arch 443 Physical Environmental Control _2016

1.4. 'Sustainable & Environmental Friendly Building Design & Certification' Seminars (since 2010): " BREEAM vs. LEED"

- Çankaya University_ Dept. of Interior Design _20120508
- ESOGÜ_ Osmangazi University_ Dept. of Architecture _20120329
- BÜ_ Başkent University_ Dept. of Architecture_20160304

2. Publications / Congress / Conferences *(full papers can be provided upon request)*

2.1. Paper submission and Presentation at LIVENARCH VII_7th International Congress (28-30 September 2021_ KTU, Trabzon) co-writer with Tanverdi, B & Yılmaz, F. "Architectural Education Beyond The Borders Of Other(s): A Proposal For Transitive Workshops As Expansive Integrative Educational Mediums"

2.2. Paper submission and Presentation at 6th International Project and Construction Management Conference_IPCMC 2020 (virtual / 12-14 November 2020_ITU, İstanbul) "Re-thinking Design Management"

2.3. Paper submission and Presentation at '5th International Project And Construction Management Conference- IPCMC2018' (16-18 Nov. 2018 _Cyprus International Univ. -/ Northern Cyprus) "Challenges and Complexity In Multidisciplinary Projects' Process Management"

2.4. Award winning Paper submission and presentation at 'Project And Construction Management Conference' (3-5 Nov. 2016 _Anadolu Univ./ Eskişehir) " a New And Innovated Integrated Project Delivery Model In Project Processes" "Best paper award"

2.5. Paper Submission and presentation at 'Project Management Conference With International Participation' (19-20 Sep. 2014 _ITU / İstanbul): "Process and Knowledge Management Models in Architectural Design and Project Management"

2.6. Paper submission and Presentation at 'Project And Construction Management Conference' (6-8 Nov. 2014 _Akdeniz Univ./ Antalya) "Process Management Models to be utilized in Architectural Design Management

3. Workshops

As a co-founder of the Non-profit organization of **"archiPRact",** a series of workshops have been held in different universities in Turkey with the participation of students of Faculties of Architecture and / or Interior Design; some of which are given below. the main aim- method and structure of ArchiPRact workshops are also summarized

aim_ to create awareness about the multi layered and multidisciplinary dynamic process of design management	**method_** active role-playing and simulations in different positions / perspectives within the process of design in full synchronized collaboration.	**structure_** a dynamic-participatory and interactive learning through active work reverse engineering-analysis- decomposing – restructuring

PROFESSIONAL EXPERIENCE-OFFICE REFERENCE

A total of 23 years of experience (4 years professional practice of architectural design in various firms, 9 years of owner / partnership & 8 years of professional practice as a general coordinator)
Design Process Management has been performed professionally since 2003 for a considerably large number of successful projects most of which are executed by international project teams and having quite unique and critical construction criteria.
The detailed information and portfolio completed until today can be presented upon request. However, in general MXD, Residence & Housing Projects and University Masterplans & Education Building Designs as well as some awarded

Cultural centers and Museum buildings can be given as major examples of experience for the AEC projects coordinated, managed and/ or designed.

2019- still	Bilkent University FADA- Department of Architecture Instructor
2012 -2019	ÖNCÜOĞLU +ACP ARCHITECTURE General Coordinator BREEAM Energy Efficiency Consultant
2011 to 2012	YPU YAPI PROJE UYGULAMA Manager/ Business Development Energy Efficiency Consultant
2006 to 2010	YPM YAPI PROJE ARCHITECTURE Managing Partner
2004 to 2006	YPM YAPI PROJE ARCHITECTURE Senior Architect
2003 to 2004	P3 PEKUP DESIGN Owner
2001 to 2003	ÖZKAN GRUP Architectural Group Leader
2001	CHAMBER OF ARCHITECTS of TURKEY, ANKARA BRANCH Architect,
2000 to 2001	ROTAM HOLDİNG Project Manager
1999 to 2000	METU PROJECT GROUP. Architect

FOREIGN LANGUAGES

	Speaking	Reading	Writing
Turkish	Native Speaker	Native Speaker	Native Speaker
English	Advanced	Advanced	Advanced
German	Beginner	Beginner	Beginner
Russian	Beginner	Beginner	Beginner

COUNTRIES OF PROJECT EXPERIENCE

Turkey, Kazakhstan, Uzbekistan, UK, Russia & CIS, UAE (Dubai), France, Iraq, Cyprus, Libya

CERTIFICATES

LEED General Education	ERKE	2012
BREEAM International Assessor	BRE GLOBAL	2010
Project Management	Chamber of Architects	2008
Development Plan Regulations	Chamber of Architects	2008
Architecture & Glazing Design	Chamber of Architects	2008
Environmental Law & Regulations	Chamber of Architects	2007
Acoustics Design & Noise Control	Chamber of Architects	2007

COMPUTER SKILLS

Drawing & Presentation:	AutoCAD, 3DMax, Adobe Photoshop , MS Project & Primavera , BIM (executive / coordinating level only)
Documentation	Microsoft Office