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Journal of contemporary urban affairs is the interdisciplinary academic, refereed journal that publishes two times a year by Anglo-American Publications LLC. Journal of Contemporary Urban Affairs brings together all the theories, manifestoes and methodologies on contemporary urban spaces to raise the understanding for the future of urban planning. Overall, the journal of contemporary urban affairs aimed to establish a bridge between theory and practice in built environment. Thus, it reports on the latest research findings and innovative approaches, methodologies for creating, assessing, and understanding of contemporary built environments.

JCUA distinguishes itself by providing an international and interdisciplinary platform for the exchange of ideas and information among Architectures, urban planners, policy makers and urbanists from all disciplines to focus on seven main concern of this journal which are Housing studies, Emerging cities, urban ecology, Infra Habitation, Revitalization strategies, conflict, divided territories and overall contemporary urban issues about mentioned concerns. Submissions of empirical, comparative, theoretical research, critical review and manifestoes for the future of cities from different scholarly disciplines and methodological perspectives are encouraged.

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- Conflict and divided territories.
- Emerging cities.
- Urban ecology, morphology and growing concern on sustainability.
- Infra Habitation (Slums / Affordable houses and Gated communities).
- Revitalization, regeneration and urban renewal.
- Housing studies (livability, responsive environment, quality of life and etc.)
- Contemporary urban issues (politics, strategies, sociology, Crime, Immigration and international labor migration and etc. New urbanism, Rapid urbanization, Urban sprawl).

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Journal of Contemporary Urban Affairs is an open access international peer-reviewed journal, which provides a platform to bring together current manifestoes and methodologies on urban affairs to raise the understanding for the future of urban planning within some specific subject fields which are: Housing Studies, Emerging Cities, Urban Ecology, Infra Habitation, Revitalization Strategies, Conflict, Divided Territories and contemporary urban issues about above mentioned subject fields. Thus, it reports on the latest research findings and innovative approaches, methodologies for creating, assessing, and understanding contemporary built environments.

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The journal explores a range of academic and policy concerns including, but not limited to:

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This issue has 17 articles. The editors seek to publish articles considering contemporary urban affairs in the specific field of: Housing Studies, Emerging Cities, Urban Ecology, Infra Habitation, Revitalization Strategies, Conflict, Divided Territories; they are looking forward to substantial improvement of educational processes and outcomes.

With kind regards,
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Vernacular Architectural Preservation of Material and Spiritual Interconnected Cultural Heritage

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ABSTRACT

Vernacular architecture presents sustainable minimum-impact structures harmonized with their context and inhabitants. Heritage preserved tangible and intangible in material forms, encrypted spiritual believes of humanity's life in dwellings' organization unveiling the details of our ancestors' life and world cultures' connectivity. Instigated by modern-world urbanization, sustainability and cultural diversity issues, the study is researching on cultures connectivity, corresponding to the scale and context of the global cityscape and attempting to synthesize vernacular heritage. The objective of this research is to study indigenous human congruent architectural examples and their relationship with intangible aspects of habitat. This paper will be adapting a qualitative method, by which it aims to study and observe various examples so as to analyze interconnections of Siberian Chums and Native-American Tipi, their design driving forces, settlement of the 2nd century BC- Arkaim and Japanese traditional architecture.

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1. Introduction

Vernacular architecture bears climate-efficient regional and time proven sustainable systems, the analysis of which can benefit locally oriented modern architecture. Through the study of various examples, one can notice the firm presence of spiritual aspects, religious or pagan believes as driving forces of dwellings' planning. Space will always remain to be very influential to the quality of human life that is based on intangible psychological aspects and habitual traditions. Importance of vernacular architecture's preservation is indisputable, it absorbs to reflect culture and traditions performing as a living historical

evidence. Thus analyzing extant vernacular architectural forms and venturing into their inner space organizations this study seeks to identify the unifying principle.

The case of Siberians and Native American inhabitants' architecture similarities is not a coincidence, it is another proof of cultures' links on a par with language analogies proposed by Edward Vajda and detailed DNA analysis held by the Centre for GeoGenetics. As two

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distantly evolving communities, Siberian including Nenets, Evenks, Navkhs, Yuits, Kereks and Native Americans or so-called Indians have same believes, shamanic background and therefore architectural analogies shown in Chums and Tipis.

Centralization of fire, noticed in Japanese architecture and so common for Zoroastrian architecture is seen in both of previously noted **vernacular dwellings' examples as well as in another case of research, the Bronze Age settlement of Arkaim inhabited by Agni-worshippers.** Studied in light of cultural connectivity through the intangible background of spaces design by first architects, its religious aspect may link it with present-day differentiated cultures and arise more research possibilities.

2. Siberian Chum – the life center of Nenets people

Siberia region of Russia has exceptional architectural treasures, carefully transferred to the modern world by the indigenous population of this region. The example of chums is referred to Middle Siberia inhabited by Nenets tribes, also noticed in the cultures of Hasova, Samoeds, Evenks, Navkhs and Uraks. Yamal peninsula, the place where Nenets people abide, is not an exception for the impetus of infrastructure in the 21st century.

Local research conducted by Boyarsky and Stolyarov (2000) shows that Yaman peninsula, and Vaigach Island in particular, was preserved and guarded by locals in the past because of its significance and sacred meaning. Moreover, as R. Jones, a member of S. Borrough's expedition held in 1556, wrote: **"wild Samoyeds live there, not allowing Russians to land"**. (Boyarsky, Stolyarov, 2000, p. 30) However, inducing an economic interest nowadays, the region inhabited by Nenets is under the process of new development. With the construction of Obskaya-Bovanenkovo railway line, which is the northernmost in the world, Yamal Project has already impacted the local land ecosystem and the nomadic pace of Samoyedic life that was followed for centuries by disrupting their migration routes. Chance (1995) and Andreeva point on the problematic situation in the Russian North, saying that nowadays it is experiencing most dramatic environmental devastation that directs to the social disintegration. (N. A. Chance, E. N. Andreeva, 1995).

The harsh climate with long winters and seasonal winds, severe waterlogging, and isolation forced ethnic group to adhere to their

centuries' nomadic routine solely dependent on hunting and deer keeping. Same as centuries ago, today Chum remains the center of Nenets' lives, both habitual and sacred. However, this example shows that a vernacular dwelling preserves much more than a material architectural form.

Detailed information was provided by the expedition of D. Andersons, in collaboration with the archaeological field research team of Dr. Viktor Vetrov of the Irkutsk State Pedagogical University and Baikal- Hokkaido Archaeology Project (BAP) and then documented by Andersons. The author states that Evenk's cone-shaped dwelling is an example of **"how vernacular architecture reflected social structure"** (2, 2006). An influential work done by Shirokogoroff (1929) unveils details of the indigenous pace of life and the meaning behind its details, providing **"an early authoritative schematic of the structure of a conical lodge with its distinctive pattern of names, which in turn implied certain roles to men, women and to guests"**. (1929, pp. 255–256).

2.1. Spiritual understanding of the world behind the spatial organizations of the dwelling.

Same as in the previous century, modern chums bear the original vernacular exterior and interior spatial organization that have carried traditions, language and religion by the definite interdependence between form and function. Similarly as for inhabitants of North America or **Canadian Plains, most aspects of Nenets' life** are interlinked with shamanism and this belief is shared among most of the aboriginal cultures of Siberia.

In shamanism, the world differentiated into three partials: the sky, the land, and the underground are believed to be inhabited by human souls as well as by many other spirits, gods, protectors, and helpers that only shaman can reach to. For aboriginals of Siberia their self-eidolon was not differentiated from animals. It is important to mention that images of the world tree, the bear and the bird play a significant role in their life and folklore. (Mchedlov, et al., 2002)

Despite forced Christianization, Siberian aboriginals preserved their religious and cultural identity, animism, totemism and shamanism, thanks to the successive mode of life and continuous direct dependence from nature. Chum, the resultant of nomadic Nenets' life has always remained habitual and sacred central element. The **dismountable dwelling's spatial arrangement** goes in accordance with

shamanic order, hierarchy of the clan and gives meaning to all the dwellings' elements. Reindeers are the source of food, clothing and building materials, all necessities for Indigenous Siberians, Nenets in particular (Lissner, 1961). Constructed not without materials provided by deer, chum's conical structure with an inlet for the smoke (Sona) is covered by the sewed skins in the winter or with boiled bark, canvas and burlap in the summer. Dwelling's frame consists of approximately 40-50 sloping poles (Golovnev, 1995).



Figure 1. Construction process (Developed by Author).

The location of the chum is decided by man and the first act, placement of the metal fire sheet [Tumu] on the ground, by woman. Thus the hearth becomes the central, first and most significant element of the house. Golovnev wrote that "Perhaps in this first movement, the idea of the 'hole' to the lower world coverage and the symbolism of the primary designation of the center and the history of the chum itself which was originally a "bonfire closed from the wind", are combined." (1995, p. 212).



Figure 2. Woman installs 'simzi'. (Dmitry Tkachuk, 2016).



Figure 3. Installment of suspended furnace. (Dmitry Tkachuk, 2016).

Central vertical sacred pole simzi handles seven ancestral spirits' heads and tops with a Minley bird figure in the house of a Shaman. Many shamanistic rituals such as herb smudging involve the use of fire and simzi and are performed daily as well as on special

occasions. The house is maintained solely by women, construction and deconstruction of the chum, combustible moss, bushes and firewood preparation, smudging is dependent on her. She can freely walk and touch everything in the house including sacred pole and maintain fire and men believe in her spiritual mighty power to give and take human life, to empower and disengage sacred meaning of the simzi pole. Man and women are understood as opposing elements that converge in the center, man's place in chum (si-nyangi) is further from the entrance when woman's (nie-nyangi) is closer. Geometrical spatial allocation goes along with the sacred meaning behind it. Thus, women's space, protector from the evil, adjoins to the entrance doors and the opposing is considered as men's. Moreover, it is a serene sacred space (si) where all everyday utensils and the casket with spiritual patrons' figures are kept. (Golovnev, 1995).



Figure 4. Chum in winter (Kristen Richard, 2016).

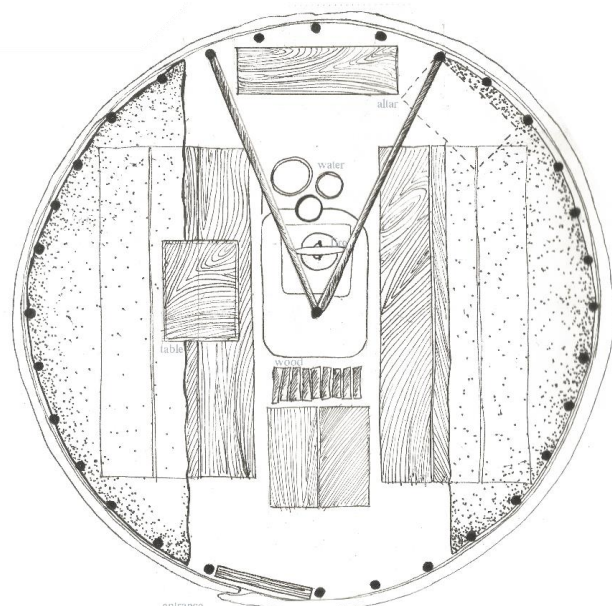


Figure 5. Interior plan of the Chum (Developed by Author).

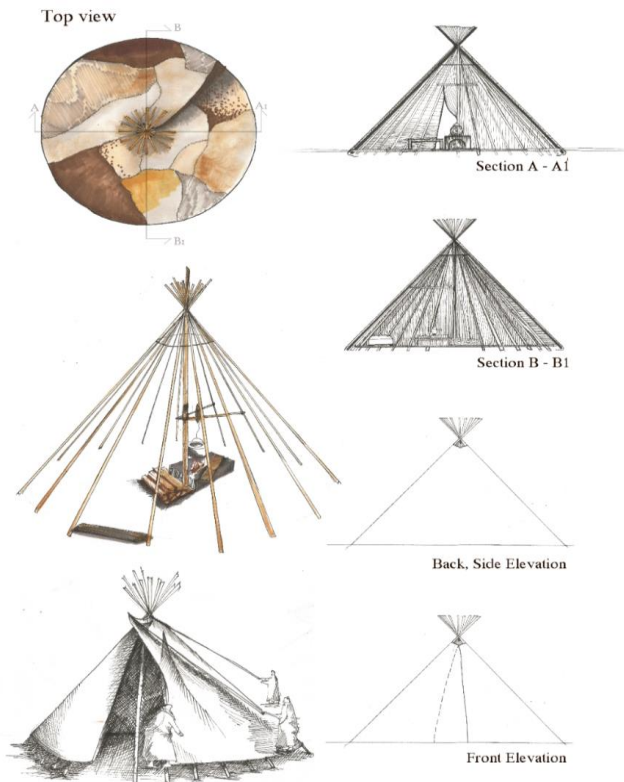


Figure 6. Elevations and sectional views; Chum illustrated during the construction process (Developed by Author).

Vernacular architecture is the result of peoples' adaptation, reflector of their culture, beliefs and traditions. Maximum affordable or free local sustainable materials and inherited techniques are used in the construction of these dwellings. Speaking about Nenets people's vernacular architecture, Chum is the only tangible object to absorb, conserve and afterwards reflect traditions and mindset of Samoyeds - Siberia inhabitants and nomadic nations in general. Their life is a rare example to bear authenticity in the modern globalized world. Moreover, thence providing pure cultural architectural evidence.

3. Tent-like architectural form links distant continents' cultures.

Chums as well as Native American Tipis, dwellings more than 6000 kilometers away, have striking similarities despite the distance. One can notice the connection between distant cultures of Siberian and America's first inhabitants through their vernacular architectural heritage. When studied more in detail and through the prism of equally important spheres of linguistics and genetics, too, it can serve as an evidence of cultures' connection.

The motivation and the leading force for most vernacular cultures remains to be the spiritual

aspect of lives and thus every details of the indigenous dwelling becomes more than just a form but a conveyor of traces in some cases and the preserver of the heritage in others. Regarding architectural similarities, Siberian chum and Native American tipi are of circular shape, with fire as a main central element and shared spiritual background. Indigenous dwellings are both using poles to shape a cone structure and are covered with canvas or animal skins.

This segment of the study will present Siberian-Native American connectivity analysis alongside the synthesis of different perspectives to enrich their hypothetical relativity to one another from an architectural standpoint.

3.1. Dene-Yeniseian, a linguistic link between America and Siberia.

Due to the vital present-day debate apropos the origin of Native Americans, this paper suggests an alternative look upon their heritage comparison which is involving architecture. Some researchers are stating they have moved from West-Asia, and contemporary ones believe the wave of migration came from Siberia via north-eastern Alaskan bridge. A linguistic approach to this discussion, a hypothesis of Na-Dene (excluding Haida) and Yeniseian languages' connection was presented in Dene-Yeniseic Symposium held in Alaska in February, 2008 (Vajda, 2010). It included multiple notable linguistic researches and was reinforced by various more from spheres of archaeology, genetics and folklore. Na-Dene is one of the most studied and widely used indigenous languages of Americas. Yeniseian, however, is a vestigial linguistic family with only Ket remaining in scarce use. Nonetheless, I would propose this hypothesis to be applied on the Indigenous American and Central Siberian cultures' relationship. Siberian communities and nations can be differentiated into several groups when conducting linguistic, genetic, folklore and religious analysis. Thus, we can easily notice similarities in Samoyeds' or Nenets' and Kets' shared traditions, spiritual life background, worshipping animism, and vernacular dwellings projecting as a preeminent cultures' preservation object.

3.2. DNA analysis that unveil Native American ancestors.

Another biological perspective was recently proposed by the international group of researchers. Despite the fact that the accurate ancestor of Native Americans remains uncertain, the analysis led by the

Centre for GeoGenetics, Natural History Museum of Denmark (University of Copenhagen) links them with Siberian indigenous population. The group of scientists sampled a 24,000-year-old skeletal remain from the Upper Paleolithic site of Mal'ta in south-central Siberia at the Hermitage Museum (Saint Petersburg) in 2009; and the second sample from Afontova Gora-2 that is dating to about 17,000 years ago. Results revealed the direct connection to Siberia. The group of scientists led by Eske Willerslev "estimate that 14 to 38% of Native American ancestry may originate through gene flow from this ancient population" (Rasmussen, S., et al., 2014, 87). Both of these hypotheses remain debatable, however outcomes demonstrate how vernacular architecture in its original form can act as a culture bridge.

4. Indo-Aryan Settlement of Arkaim – Coexistence of Sacred and Material.

Arkaim is less studied and distant in time vernacular settlement that is embodying spiritual aspect of human life. It also became an architectural evidence to convey hereditary messages. Fire-centered space organization is referring to the fire-worshipping Indo-Aryan nature of the settlement with no doubt, creating a universal network of local architectural systems.

The ancient settlement is located in Trans-Ural Steppe, southern part of Chelyabinsk region of Russia. Arkaim and Petrovka (settlements) are rare examples of Sintashta vernacular architecture which existed in the 2nd century BC and is known for extensive copper and bronze metallurgy as well as for astronomically verified settlements' layouts. Some sources are dating it back to 8th-9th century BC (Khafizov, 2009).

It was a birthplace of numerous cultures where Indo-Aryans, Turks and Ugors coexisted in their beginnings. Arkaim's discovery is verily underappreciated in relation to other world renowned historical sites (Zdanovich, 2004). The area remains poorly studied and even the exact date of its origin is still unknown. In the traditional system of chronology sites date back to XVIII-XVI centuries BC, at the same time radiocarbon analysis indicates the XXI-XVIII centuries BC. Moreover, in the past it was in the risk of deterioration. In 1987 archaeological expedition of Chelyabinsk State University, Ural branch of Russian Academy of Science, discovered more than 70 archaeological sites in the 21 square kilometers area of oval shaped Bolchekaraganskaya Valley, framed by the

Ural Mountains. Findings are from various eras: temporary towns from Middle and New Stone Ages – Mesolithic and Neolithic to mounds and ritual fencings of Kimak and Kipchak tribes. However even with the obvious historical value, the area was meant to be flooded and serve as a water reservoir if not the will and efforts of Gennady Zdanovich that proofed the significance of the area and it was declared cultural reservation in 1991.

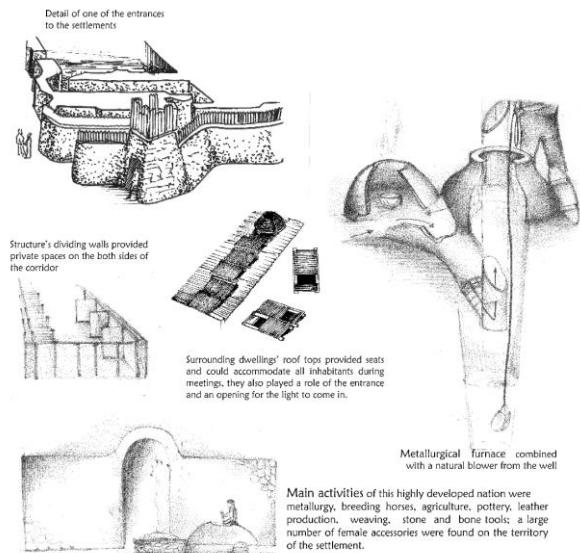


Figure 7. Illustrative details of the indigenous habitat (Developed by Author).

The deeper research of more settlements and cemeteries that refer to the same culture occurred in the late 1980s after the decipherment of aerial images by Batanina and Levite that indicated mounds' forms. Arkaim is an evidence in the architectural tangible form that shows the high development level of so-called "cities of the country", southern part of Chelyabinsk region of Russia that includes the settlement, numerous ancient mounds, necropolises and other archaeological finding. As seen on the case studies of all vernacular architecture examples presented in this research, this settlement unveils consciously planned space organization that bears idem centralized sacred relation to fire in a different scale.

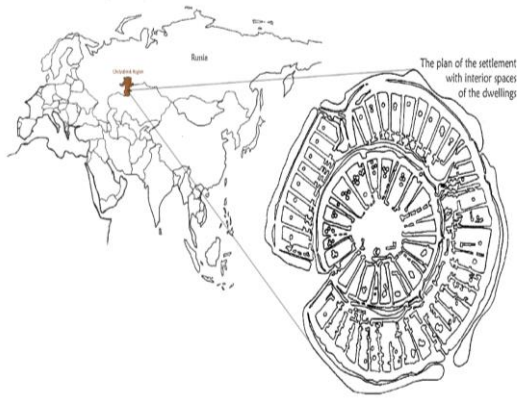


Figure 8. Location and the plan of the settlement with interior spaces of the dwellings (Developed by Author).

The circular settlement is 150 meters in diameter and covers 20,000 square meters area. Located on the confluence of two rivers in the elongated valley, surrounded by hills and ridges, its geometry objectifies the astronomical concept in its form. Houses follow the round shape forming two inner circles outlined by a moat and a wall. Plan's central rectangular square was used for sacral religious acts. Surrounding dwellings' roof tops provided seats and could accommodate all inhabitants during meetings and rituals. *“Evidently, the fire ritual played a major role here, considering that Zoroastrianism, the solar religion of fire-worshippers, arose in these places.”* (Khafizov, 2009, p. 40).

66 trapezoidal shape dwellings were revealed inside the settlement using geophysical methods and archaeological excavations, and 20 of them underwent detailed analysis. The size of single residential building varied from width 110 to 180 square meters, 8.6 meters in width and 20 meters in length (Zdanovich et al, 2009). Zdanovich also noted that two outer rings of fortifications were adapted for astronomical observations. Following ones were two dwelling circles and one street with sewerage. The second defensive wall consisted of a log-ground parts and wooden parapet and bypassed by a 2 meters deep moat. Fortifications were simultaneously main walls of the settlement; two neighboring sectors were divided by a wall in between. One Arkaim's sector – could hold up to 40 - 60 people. Different family clans occupied private family bedrooms separated by wooden partitions which were warmed up with the central oven – the hearth of the house. Typical dwellings had only two exits - one terrestrial, the other, from the opposite end, led by the stairs to the roof opening which let the light to come through. There were different areas in the house: almost all dwellings started with a small courtyard, with

the stove in the corner and the pit connected with the storm sewerage. Then the corridor began with small rooms on both sides (Zdanovich, 2004).

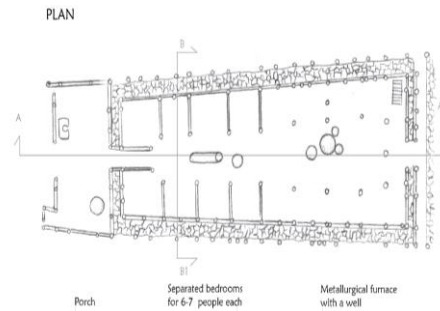


Figure 9. Plan of one single dwelling (Developed by Author).

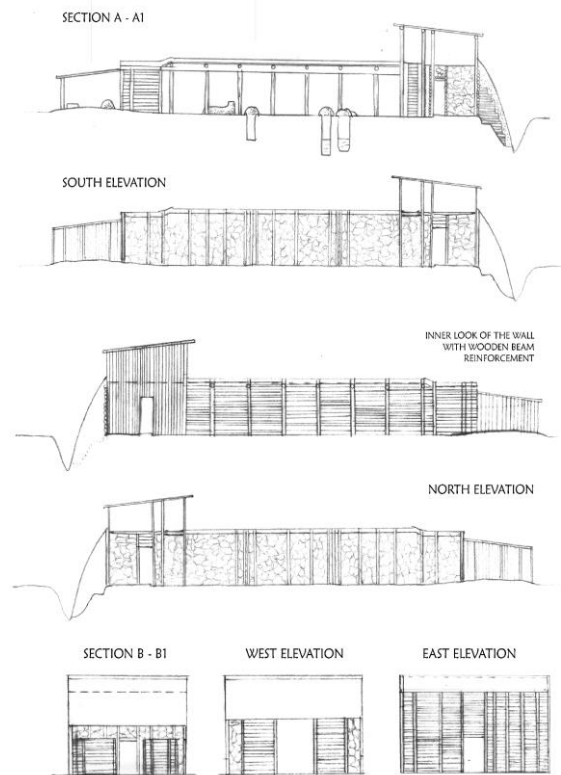


Figure 10. Elevations and Sections on Arkaim dwelling (Developed by Author).

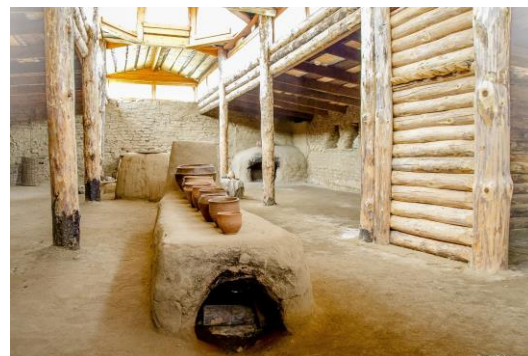


Figure 11. Reconstruction of the dwelling in Arkaim Museum. (Rinat Hayratdinov).

Working area and general family gathering place occupied approximately one-third of the house. Architectural, domestic and hand-crafted findings are pointing on the fact that metallurgy was inhabitance's primary occupation along with leather, pottery stone and bone tools production, weaving, breeding horses and agriculture. There was a well-fridge (pit, cellar), metallurgical furnace combined with a natural blower for the well and stoves in every house. An altar with skulls and other bones of domestic animals was placed at the bottom of each fireplace.

House represented harmonized unity of earth, fire, air and water. Indoor comfort was achieved with both cold and hot spaces, potable and household water accessibility for everyday and ritual ceremonial needs. Dwelling accommodated spaces for sleeping, recreation, work and prayers. Each sector replicated the principles of the settlement structure, thus fireplace can be identified as the gathering space for a family or a community, in the scale of a single house or the settlement respectively. The whole city was concentrated around the central square, the heart of Sacred Arkaim. (Zdanovich, et.al, 2009). Arkaim settlement communicates the system of men and nature symbiosis in unified arrangement of various elements, forms and structures. One can state that vernacular architectural representatives of Sintashta culture point on very developed nations' habitual and scientific level.

Spatial arrangement of Sintashta nation is referring to the one of Chums and Tipis. Centralization of fire is noticed in Arkaim in the dual form. Being the early origin of Zoroastrism, the settlement combined fire worshiping with animism. This element appears to intersect distant detached or relative cultures' vernacular dwelling spatial arrangements.

5. Japanese vernacular architecture and interior spatial arrangement.

5.1. Anthropological approach to the Japanese vernacular architectural differentiation.

Due to Japanese land' isolation, long standing attentiveness and care to national heritage, vernacular architecture was preserved and is treated with respect till today. Professor Jean Louis Armand de Quatrefages differentiated anthropologically juxtaposed races into four groups: (1) Almost entirely blended 'Negrito type', (2) 'Yellow element' with the well recognizable Chinese origin, (3) 'White Ainu element' and (4) 'White Indonesian element'. He noted that "yellow and white elements

occasionally occur juxtaposed and not intermixed in any striking manner." (Mechnikov, 1881)

Bearing the same approach in mind, development of Japan may be differentiated into two periods, Pre-Buddhist and later mainland-influenced. The earlier one includes Jomon (10000 BCE-300 CE), Yayoi (300 BCE-300 CE) and partially Tomb Mound (300-710) periods. Flat-land buildings, heichi jukyo came from an earlier pre-ceramic period and can be of a circular or rectangular plan and be constructed using vertical and horizontal intertwined poles. Following Yayoi and Tomb Mound periods experienced Korean blending that influenced all spheres of life including architecture primarily with the expand of wet rice agriculture (Young M., Young D. T., 2012). Dwellings could be grounded, flat or raised on poles. Details such are the interior spatial arrangement of Pre-Buddhist architecture examples remain obscure, however, clearly identified forms and construction methods retained their influence by this time.

5.2. Ainu huts, Indigenous Japanese dwellings.

Ainu people may be considered the aboriginal nation of Japanese archipelago. As recorded by the number of researchers and travelers (J. Batchelor, I. L. Bird, J. K. Goodrich) in the late 19th century, Ainu's huts are of a flat land construction with very minimal furnishing and the central elongated hearth. Similarly as in the previously discussed chum interior organization, Ainu's dwellings' hearth-sacred relationship follows the same algorithm in terms of physical and intangible. This fact is very surprising, however one can easily notice on plans (image 12-13) how repetitive is the sequence of entrance, fire (hearth) and the sacred. Goodrich wrote: "A sacred window is left in the middle of the eastern wall, through which the sun-god is worshiped, and before this an inao is placed. ...the northern of the fireplace is sacred to the family" (1888, p.499). So-called 'Inao', willow-shavings as the representations of gods occupy the essential part of the dwelling (Batchelor, 1892). Thus, following the same analogy, sacred parts of the dwelling are centralized hearth (place of fire) and further inner space, east window with 'inao'.

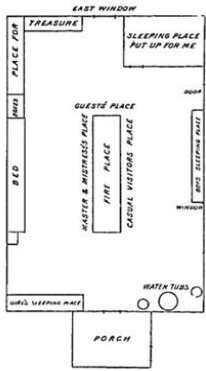


Figure 12. Plan of an Ainu Hut (From Bachelor, 1892, p.73).

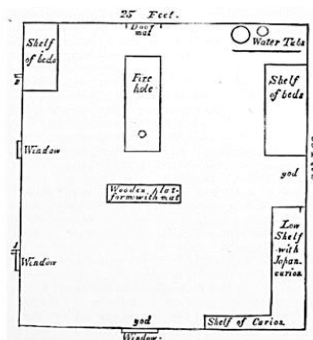


Figure 13. Plan of an Ainu House (From Goodrich, 1888, p.501).

5.3. Cha-no-yu, spiritual meaning in spatial organization of Japanese tearooms.

Cha-no-yu may be considered one of those traditional Japanese typologies that are prevalent in the modern life. Not always consciously taken into account, the background that stands behind habitual actions and planned spaces goes far back to Japanese spiritual origins.

Among eight varieties of tearooms' arrangements most common and original one is the 'four-and-a-half' mat where the middle 'ro' mat and a hearth are surrounded by four full tatami mats (Sadler, 2011).



Figure 14. Four-and-a-half Tatami Tearoom arrangement (Developed by Author).

Centralized hearth algorithm, transferred to the common dwellings' plans found its place and meaning in the regular routine. "The Japanese hearth is also normally in the dirt-floor kitchen,

but in the middle of it, or sometimes at the center of tatami room" (Sirvimaki, 2003, p.86). Black (2011) also presents how a typology of a tearoom with centralized hearth repeats in various building types, including so-called 'thatched minka' farmhouse or people's house and in some samurai residences. Moreover, the central tea table, commonly seen in later (Edo period) occurred typology, the 'machiya' (city house), can be considered as an evolved adaptation of the hearth (Black, 2011). However, "Despite its centrality to Japanese cultural identity, Japanese Tea ritual or chanoyu has been treated superficially in the ethnographic literature" (Anderson, 1987, p. 475). Anderson studies The Way of Tea and the religious symbolism of its etiquette that unconsciously rebounds in daily tea ceremonies. He noted the strong presence of Shinto and Taoist believes in actions (1987). The final stage of the ceremony finds its place in the tea room of chashitsu (tea house).



Figure 15. Tea Ceremony, from the series Etiquette for Ladies (女礼式ノ内 茶之湯ノ図) (Yōshū Chikanobu, 1888)

And even the traditional house of modern times retains this important feature in its approximate form and meaning. Irori (sunken hearth) is named to be the focus of household life, place for communication and relaxation and to preserve hierarchal order of guests' seating placement.

6. Conclusion.

Recalling three principles of conservation, in the current context of vernacular heritage, introduced by Hosey, which include: 'reduce, reuse, recycle', the fourth step comes as first, 'rethink' (2012). Following my considerations, modern strategy of vernacular architectural heritage should be rethought to be further improved. This paper aimed to find the unifying algorithm through several distant or relative indigenous dwellings' analysis. Detailed case study included Chums of Nenets from the Central Siberia, Tipis of indigenous Americans,

Arkaim Settlement of the early Indo-Aryans, Ainu aboriginal dwellings and the Cha-no-yu traditional Japanese teahouse. Successfully, the proposed algorithm was noticed to be repetitive in all of those examples. In this regard, the unifying centralized fire spatial arrangement is also bearing same spiritual significance in its background. Thus, vernacular architecture in the modern universalized world could be introduced in new global, simultaneously global and local, perspective.

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An Industrial Heritage Case Study in Ayvalık: Ertem Olive Oil Factory

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ABSTRACT

Ayvalık is a pioneer settlement in the West Anatolia with an olive-based industry since its establishment. However, due to fast technological developments and changes in production systems, there is a large stock of derelict industrial buildings within the city center. In addition, few of them are restored under poor conditions as a result of financial profits. This situation puts Ayvalık's olive industrial heritage which constitutes the identity of the town at critical risk of extinction. Ertem Olive Oil Factory is one of the industrial heritage buildings in Ayvalık dating back to 1910 which is a typical well preserved-medium scale 19th-century olive oil factory including both olive oil and soap productions. The aim of this paper is to discuss a conservation approach for the industrial settlement of Ayvalık by assessing the factory and its close environment through values, problems and potentials. The paper thus begins with brief history of Ayvalık and the effects of industrialization on the city. It continues with theoretical principles of adaptive re-use through contemporary literature and general evaluation of adaptive re-use examples in Ayvalık according to these principles. The third part focuses on the general characteristics of Ertem Olive Oil Factory and its close environment. The final part discusses the conservation approach for the adaptive re-use through values, problems and potentials of the building and Ayvalık.

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1. Introduction

Industrial heritage places, landscapes, buildings and/or complexes are characterized by a pragmatic value-driven approach due to their construction purposes. They have often been both the reflection of transformation and modernization as a result of the industrial revolution. Industrial buildings usually lost their functions due to the fast technological developments and changes in production systems (Cengizkan, 2006: 9).

"Industrial landscape of Ayvalık" defined by a specific geography, in the Western edge of the Anatolia is accepted on the tentative list of UNESCO in April, 2017 as an outstanding example of social and economic structure of 19th-century industry based on olive-oil production in Western Anatolia (UNESCO,

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2017).

This paper focusing on a case study selected from Ayvalık aims to discuss a conservation approach by assessing it and its close environment through values, problems and potentials. In this regard, the first part of this paper comprises a summary of the history and characteristics of Ayvalık as an industrial heritage. The second part contains the comprehensive review of the adaptive re-use principles and interpretation of Ayvalık industrial landscape through adaptive re-use examples. The third part describes the case study -Ertem Olive Oil Factory- and its assessment as an industrial heritage. And the last part provides a conservation approach for the adaptive re-use of the selected case study.

1.1. Understanding the History & Characteristics of Ayvalık as an Industrial Heritage

Ayvalık is a seaside town on the northern Aegean coast of Anatolia which is a province of Balıkesir. The geographical settings of Ayvalık, that is confined by the sea in the west, is surrounded by Ida Mountains and Gömeç plain; Altınova province in the south and Madra Mountain that stretches from the north-east to the south-east in an arch form in the east (See Figure 1). It is situated on a volcanic peninsula. From the west, Lesbos Island can also be seen; on the north-east, there is Gömeç; on the south, there are Dikili and Bergama.

This unique geography is covered with olive groves that are a component of the natural character of Ayvalık constituting almost 41.3 per cent of the region which is the main source of the industrial landscape of Ayvalık. There are more than two millions olive trees which originate from the wild olive (*olea olester*) that existed as local species among other species and were domesticated and converted genetically endemic species (UNESCO, 2017, para. 4).



Figure 1: Location of Ayvalık (Google Earth, last accessed on September 12, 2016) and its close environment (source: <http://www.thefullwiki.org/Ayvalik#Notes>, last accessed on August 24, 2016)

According to the written sources, there have been settlements in Ayvalık region since the antiquity. However, there are no clearly-

defined information about Ayvalık related with the foundation of the settlement because of the uncertain sources. It was known as Kydonia, capital of Eolia in ancient Greek¹ (Yorulmaz, 2000: 34-38; Psarros, 2004; Şahin Güçhan, 2008). Ayvalık has developed in the region where Christians and Muslims lived together since 1580 and the rapid growth of the settlement started after the 18th century with the increase of olive and olive oil productions (Psarros, 2004; UNESCO, 2017).

The late 18th and the beginning of 19th-century was the period of Ayvalık's development of international trade with the help of İzmir as a metropolis. Ayvalık became one of the important port cities which consists of Rum² population. The main activities related with the trade was olive oil and its products such as soap and olive pomace -pirina- in addition to flour. By the help of these developments, the population flourished rapidly. Moreover, in 1803 an important academy that makes Ayvalık an educational center in the Greek world was founded.

In the 19th-century, the north of İzmir region including Ayvalık was defined as 'olive region'. In that period, due to the weakness of the Empire, Anatolia became an open market for the colonialist powers and Ayvalık was one of the important gates for penetrating to the economy. Thus, it drew the attention of foreign investors such as English R. Hadkinson who was a pioneering entrepreneur of olive-oil trade during the industrialization period by introducing the machines instead of the primitive tools in Ayvalık and İzmir. It is estimated that in 1884, he constituted an olive oil factory in Ayvalık. And it was developed in time at the sea shore within the city center (Bayraktar, 1998: 16-17, 23).

In the 101st issue of Servet-i Fünun, for identifying the socio-economic situation of Ayvalık in 1894, it is written that there were 11 districts (mahalle), 1 mosque, 12 churches, 6 monasteries, 26 soap plants, 78 olive oil plants, 40 tanneries, 25 wind-mills, 2 hotels, 2 restaurants, 7 olive-oil and flour factories, 45 furnaces. Moreover, in 104th issue of it, it is mentioned that there were 9 quarries in Sarımsaklı (which gives the name to the stone that used in the buildings in the region 'sarımsak

¹ Ayvalık was also known as Αἰβαλί, *Ayvali* or Κυδωνίεα, *Kidoniyes* in Contemporary Greek and *أيوولق* in the Ottoman Turkish (UNESCO, 2017).

² 'Rum' is defined as Greeks [Orthodox, East Romans] of Anatolia, Greek speaking- Christians under Ottoman rule. The word 'Rum' is derived from 'Romeus' (Roman east roman_) (Türkçe Bilgi, n.d.). Throughout the study, it is used as 'Rum' when referring the Greek population under the Ottoman rule.

stone'), 14 tile and brick kiln and 7 pitcher kiln. This period contained the industrialization and machine power. When it comes to 1900-1914, according to French commerce annual known as "Annuaire du Commerce 'Didot-Bottin' Etranger 1914, Paris, tome II", the trade activities in Ayvalık increased rapidly. New factories were added to the old ones by the supports of foreign investors through the industrialization effects of Europe. Moreover, these trade activities also led to the establishment of consulates in the town such as Greek, England, Italy, France and Norway (Yorulmaz, 2000: 59-61).

In the second half of the 19th-century, the political and demographic situation of Ayvalık changed. By the accordance with the Treaty of Lausanne in 1923, the Rums in Ayvalık were forced to move to different parts of Greece, while the Turks living in Lesbos, Macedonia and Crete were moved to Ayvalık and Cunda. As for the main economic activity of the city that is olive industry was continued by the Turks, especially after 1960s -almost 37 years- (Şahin Güçhan, 2008: 84). After this turning point, it was remarked that the main economic activities were still same as olive, olive oil and soap production. In 1923, there were 32 olive-oil mills and 28 soap factories in Ayvalık (Yorulmaz, 2000: 60).

2. Literature Review

2.1. Adaptive Re-use as a Strategy towards Conservation of Industrial Heritage in Ayvalık

The most profound impact of industrialization on industrial areas in urban settlements was preventing the industrial activities in the city center by closing the traditional factories because of changing technologies and new demands. And they moved the industrial activities to outside the city center. Thus, industrial heritage within the centers became derelict (Föhl, 1995; Köksal, 2005).

The same also happened for Ayvalık's industrial heritage. Through the 1972 Development Plan, prepared by Architect Yavuz Taşçı, it was planned that industrial activities which had been hold in the traditional factories within the city center causing the pollution due to their functions, were moved out of the city center. This decision started to be implemented by the 1980s and the industrial activities started to be continued outside the city, near Çanakkale-İzmir Highway, inside the new buildings.

This inevitable transformation that comes due to the technological developments (modernization of the method), solved some problems in the city. However, it caused the

majority of the industrial buildings within the city center to become abandoned/non-functional. And today, while half of the industrial buildings are abandoned, the other half of them are converted into different functions some of which are done by ignoring the values. This situation leads to a loss in Ayvalık's industrial characteristics which creates a danger of extinction on the identity of the site. To overcome this problem, it is necessary to define principles of adaptive re-use of such buildings.

Nowadays, repairing and restoring existing buildings for sustainable use has become a creative and effective challenge which is often called 'adaptive re-use'. According to Brooker and Stone (2004: 26) 'adaptive re-use' (in other words, re-modeling, retrofitting, conversion, adaptation, re-working, rehabilitation or refurbishment) means that "the function is the most obvious change, but other alterations may be made to the building itself such as the circulation route, the orientation, the relationships between spaces; additions may be built and other areas may be demolished".

Re-using our heritage building stock is one of the most effective strategies to conserve them. And industrial buildings are the most appropriate heritage buildings to re-use them since they offer great opportunities for transformation of the sites. Binney et al (1990) tried to identify four advantages of industrial buildings for adaptive re-use: 1) Their walls are solid and the floors are made to carry massive weight. If they are being well maintained, they have a life of centuries which make them suitable for adaptive re-use. 2) Most of them are laid out open plan and can be refurbished and adapted for variety of uses. 3) Benefits of re-used industrial buildings such as new job opportunities which often give a certain sense of prestige and promote the development of local economy. 4) The setting of industrial buildings such as being close to the water sources and open land surroundings has quite unexpected potentials. Therefore, adaptive re-use of industrial buildings offers great opportunities for large scale regeneration.

A number of publications have been written on what is considered 'good practice' for adaptive re-use. Among the contemporary literature, 1970s up to the present, three different approaches related with the new design principles were identified on adaptive re-use by considering only the field of heritage conservation and architecture by scholars. These are shortly given below:

A) *Programmatic approach (contemporary use)*

Dwellings, schools, universities, art centers, museums as well as mixed-used are among the functions located in the former industrial buildings/sites. Trinder and Föhl (1992) stated that there are different areas of new usage for the obsolete industrial structures from classical museum to interactive museum. There are also re-use examples such as concert halls that give the possibility to experience this activity in different ambient. The gas depots converted into diving schools or chimneys reused as the climbing wall are the other examples in that sector.

However, as manufacturing technology, in the case of industrial buildings is a crucial factor that influenced the development of architectural characteristics, except for stylistic, the design principle that unites all the elements into a whole is the 'technological functionalism'³. Therefore, for the industrial buildings/sites, technological functionalism can be understood as a principle of aesthetic integrity of industrial heritage which also affects the functional integrity in re-use. Understanding the technology of the manufacturing process, from the aspect of industrial archaeology, machines and buildings that represent their physical frame is equally important.

In a post-industrial society, when these buildings can no longer continue their original uses, the problem of conserving the archaeological value of industrial heritage which is defined as technological functionalism, comes to the fore. The characteristics of the industrial buildings/sites reflect their technological manufacturing process which unfolded in them, or still does. And technological functionalism is limiting factor in adaptive re-use in terms of contemporary use as well as related interventions. Proposing any other function for the former industrial buildings, except of converting into a museum of industry, is contradictory to its archaeological value according to industrial archaeologists (Rogic, 2009: 42).

On the other hand, Föhl (1995) mentioned that the museum as a new function is the first thing coming to mind and preferred method for preserving its archaeological value. However, it should be pointed out that museum as a new function became very common method through increasing number of them in the

sector. As a result of that, the necessity of them should be thought for each case.

Nevertheless, it is important that new function should be given to the historic buildings continually and increasingly being adapted for a whole range of functions instead of freezing the history. In each of these functions, the characteristics of the existing building and linking it with the design principles are essential.

B) *Design Principles of Interventions*

In the contemporary literature, design principles are mainly divided into three categories which the alterations to existing fabric are low, medium and high. Brooker and Stone (2004) (intervention-insertion-installation), Feireiss and Klanten (2009) (Add-on, inside-out, change clothes), Jager (2010) (addition-transformation-conversion) and Rogic (2009) (coexistence-imposition-fusion) are the ones among the authors who were dealing with this approach of adaptive re-use. They discussed the design criteria and formulated them according to the good example projects.

Basically, all abovementioned models show us that the main criterion for the definition of design principles is the relationship between the existing building and the new intervention. For each model, one design principle was presented which implies dependence on the existing building and minimal change. The original building conducts the intervention and decisions. And all characteristics of the new elements derive from characteristics of the existing one.

For instance, according to Brooker and Stone (2004), the design principle of "Intervention", even though it allows for a substantial change, implies the predominance of the old building as all the characteristics of the new elements depend on the character of the existing building. Second design principle, "Insertion", preserves the image of the old building but changes substantially its inner spaces, making both old and new equality present and dominant. The third design concept, "Installation", implies the highest autonomy of the new elements, both materially and structurally,

Consequently, there are several approaches related to design principles for 'good practice' which developed by the scholars as mentioned above. The criteria for the design principles were mainly material relationship-structural dependence and formal-spatial organizations in terms of relationship between the old and the new.

³ For further information about 'Aesthetic Integrity' and 'Technological Functionalism' of Industrial Buildings, see (Rogic, 2009, Chapter 1)

C) Technical Aspects of Re-use

This approach indicates fire resistance, thermal performance, and acoustic performance, prevention of damp penetration, condensation and timber decay. Energy efficiency is another key point for this approach. It is also important to focus on how to adapt a building so as to ensure it in the best way for the new function's technical requirements. Optimizing the new use requires a detailed assessment of many aspects related to its values, existing condition such as structural layout, building capacity for the new use, its potential to meet standards (Bullen&Love, 2009).

In addition to the above given adaptive re-use approaches, it is necessary to make a critical evaluation of selected adaptive re-use examples in Ayvalık in order to understand the site (See Figure 2).

Currently, there are factories with a large program which are more than twenty in number within the building stock in Ayvalık. Some of them are being used for new purposes of which are mostly cultural, touristic and administrative purposes. For instance, state-owned ones, Vakıflar Olive-Oil Factory and Kırilangıç Factory are being used for public interest. While Vakıflar Olive-Oil Factory was converted into Olive History Museum that represents the industrial past of Ayvalık, Kırilangıç Factory Complex was converted into the administrative purpose for Ayvalık Municipality and social center for local people. On the other hand, those owned by a private entity are generally converted into touristic purposes such as hotel, café which is shaped according to the stakeholders.

Within the scope of the study, selected adaptive re-use examples in Ayvalık (See

Figure 2) were discussed according to the theoretical principles of good practice, their contribution to the site and their negative effects as well. Here, the intention was how theoretical principles are applied to the practice, specific to Ayvalık. These chosen examples originally constructed as olive-oil and/or soap factories, located in the northern part of the port, close to Ertem Olive Oil Factory. This investigation is important for comprehending the site demands, what should or should not do for Ayvalık when constituting the conservation approach and principles for Ertem Olive-Oil Factory and Ayvalık as well.

For Ayvalık, the continuation of the olive industry as a tradition at the different zone of the town and re-functioning traditional industrial buildings for food culture tourism (gastronomic tourism) or re-functioning as hotels have caused the transformation of the city from an industrial center to a touristic-commercial center.

It is obvious that re-functioning of these industrial buildings for touristic purposes is a way to preserve them for the future of Ayvalık as suggested by the Ministry of Culture and Tourism in 1984 through a research that was made by Tourism Bank. However, while giving a new function regarded with touristic purposes, the capacity of the existing building becomes essential in order to prevent the negative effects of tourism. As seen on Bacacan Hotel example, the new function is not compatible with the original capacity of the building. And it damaged the old.



Figure 2: Selected Ayvalık Adaptive Re-use Examples for the evaluation of the site within the scope of the study.

From the programmatic point of view, it can be said that most of the examples make a contribution to the site in order to provide the sustainability. Moreover, the intention of giving the museum example (Formerly, Vakıflar Olive-Oil Factory) is to understand the site demands towards developing a conservation approach for Ertem Olive Oil Factory. Because, while giving a function as museum, the necessity of it for the site should be analyzed. Thus, in Ayvalık, there is a museum of olive history that one can see the production processes, primitive and 19th-century processing tools, information about family enterprises. In addition to Olive History Museum, there is also Rahmi Koç Museum in Cunda (Formerly, Taxiarchis Church).

For their conservation approaches, it can be concluded that the successful ones have the

acceptable relation between the new and old. Generally, minimum interventions provide the success as is seen in the examples of Museum-Library, Piu-Roma Café due to their compatible functions. On the other hand, hotel examples have some additions due to their new program's requirements. In that sense, both examples, Sızma Han Boutique Hotel and Bacacan Hotel, have irreversible interventions which damage the existing structures.

Consequently, the new functional requirements can be provided through comprehensive design principles by establishing a good relationship between new and old. And it must be succeeded by analyzing the buildings both technological context and its reflection to the architecture. Generally, when the technological functionalism is used as a guide for constituting the design principles, a good

relationship between new and old is achieved for adaptive re-use of industrial buildings.

3. Understanding and Assessment of Ertem Olive Oil Factory as an Industrial Heritage
Ertem Olive Oil Factory (See Figure 3) is one of the industrial heritage buildings in Ayvalık dating back to 1910 constructed before the population exchange -1923- by a Rum named Anastasyos Yorgolos (Efe et al., 2013: 65). The factory was used by several owners for producing olive oil and by-products. In 1952, the ownership of the factory took over to Ertem Brothers who give the name to the factory itself. Ertems who immigrated from Crete in 1924, was settled in Ayvalık after the population exchange. They were one of the important families that come from olive trade originated family and they operated the factory until 2000 (Efe et al., 2013: 65). Today, the ownership of the factory belongs to a Turkish Doctor who lives in the USA. It is abandoned and under the risk of destruction due to the factors of human and nature since 2000.



Figure 3: Ertem Olive Oil Factory, top: view from the sea; bottom left: the most elaborated façade; bottom right: entrance façade (taken by Gözde Yıldız, 2015)



Figure 4: Top Left: cadastral plan (obtained from municipality); Top Right: site plan (prepared by the author, 2016), Bottom: physical layout of the building (Google Earth image, 2016 is digitally manipulated by the author)

The building lot (See Figure 4) which is located on 14. Street, Sakarya District in Ayvalık/Balıkesir-Turkey, covers an area of 1125 m², of 582 m² which is occupied by the factory. The factory is located at the north-east part of the lot. It is composed of three blocks (See Figure 5) adjacent to each other. The main entrance to the factory is provided from 14. Street, from the middle block named as '2nd Block'. The courtyard entrance is also provided from 14. Street, through a courtyard door that is adjacent to the factory.



Figure 5: Blocks forming the factory, source: Gözde Yıldız, 2016.

People leave their cities to have a healthier life, '1st Block' of the factory named as 'soap production block' (Sabunhane Block), has rectangular plan type located on the northern edge of the lot. It is two-storied block that is measured 8x23.5 m in plan dimensions and 7.5 m high from the ground level. It is constructed with the stone masonry system at the ground floor and brick masonry system at the first floor. The ground floor of this block was arranged with five different spaces for the preparation of the soap production and partially olive oil production. The first floor of this block was arranged as a single large space for the soap production processing unit. The chimney is located at this block which is made out of brick. The entrance is provided from three sides of the block. '2nd Block' of the factory named as 'olive-oil production block' (Yağhane Block), has rectangular plan type located in the middle of the other blocks. It is also two-storied block that is measure 8x15.9 m in plan dimensions and 7.45 m high from the ground level. It was arranged as a single large space on both floors. While ground floor of this block serves as olive oil processing unit, the first floor of it serves for the preparation. It is constructed with the brick masonry system and cut stones are used at the corners. The main entrance to the factory is provided from this block. There is another entrance from the west part of it which is located on the courtyard. Reaching to the

first floor is supplied from this block by the iron stairs that are located inside.

'3rd Block' of the factory named as 'Annex Block', has rectangular plan type which is two-storied block. It is 5.5x14.9 m in plan dimensions and 6.15 high from the ground level. '3rd Block' is the part of the factory that added lately as a storage for productions and resting places for the workers. It is a reinforced concrete structure that was articulated to the '2nd Block'. The entrance is provided to this block from the ground floor of it. Access to the first floor of this block is provided through a concrete stairs located in the courtyard adjacent to '2nd Block'. (See figure 6).



Figure 6: Ertem Olive Oil Factory (taken by Gözde Yıldız, 2016)

Accordingly, the factory which housed both olive-oil and soap productions, is two-storied building that was constructed with stone and brick masonry technique in Neo-classical style as similar ones in Ayvalık. Architectural and technical (process) elements of it which form the architectural characteristics of the structure have still survived as they are or with their traces. Almost all changes throughout the history are because of the developments in production processes and related spatial requirements. Thus the factory still has its originality (See Figure 6). Moreover, one of the important technological elements, the steam engine of the factory, is exhibited in Rahmi Koç Museum in İstanbul today.

3.1. Assessment of the Factory as an Industrial Heritage and Possible Conservation Proposals
Assessment regarding Ertem Olive Oil Factory can be defined into two contexts considering the building integrated entity within the city. Thus, in order to discuss a conservation

approach for the factory; problems, values and potentials should be identified for Ertem Olive Oil Factory and for Ayvalık as well.

To begin with the city scale assessments, Ayvalık has an important silhouette from the sea due to having olive-oil and soap factories lying along the coastline with their chimneys. Courtyards of the buildings and narrow streets are important open areas that have unique vista points as a link with the sea and settlement pattern. However today, the courtyards of the buildings which are the important open areas of the site are being used as car parking area, private spaces for the ones that have been restored for different uses or they are not being used because of abandonment. Hence, it is hard to find a place to connect with the sea as a visitor or an inhabitant.

In addition, one of the important problems for Ayvalık is the transaction of the properties. Today, most of the inhabitants prefer to stay in apartments, thus they sell their houses for purchasing the new one located outside the center. On the other hand, the historical buildings in the city center take the attention of intellectuals, mostly from İstanbul, Ankara and accordingly, prices rise. This situation causes the seasonal usage for the buildings. As a result of this, the living population within the center decreased. Although this situation creates decreased living population problem within the city center, it also gives a potential to the site in terms of re-functioning abandoned industrial buildings through their use value for artistic purposes by aforementioned intellectuals from Ankara and İstanbul who chose Ayvalık to stay for seasonal artistic activities, workshops, festivals such as Taste Festival, Music Festival that is specific to Ayvalık.

Another problem of the site is the abandonment of the traditional industrial buildings within the center. While few of them are re-used for cultural, commercial and touristic purposes in the northern part of the port, others are mostly abandoned such as Ertem Olive Oil Factory. Thus, negligence creates physical problems such as material, structural decays. For the restored ones, the problem is irreversible interventions that damage the buildings' originality. Those can be considered as physical problems of the city.

Although the original character of the city is damaged with the new interventions and aforementioned problems, the industrial identity of the town is still visible. All characteristics of the city such as existing traditional fabric with natural values of the site, are created potentials for the city. These

features of the area also give touristic attractions to the site and to the factory. Existing commercial and cultural activities, touristic services in the city and surroundings of the factory, give economic value and potential to the area and to the factory itself. It can be said that Ayvalık is an important touristic and cultural area with its boutique hotels, museums, festivals and related events. This situation creates a big potential for the site in terms of improving this socio-cultural features. Furthermore, the strong relation between Lesbos and Ayvalık is also important. It comes from the history, as mentioned by Psarros (2004), Ayvalık was the agricultural hinterland of Lesbos and known as 'Coast of Mytileneans'. In the history, there was always continuous trade between these settlements. And the population exchange in 1923, creates another cultural, political-social common point for these settlements. And today, these strong relations between Ayvalık and Lesbos is still continuing. The transportation network between Lesbos and Ayvalık as a result of this relationship affects the touristic attraction of each city as a potential. Accordingly, being located at the very center of the city, near the coast line, gives an important role to the factory. Its specific location that directed to the sea, within the city center is a value and potential. The well-preserved architectural features of the factory such as original plan schema, spatial organizations, are important potentials in order to adapt the building into the new life. Moreover, its big courtyard confined by the sea is another potential for new uses. Accordingly, spatial characteristics, due to serving for special purpose, related production process, which consists of valuable elements or their traces have big potential for exhibition purposes. They constitute specific ambient for new attributed functions. Therefore, the factory has functional and technological value by having specific elements inside of it. In addition to those, the valuable gastronomic culture of Ayvalık has a big potential in order to give the second life to the building with the conservation proposal.

Within this context, Ertem Olive Oil Factory which is one of the well-preserved 19th-century olive oil factories owned by a private entity as an industrial heritage in Ayvalık should respond both public demand and owner needs in terms of programmatic approach. Moreover, there are already industrial museums in Ayvalık and close surroundings that one can see these cultural rituals coming from the history. Thus, in order to avoid the increasing number of museums in the site, the factory can be

converted into multi-functional uses by referring the cultural events of Ayvalık. It is a very appropriate place for developing of these cultural backgrounds of the city such as taste festivals, music festivals, historical and cultural discussions, etc. The factory can host all of these events through its originality which behaves like an exhibit object due to its technological value that shapes its architecture. Regarding the originality of the factory which was used for the same purpose - 'olive oil and soap factory'- from its construction until its abandonment, all design principles should be highly respected. All actions as a reason for changes should be considered as valuable, even though they may have negative impacts. Thus, all interventions should be kept in minimum and they should be supported with technical specifications without harming the existing structure in order to provide the new function requirements (See Table 1).

Table 1: Conservation Proposal for Ertem Olive Oil Factory

1.PROJECT	Ertem Olive-oil and Soap Factory
AREA	1155 m2 closed area, 565 m2 open area
OWNERSHIP	Owned by private person
2.PROGRAMMATIC APPROACH	Converted into multi-purpose use that housed festivals (cultural purpose)
ARCHITECTURAL PROGRAMME	*Cafe *Sales Office *Service Units *Flexible Event Units (Multi-purpose Halls) *Didactic Area (Seminar)
3.DESIGN PRINCIPLES OF INTERVENTION	Alteration to the existing fabric: Low
Material Relationship	All the characteristics of the new elements depend on the character of the existing building. Interventions are in minimum.
Structural Dependence	Preserve the existing structure as it is.
Formal-Spatial Organization	Old formal-spatial organization is preserved.
4.TECHNICAL ASPECTS	-supported with the technical specifications for new program

4. Conclusion

Industrial buildings such as Ertem Olive Oil Factory are one of the main symbols of the socio-economic past of the towns as being cultural assets with their technological values which drives their architectural characteristics. They are important icons of our industrial-technological past due to representing the technological developments throughout the time. Since the main aim of this paper is to discuss a conservation approach for Ertem Olive Oil Factory, the first step is to investigate an accurate conservation method or approach for industrial buildings and re-evaluate Ayvalık industrial heritage through selected adaptive re-use examples according to this developed conservation approach by benefited from the contemporary literature. Accordingly, three main parameters come to

the fore for strategies of adaptive re-use of industrial buildings. These are the programmatic approach (new appropriate function), design principles of intervention (principles related to physical problems which are categorized as a material relationship, structural dependence and formal-spatial organization) and technical aspect of re-use (technical requirements for new function). Moreover, ownership statue of the buildings is another important factor while re-functioning them. That's why re-adaptation of industrial buildings is always problematic in the world. Accordingly, industrial buildings are generally converted into multi-functional uses and/or museums. It is because of their technical values that are production equipments unfolded inside of them which also give 'aesthetic value' to these buildings. They represent a symbolic and commemorative value for the collective memory as being a witness of the industrial-technological history. Thus, in order to conserve these buildings, minimum intervention is essential for the success. And it can be provided by using the technological functionalism as a guide for the design principles which is also the limiting factor for adaptive re-use.

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Multifunctionality of the oasis ecosystem. Case study: Biskra Oasis, Algeria

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ABSTRACT

The oasis, this green and ecological entity of the desert, a promise of life and hope in a rather unfriendly environment, has been for a long time a beneficial basis for the ecosystem services provided to human beings, for its socio-economic and urban values, and also for its ecological value. Today many ideas and concepts are developed in the scientific literature to demonstrate the benefits derived from ecosystems, such as ecosystem services, multifunctionality, and ecosystem values. However, the analyses of multifunctionality or ecosystem services of the oasis lack from the scientific literature. This study uses a literature review and a prior assessment of the oasis ecosystem services in order to create a particular conceptual framework for the oasis in an attempt to create a toolbox of variables or indicators for the evaluation of ecosystem services in the particular case of a desert ecosystem, i.e., the oasis.

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1. Introduction

The oasis is a small area in the desert where the presence of water allows for cultivation (Larousse, 1982). The oasis is an area of sedentary life, which associates the city [medina] or village [ksar] with its surrounding feeding source, the palm grove, within a relational and circulatory nomadic system (Kouzmine, 2007). The oasis is also a socio-spatial unit in the middle of the Saharan space, and also a distinctive mark of the cultural identity characteristic to a particular human

settlement. It is important to clarify that the oasis is primarily a form of adaptation to the harsh physical conditions of arid environments. For centuries, the oasis has been able to overcome the major obstacles of the desert. The poor quality of the soil, the rise of salt, the problems of silting, the lack of access to water

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resources and the inclemency of climatic conditions have not stopped the process of creating islands of greenery in the middle of the desert (Kerroumi, 2011). According to Ramad (2002), in the encyclopedic dictionary of ecology and environmental sciences, the oasis is a biotope located in a desert zone around a water point or in depressions where groundwater are close to the surface. According to Bouzaher (2015), the oasis is an ecosystem, traditionally structured by three fundamental elements, water, palm and habitat. Oases have played and continue to play a major role in the organization of space, the maintenance of the population and the economic functioning. This importance comes from the plurality of functions that oases have constantly fulfilled throughout history. The different functions provide to the oases, despite their limited size, a primary role in the development of Saharan and pre-Saharan territories (Kassah, 2010). Despite the importance of this ecosystem and its multiple functions, the oasis today is in a state of degradation. For that, this work aims to provide an answer to the following research question: How could the multiple roles of the oasis be demonstrated in order to challenge the degradation of its ecosystem services?

As the scientific literature lacks indicators of the ecosystem services of the oasis, we are interested in determining the major categories of benefits that the oasis society has derived from this ecosystem.

Much of the research has recognized many benefits of the urban vegetation, and most oasis-related research recognizes the fact that this ecosystem provides many different social, cultural, ecological and economic benefits.

The work of Selmi (2013), who explored the link between the two concepts, ecosystem services and multifunctionality, was used as a guiding frame for this article.

In this context, our study is based on a review of the scientific literature aimed at exposing a state of the art on the concept of multifunctionality and its relationship with the ecosystem services in the particular case of an oasis.

For this reason, we carried out a review of the scientific literature and an exploratory field survey aimed at accomplishing the following objectives:

- Collecting useful and relevant data for understanding the concept of the multifunctionality of the oasis, and ecosystem services.

- Acquire field observations and perform a qualitative assessment of the degradation of the oasis ecosystem.

The first step was to develop a study based on a qualitative approach, consisting of a documentary research, followed by a selective research focused on the contents of relevant documents (Fig. 1).

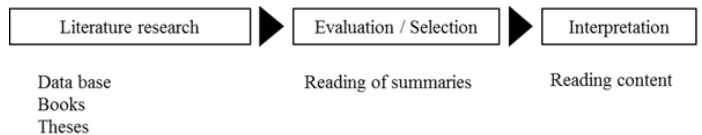


Fig. 1. Workflow of the review.

It is worth remembering that the main objective of this work is to show the link between the multiple functions of the oasis ecosystem and ecosystem services, in order to design a matrix of indicators for their evaluation, which can prove the degradation of the oasis ecosystem by the degradation of its services.

The study is not exhaustive, given the limits of research done on the topic of the oasis. This area is still under development and deserves to be developed. The objective of this work is to consider the different advantages of the oasis in several ways, as an attempt to enrich the theoretical and methodological contribution to this topic.

1.1. Conceptual frame

It was very necessary to understand, explicitly, the meaning of the notion of ecosystem services and also of the oasis ecosystem, by looking at their definition. Next, we classify the ecosystem services into several categories, and identify the components of the oasis ecosystem.

2.1. Ecosystem services: exploration of the concept

The notion of ecosystem services has become a topic of scientific debate in the international public spaces of biodiversity for some ten years now. Ecosystem services are the benefits that humans derive from the ecosystems. The Millennium Ecosystem Assessment was launched by the United Nations in 2001 to provide policymakers scientific information on the links between ecosystem change and human well-being, in order to define the actions required to strengthen the conservation of ecosystems and their exploitation in a sustainable manner.

The literature review shows that the notion of the benefits of nature for humans produced was forged in the 1960s and 1970s in the United States. The concept of “ecosystem services” was then formalized among conservation biologists since the 1980s in order to draw global attention to biodiversity loss and ecosystem degradation. Then, the concept developed from a market perspective at the beginning of the 1990s through the development of ecological economics and research on payments for ecosystem services (Petrișor, 2016). The notion was publicized in France after the launch of the ecosystem assessment for the millennium between 2001 and 2005. After this time, the notion of “ecosystem services” was developed in the perspective of a very anthropocentric vision of nature (Cardona, 2014; Lamarque, 2012). The notion of ecosystem services emphasizes first of all the dependence of man on his environment, but is based on finding out that the environment is destroyed on an alarming scale; this process leads to the question about the well-being of the man (Xavier et al, 2014).

services into four broad categories: provisioning services, which represent products and materials obtained from ecosystems such as water, food, fiber etc., regulating services which represent the benefits derived from the regulation of natural processes: climate regulation, watercourse regulation, disease and pest control, support services represent the services needed for the production of other services: soil formation, photosynthesis, nutrient and water recycling and cultural services refer to the non-material benefits provided by ecosystems and landscapes, aesthetics, places recreational activities (Lamarque, 2012). Other classifications have been proposed subsequently, disrupting other categories according to the type of ecosystem. Groot et al (2002) developed an ecosystem services analysis framework based on the detailed analysis of natural elements and the introduction of value categories (Fig. 2). These authors identified four types of ecosystem functions that constitute a mixture of ecological processes, conservation issues, production and use of ecosystems and biodiversity for socio-cultural activities (Roche et al, 2016) (Fig. 3).

2.1.1. A Framework for the Ecosystem Services Analysis

The Millennium Ecosystem Assessment (2005) has proposed a classification of ecosystem

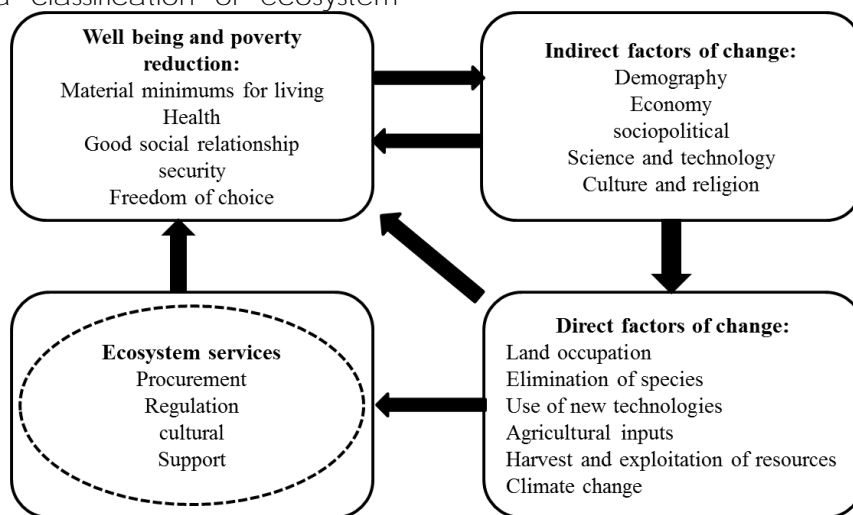


Fig 2. Framework for Ecosystem Services Analysis (Roche et al, 2016)

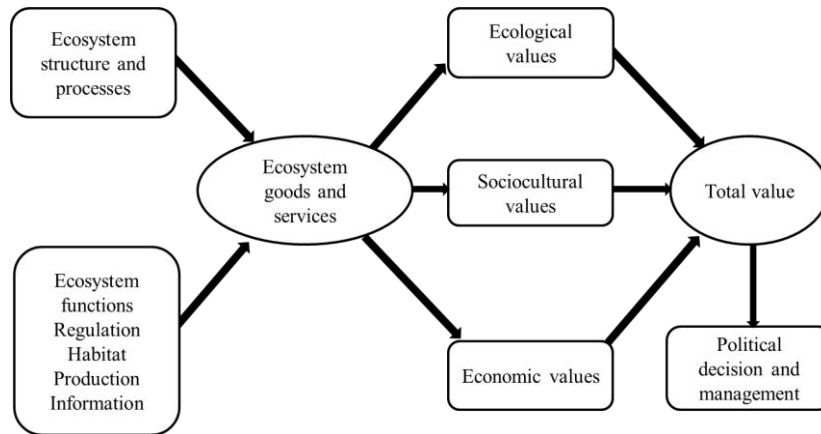


Fig. 3. Ecosystem flows and values, according to Groot et al., 2002 (Roche et al, 2016)

According to Zhang's model for agro-ecosystems (2007), we can distinguish three types of ecosystem services: input services, those that contribute to the supply of resources and the maintenance of physicochemical supports for agricultural production, and which ensure biotic interactions such as soil fertility, production services contributing to agricultural

income that concern plant production and animal production, Services produced excluding direct agricultural income, which include water quality control, carbon sequestration or the aesthetic value of landscapes in particular (Lamarque, 2012) (Fig. 4).

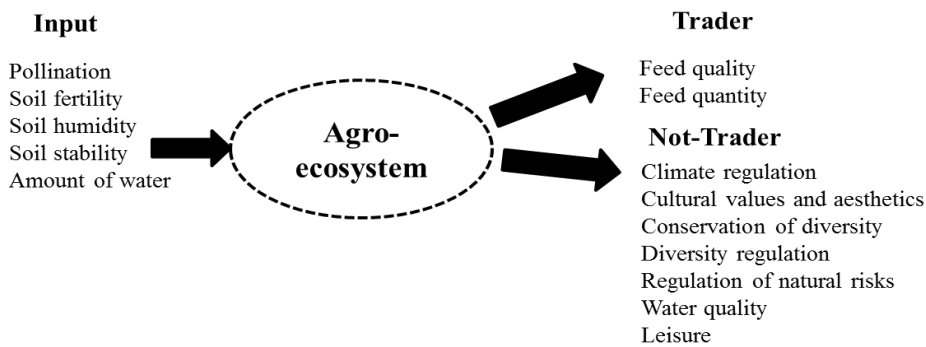


Fig. 4. Conceptual diagram of the services organization for an agro-ecosystem (Lamarque, 2012).

Another model of ecosystem services, which is also the most outstanding and widely used and disseminated in the scientific literature, has been developed by Haines-Young and Potschin (2010), and is referred as 'the cascade model' (Fig. 5). The phrase emphasizes the succession of levels that start from the ecosystem to the benefits for individuals and makes a clear distinction between the biophysical ecosystems, the ecological function, the ecosystem service and the benefit considered.

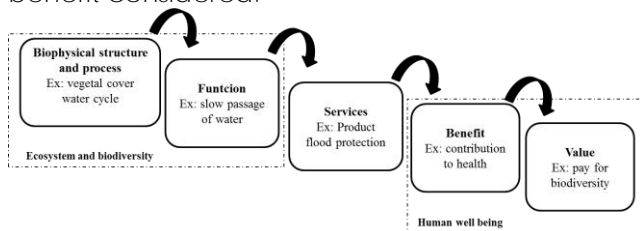


Fig. 5. Cascade model adapted from Haines-Young and Potschin (2010) (Source: Pesche and Méral, 2016).

However, the term 'ecosystem services' is a subject to many controversies, with respect to the confusion of the following terms: function, process, service, and benefit. For some authors (De Groot, 2002), 'function' refers to the ecological process of the ecosystem, and 'human well-being' refers to the benefit of the ecosystem, suggesting that ecosystem services are the result of the ecological functions of the ecosystem (Selmi, 2013).

Balmford and al. (2011) have developed a conceptual framework that extends the Millennium Ecosystem Assessment (MEA) ambition to make its previously developed framework more relevant and consistent with the proposal. The authors have classified ecosystem services in two categories: services that reveal fundamental processes of the ecosystem and those that are more directly useful to humans, by distinguishing between the ecosystem services and function (Fig. 6).

Fisher, Turner, and Morling (2009) distinguished two categories of services: ecosystem-based processes, called intermediate services, and those that are directly useful to humans, called end-services (Pesche and Meral, 2016).

This review shows that the concept of "ecosystem service" has been the object of study of several researchers working in several fields and, there is a strong need for its conceptual development.

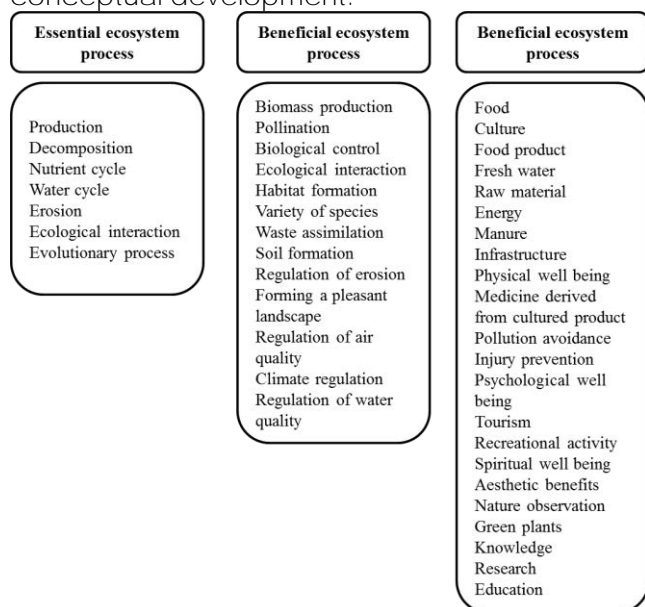


Fig. 6. Framework and typology proposed by Balmford et al (2008) (Source: Pesche and Méral, 2016).

2.1.2. Ecosystem services at the heart of environmental sciences

In general, ecosystem and ecological services are often associated or even confused. They both refer to services that humans obtain from the nature. The concept of ecosystem services was considered more important by some ecologists in the 1970s in order to highlight the dependence of human societies on nature and the urgency of safeguarding the proper functioning of ecosystems.

This is how the social sciences have understood the genesis of the notion of ecosystem services and its dissemination, in order to better understand the changes that the concept could induce in public policies and decision-making.

In the late 1980s, a stream of ecological economics studies has revealed another aspect of the ecosystem services approach, addressing the general idea that the economic system is embedded into a larger system that has taken several names such as ecosystem, nature, or biosphere. This trend aims to assess biodiversity in a monetary and economic way, the anthropic pressures on biodiversity and the negative impact it has on economic activities

and human well-being (Pesche and Méral, 2016).

Based on these results, we have oriented our work towards another perspective that is based on the three pillars of sustainable development and its relationship with the notion of ecosystem services, situated at the crossroads between the contribution of environmental science in the services ecosystem approach, the social and economic sciences and bring them together in a single evaluation grid afterwards.

2.1.3. Sustainable development and ecosystem services

Today, economics is particularly interested in the services provided by biodiversity (or ecosystems), i.e., the benefits that humans derive from nature (Bonnet and Curri, 2012). Sustainable development reconciles man, economy and the environment in a circle of interdependence, and attempts to ensure a sound and reasonable management of resources, without harming the environment and human.

In order for the development to be sustainable, society must use the natural resources at a rate that allows them to recover naturally. The quantity and quality of ecosystem services obviously play a crucial role in this process. The use and sustainable management of ecosystems are also at the heart of poverty reduction actions. Ecosystem services are an integral part of poor people's lives, and their degradation or loss can have a devastating impact on both the well-being of the poorest and on the efforts to reduce the incidence of poverty (Kosmus, Renner, Ulrich, 2013).

In the public debate and scientific literature dealing with environmental issues, the very broad concept of sustainable development has been supported by the notion of ecosystem services, which accounts for the link between humans and the ecosystems around them (Petrișor, 2017). Although this concept is slightly different from 'sustainable development', the notion of ecosystem services specifies the form of human-nature relationships, by proposing a detailed nomenclature of the different forms of services provided to the human society by nature. This enables highlighting the links between the urban form and environment: urbanization can have detrimental, but also beneficial effects depending on the type of ecosystem services studied (Regnier, 2017).

It seems clear that the notion of 'ecosystem services' has a broad relationship with

sustainable development, as the services provided by nature or any kind of ecosystem must be used in a reasonable way in order to maintain the living standards of current generations by turning them into beneficiaries of the natural ecosystems, and also ensure the survival of the future generations by protecting the natural resources in order to meet their needs.

2.1.4. Sustainable planning and ecosystem services

The city offers the best chances to establish a sustainable development approach based on the protection of biodiversity, respect of its rhythm and maintenance of ecosystem services provided by it (Selmi, 2014). The city is the basis of all types of urbanization projects. Recently, in terms of sustainable development, urbanization projects are subject to evaluation by certain tools, in order to verify their sustainability performance and the compliance with the objectives, targets and requirements of sustainability. These tools guide the action, step by step, helping to organize the process of retaining what is important, and providing options for tailored solutions. The implementation of these tools requires understanding and analyzing the phenomenon and then setting sustainability targets. Today many researchers and urban practitioners are building evaluation tools using the ecosystem services approach.

In the context of the worldwide accelerated urbanization, understanding the inter-relational complexity between humans and the urban environment has become a key concern. For this purpose, some studies have recognized the fundamental role that biodiversity plays in the city. The ecosystem services approach is integrated into urban planning policies in Europe, and this approach is clearly identified as a tool for building good resilience of cities and improving the quality of life (Pesche and Méral, 2016; Petrișor et al., 2016).

According to Bonnet and Curri (2012), understanding the value of ecosystems can lead to more informed and potentially different decisions. Taking into account the fact that this value can lead to a better management, investments in natural capital can be very profitable and sharing the benefits of these actions can generate real benefits for the most disadvantaged.

The analysis of ecosystem services is essentially based on the analysis of the values and benefits of a natural, semi-natural or urban ecosystem. These values are diverse: social,

cultural, spiritual, economic or ecological. The choice of the values to be analyzed remains dependent and determined by the researcher who carries out the evaluation of the ecosystem services; in addition, the evaluation methods are also diverse.

According to Breault (2014), the economic valuation of ecosystem services is one of the decision support tools, although it is only one element of an entire toolkit designed to help decision-making. It represents the particular advantage of associating a monetary value with the non-market services provided by urban ecosystems. This value is directly usable for evaluating the costs and benefits of urbanization projects leading to changes in the flow of ecosystem services delivered to the community, and to assess the required compensation if there is a net loss of these.

All of the above demonstrate that even though the ecosystem services approach is recent, many practitioners have put in place attempts related to sustainable management. As an example, Selmi (2014) has tried to develop an approach for evaluating the functioning and ecosystem services provided by the natural components of the city, or more specifically the analysis of urban green spaces based on their ecosystem services. Regnier (2017) has linked the problem of urban sprawl to the ecosystem services rendered by the urban ecosystem, in order to finally propose an urban form compatible with the preservation of the environment. Breault (2014) has attempted to set up economic evaluation tools and payment programs for the provision of ecological services in urban areas. This indicates the importance and interest in using the approach of ecosystem services in the field of sustainable development.



Fig. 7. Traditional oasis landscape

2.1.5. The oasis and ecosystem services

If there is a place that symbolizes human life in the desert, this is the oasis. The development of the cultivation of several varieties of dates, and, more recently, the cultivation using greenhouses, have favored the marketing of

oasis agricultural products. Oases have been integrated more and more into the market economy and international trade.

The oasis systems are characterized by a great diversity and carry multiple functions: agricultural or productive function, strategic or territorial function, recreational or tourist function, symbolic or identity function. Water appears to be an asset and major constraint, and determines the development strategies for the future in the form of technological innovations and bold choices between: a qualitative leap associated with stabilization or a reduction of surfaces (strategy of the hedgehog) and a quantum leap in extension and creation of new oases (bull strategy) (Kassah, 2010).

It is very clear that the oasis is an ecosystem that offers a lot of benefits for man and the maintenance of his life and well-being. This is a perfect model of sustainable development thanks to its ecological peculiarities, its economic function in favor of a society well adapted to the desert context through the services and benefits provided by the oasis.

2.1.6 Cross look at the multifunctionality and services of the oasis ecosystem

Given the scarcity of work done on the roles and benefits of the oasis ecosystem and its services, we have tried to search for writings and documents that have addressed the oasis not only in terms of urban planning, but also in economic and ecological terms, in order to get an idea about its functions and the role it plays at different levels.

According to several researchers (Bouzaher, 2015; Lakhdari and Cote, 2012; Zekri, 2011; Kassah, 2010; Brunel, 2006; Collete and Riou, 1990), the oasis represents a green island in the desert, a symbiosis between humidity, heat and light, a biodiversity reservoir due to its rich flora and fauna, all making together a the system used for shelf culture and breeding practices that maintain the soil fertility. The latter is maintained by cyclic organic inputs of animal origin, but also by the use of the shelf culture system.

In addition, the palm tree, as long as a characteristic oasis species, is used for ecological purposes, protects the trees and plants that are positioned on the lower floors, and also acts as a stabilizer and crop regulator. It is also used as an umbrella to protect plant species below from atmospheric aggressiveness, such as solar rays, and creates favorable conditions for their cultivation. Because of its density, it prevents the drought

of soil, improves the water reserve in the dried grounds, allowing for the maintenance of soil moisture, and mitigates the damage of natural hazards such as the sandstorms, leading to the improvement of the climatic conditions of the living environment.

The palm grove, as an ecological unit, can play a windbreak role, limiting the advancement of the desert, acting against desertification, by fixing large amounts of dust. As long as a wetland or water exists either on the surface (visible at the *segua* level) or at the level of the water table, the oasis plays a bioclimatic role due to the presence of water and palm groves, contributing to the evapotranspiration. Measurements taken in different oases have showed that the potential evapotranspiration of the areas was reduced by 30 to 50% within the oasis. This is called "the oasis effect", and tempers the desert severity inducing a microclimate favorable to crops (wind reduction, shading and evapotranspiration).

The palm grove constitutes the fundamental element of the oasis ecosystem and provides the agricultural character of oasis social life. It is the main source of income and employment in the economy, and improves the incomes of the inhabitants thanks to the production of dates and the development of underlying crops up to 3 stages of vegetation, providing a diverse food production. Secondary crops contribute significantly to the nutritional balance and improvement of family incomes; in all oases, a peasant spot is reserved at the local market for the sale of the palm grove products. Tomatoes, fresh salad and alfalfa can all be found here, as well as aromatic plants, and always these products have an exceptional quality. It should also be noted that this practice is at the origin of a conservation of the agro-biodiversity of local species, acclimated to the conditions of the desert environment. However, this particular biotope is an exotic treasure and encourages tourism, which is its strategic function and also contributes to the economic development of oasis communities.

From a social viewpoint, the palm grove plays a major role in the lives of the inhabitants by ensuring the social stability of the populations living in the oases. This contributes to the conservation of traditional knowledge and know-how that allow for a judicious and sustainable use of natural resources, be it water, irrigation techniques, or biodiversity, with respect to the choice of adapted crops. Thus, it promotes the maintenance of the psychic and

psychological balance of the human being by positively influencing their living environment and health.

The palm grove is a natural refuge of pure air where the oasis man finds a positive psychological effect and a favorable response to his need for rest and relaxation. Due to its utilitarian function, the palm grove, like any other green space, plays an ornamental role by contributing to the beautification of the oasis landscape. The palm tree is also a constructive element and often offers planks, poles, beams, lintels and decorative fences. Under the light of all its functions and its services, the oasis, through its palm grove, contributes to the psychological comfort and human well-being.

Table 1. Example of works dealing with the functions and roles of the oasis.

Oasis ecosystem roles and functions (work)	
Author	Function and role
• Bouzaher (2015)	<ul style="list-style-type: none"> • Environmental role • Social role • Economic role • Architectural and urban role
• Kassah (2010)	<ul style="list-style-type: none"> • Agricultural function • Strategic function • Recreational function • Cultural function
• Colette	<ul style="list-style-type: none"> • Environmental role • Economic and social role • Heritage role
• Zekri (2011)	<ul style="list-style-type: none"> • Recreational value
• Boudjellal (2009)	<ul style="list-style-type: none"> • Environmental role
• Zhao (2008)	<ul style="list-style-type: none"> • Environmental role
• Brunel (2006)	<ul style="list-style-type: none"> • Ecological role
• Riou (1990)	<ul style="list-style-type: none"> • Ecological role

The literature review on the oasis was synthesized in Table 1, summarizing the roles and functions of the oasis, and Table 2, based on the ecosystem services classified into four types, ecological, economic, socio-cultural and urban.

Table 2. Oasis ecosystem services board.

Oasis ecosystem services	
Type	Service
• Ecological type	<ul style="list-style-type: none"> • Maintaining soil humidity • Wind breeze effect • Nutrient recycling • Compost production • Maintaining soil fertility • Limit of the desert advance • Solar radiation reduction • Temperature control • evapotranspiration • Resistance to damage caused by storms • Fixing the dust by the fins

	<ul style="list-style-type: none"> • CO2 reduction • Maintaining air quality • Protection of young plants by the flippers • Urban refreshment
• Economic type	<ul style="list-style-type: none"> • Date production • Income contribution • Economy and energy conservation
• Urban and architectural	<ul style="list-style-type: none"> • Aesthetics and landscape • Decoration product • Construction product • Closing effect

3. The establishment of a green oasis frame
The evaluation of ecosystem services provided by the oasis and its multifunctionality may be useful if this evaluation is used to justify the choice of plant and the design criteria in a Saharan context. This operation tends to mobilize certain ecological issues, such as the conservation of oasis biodiversity, and certain socio-cultural issues, such as the conservation of traditional knowledge.

4. Conclusion

The oasis is a natural ecosystem specific to the desert. From an ecological point of view, this ecosystem is multifunctional, given the diversity of services it provides to society.

The ecosystem services of the oasis are in a state of degradation due to several factors. For this reason, this work is only a simple initiative to define the ecosystem services of the oasis, in order to increase the awareness by underlining the losses of oases over time, and also to determine the decision-makers and planners paying attention to the importance of the oasis attributes during design and development operations.

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Catching Up With BIM: A Curriculum Re-Design Strategy

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ABSTRACT

BIM has been discussed widely for enabling collaboration in AEC professions. Its widespread benefits from efficiency to sustainability in design and construction converted it into a primary tool in most AEC education institutions in the last decade. However, Turkey, like a part of the central Europe, remains hesitant in this concern. The majority of schools of architecture have conventional curricula based on fragmented areas of expertise studied separately with disconnected contents, teaching methods, and requirements. This separation not only prevents the students from building links between different contents of sustainable design, but also increases their work load while decreasing their creative potential. Regarding the necessity for collaboration in the growing complexity of built environments, underdeveloped skills in building links between fragmented data bases is eventually becoming a serious problem. After scrutinizing the fragmented curricula of the schools of architecture in Turkey, in comparison with the integral examples from around the globe, the potentiality of a BIM based transformation is going to be discussed. In order to build a strategy to redesign a curriculum of integration, apparent obstacles and potentials are going to be evaluated, with example cases for the use of BIM as a medium to include environmental and structural information in the design solutions from the second and third year students of architecture at Başkent University. This study is expected to demonstrate how provoking the skill to employ BIM can be to integrate creative educational experience in architecture, at the center of which remains the design studio. The discussion concludes by suggesting pathways to catch up with the growing gap between the global evolutions of interdisciplinary and integral design thinking through the use of BIM in AEC education.

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1. Introduction

There is a consensus that BIM and its adoption provided a shift in AEC professions (Azhar et al., 2015), which would yield to the transformation

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of the higher education of AEC disciplines (Briscoe, 2016; Scheer 2014; Barison and Santos, 2010; Deutsch, 2017). According to Scheer (2014) the transformation by BIM would lead to a redefinition of an architects' role in the creation of buildings. This redefinition requires the academia to reevaluate the profession and its education continuously. The requirement for the interconnection between the academia and the profession is even stronger today. Because there is not enough research on the industrial requirements or on the educational opportunities or limitations in Turkey, the need for a study on adapting the architectural curricula to BIM based integration has two motives. The first motive is educational, which is on the opportunity provided for achieving an integrated learning environment, in line with the constructivist educational theory (Jonassen, 1999). And the second motive is industrial, where the construction sector deals with large scale and complex projects and constitutes a leading role in the national economy. The big number of ongoing and future large scale projects of high complexity also require minimized errors in design and construction projects to be delivered in very limited times, without taking project based economic risks. Although it is known that the requirement for BIM experience is increasing, the number of research studies on the spread of BIM among professionals in Turkey is quite small. However, there is a growing need for a BIM based architectural education, which is the consequence of the professional requirement for highly complex building and construction process designs and control. One feature of this overall transformation is the multi-disciplinary working environment, where each profession can work on the same BIM model, separately but interdependently. Therefore, the problem of adapting architectural education to prepare graduates ready for a BIM based professional practice is not only about learning to use the BIM software limited with a single disciplines conventional practices.

There are two major research questions that this study deals with:

- How can the existing condition of architectural education in Turkey be transformed to prepare for a BIM based practice of building design and construction regarding the existing possibilities and limitations?
- Is it enough to deal with the problem from the potentials and limitations of the existing conditions or is it a paradigm shift that is required in the overall understanding of architectural education?

The discussion is based on the potential of BIM as a medium for resynthesizing architectural knowledge as a comprehensive whole for an integrated learning environment in the educational settings.

2. Recent approaches to BIM in higher education of AEC disciplines

As Azhar et al. (2015) put it, the practical implementation of the BIM tools started in the mid-2000s the technology of which is based on the technique of object-oriented parametric modelling. The authors explain what parametric is, with its feature that when a change is made in an object results in necessary changes in other objects, with which it has previously defined relationships. (Azhar et al., 2015). It is this feature of BIM that made it a central concern in AEC professions, which resulted in increasing number of schools that started to implement BIM into their curricula. In order to understand the current trends in this implementation, many researchers continue conducting surveys regarding the educational realm (Barison and Santos, 2010; 2012; Adbirad and Dossick, 2016; Becerik-Gerber et al., 2011; Joannides et al., 2012).

As Adbirad and Dossick (2016) state, the transition of education under the BIM influence occurred mostly as the transition of CAD teaching courses to BIM teaching courses until 2010. According to the authors, after 2010, the process of integrating BIM into core courses begun, shaping the curricula with regards to the industry participants' and academics' views on BIM. As the author state, most recently two major themes have emerged. One of them is related with the cross disciplinary collaboration and the realization of these practices in the educational curricula. The other one is based on the in-depth analysis of innovative pedagogical strategies (Adbirad and Dossick, 2016).

Based on the general conception that sees BIM as an instrument of a paradigm shift in architectural practice and education, Barison and Santos (2010) focus on how the universities around the world deal with the introduction and/or integration of BIM into their curricula. As the authors put it, by 2010 the integration of BIM into AEC curricula had reached a range of eight categories, as depicted by the authors, some of which occur together in some programs: "Digital Graphic Representation (DGR); Workshop, Design Studio; BIM Course; Building Technology; Construction Management; Thesis Project and Internship." Becerik-Gerber et al. (2011) have also made a survey across the US schools of higher education

of AEC disciplines in 2009, which depicted that an overall 56% of all programs in their survey had offered BIM courses, which had started earlier in the schools of architecture. It was in that survey that the authors depicted that almost all of the programs which had not yet included BIM in their curricula were planning to incorporate BIM into them within a year or two. It is interesting that Becerik-Gerber et al.'s (2011) study depicts that in 2009, in many architecture programs, BIM was assumed to hinder creativity. The article does not give a specific reason for this belief but what the authors state by quoting from Denzer and Hedges (2008) is important, which indicates that the biggest challenge for design instructors is the new teaching methods required with BIM. This might mean that it is not BIM that hinders creativity, but the current educational methods require a transformation to fulfil a creative insight to be achieved via BIM. These methods are mostly about employing BIM as a teaching tool to demonstrate the course content (eg. construction detailing) on the BIM model. According to Morton (2012), BIM has a creative potential starting from the early conceptual design and academia has to fulfil it.

3. The predominating role of collaborative design in BIM implementation

With the feature of object oriented parametric modelling (Azhar et al., 2015), BIM supports the concept of Integrated Project Delivery (IPD), which means collaborative building design and construction practices. As he states, it requires the multiuser access to the BIM model to integrate multidisciplinary information in the same model (Azhar et al., 2015, 24). This is interoperability of a BIM software referring to its ability to provide working media and feedback to all of the stakeholders of the project through a single BIM model. This feature brings the opportunity of collaborative design, in which the design task is divided into parallel sub tasks that can be progressed simultaneously. Division of labor is the sharing of problems into the sub problems of different professional databases. That the task is not completely separated which is the essence of collaborative work, instantaneous feedback and test outcomes can be utilized for faster and flawless problem solutions. As Kozar (2010) explains the direct interaction of collaborators is different than cooperation where different parts of a problem are solved separately and then brought together. In line with this state Azhar et al.:

"BIM represents a new paradigm within AEC, one that encourages integration of the roles of all stakeholders on a project. This integration has brought greater efficiency and harmony

among players who all too often in the past saw themselves as adversaries." (Azhar et al., 2015, P.25)

According to Kymmell (2008), The relation between the complexity of a real life architectural design problem and BIM based design process should be included within the educational curricula. He regards collaboration as the fundamental principle to the whole BIM process and asserts that "learning collaboratively is excellent preparation for the psychological mind set necessary to work with the BIM process." As he underlines it, team building and processing is not a natural skill, it has to be developed (Kymmell, 2008). If the students do not acquire the experience of team working in collaborative design project solutions during their educations, they will not actually fulfill the required BIM skills even if they have learned how to use a BIM software in an advanced level.

Deutsch (2011) also underlines the importance of knowing how to collaborate and integrate the design working process. He cites from Charles Hardy, the director of GSA Office of Projects Delivery, about his statement asserting that only 10% of BIM is technology, while the remaining 90% is "sociology". He uses the terms "mindset" and "attitudes" for expressing the state of readiness for BIM implementation as the ultimate necessity (Deutsch, 2011). As Becerik-Gerber et al. (2011) assert, the problem of collaboration and IPD is not only the problem of the schools of architecture. As a result of the literature review that they have conducted they state that today's engineering graduates are also required to have developed team-working and multidisciplinary collaboration skills. Moreover, the authors have depicted that the rate of multidisciplinary collaboration was lower than expected (Becerik-Gerber et al., 2011).

4. The relation of educational transformations with the industrial requirements.

Azhar et al. (2015) assert that BIM is a revolutionary tool for AEC industry. Likewise, Briscoe (2016) regards BIM as a source of inspiration that is potential to change how architecture is perceived and practiced. According to him, it was when CAD dominated representation in architecture that information became fragmented (Briscoe, 2016). According to Scheer (2014), the separation of design and construction that dates back to Alberti in Renaissance, has come to an end with the replacement of drawing by simulation provided via BIM. What he means by this merging of design and construction is involving the construction and technical data at the early

stages of conceptual architectural design. This might even include, as Leon et al. (2015) exemplify, the inclusion of other disciplines as consultants or design team members at the conceptual design phase. This depiction of merge after a long break since renaissance is worth attention as it also means that in architectural education this integration is also inescapable and is going to become fundamental.

Collaboration is an ultimate part of IPD and the concept of integration requires as much attention. Briscoe (2016) points to a different facet of collaboration, which is not real collaboration but requires attention for the integrative role that it takes. As he states, the case of downloading BIM objects from the manufacturers' object designs, which is now possible with the shared BIM content, makes it possible to host another designers' highly detailed and informed system design in the definitive BIM environment. As he puts it: "This exchange suggests a culture of collaboration, so to speak, in borrowing information from the workflows, opinions, and values of others (Briscoe, 2016)."

According to Scheer (2014), simulation is replacing representation, by which he means the tools for thinking for design solutions have been exposed to a shift by the adoption of BIM and computational design in the AEC industry. When taken from the educational perspective, it is important to understand that adopting BIM especially for constructional and structural information based courses at least partially for the beginning is essential.

As Deutsch (2017) asserts, it is not only the tools but also the current state of the design community that leads the convergence in building design, fabrication, and construction. By convergence he means two or more things evolving together into one. He expands this concept of integration with its three features: simultaneity of the real time decisions, superintegration of collaboration practices, and convergence of attitudes – approaches in building design and construction. He expresses the shift in architecture with this new converging nature of the profession (Deutsch, 2017). Convergence as he discusses it, implies the change in the way that architecture is practiced and how architects are educated. In line with Kocatürk and Kiviniemi (2013) Deutsch also argue that this is a process of transformation which requires the reappraisal of architecture.

There seems to be a one way relation in between the industry and academia, which results in AEC education responding the

expertise requirements of the industry. Looking from this perspective, academia in general remains short in catching up with the required developments in industry. The reason for this is that academia is assumed passive in generating knowledge on the problem of integration in building and design construction processes. Regarding this misconception, Becerik-Gerber et al. (2011) argue that AEC education must take the leading role in the shaping of industrial requirements rather than trying to answer the arising industrial requirements.

5. The current condition in Turkey: integration of BIM in the curricula

It has been almost a decade now since Becerik-Gerber et al. (2011) completed their survey across US, the results of which were given above, and in contrast with it still there is not a significant rise in the number of studies on the reflections of BIM integration in the higher education of AEC disciplines in Turkey. Türkyılmaz's (2016) article is an example for BIM integration in architectural education, which explains the objective of the BIM course of a university in İstanbul, Turkey as the consistent production of the complete set of building representations and documentation. The author expresses the capabilities brought by BIM without including the multidisciplinary collaboration feature. Nor does he explain the practical and cognitive outcomes of the integrating function of BIM.

However, this single example should not mean that there is a dominating ignorance for the integrating role of BIM in Turkey. Indeed, Türkyılmaz's discussion is limited with the individual design practice of a single discipline, because of the current state of the educational curricula. Being aware of the potentials and requirements of BIM integration, Meterelliyoz & Özener (2017) argue that the use of BIM in education should not be limited with drawing, production and visualization and that the predominating potential of BIM on integrated design should be considered as a pedagogical input that can transform education. Based on this motive, the authors have analyzed the existing curriculum of a school for its early stages of architectural education to understand the adaptability of BIM based pedagogy, and it included understanding the convention of the courses on building systems and construction detailing. This is an example of what to do when BIM integration is late in architecture education.

6. The reasons for delay in integrating the curricula

To explain the problems of architectural education, Barison and Santos (2010) cite Fien and Winfree (2012) for their depiction that higher education of the AEC profession has been slow in adapting to technological expectations of the industry. As expressed earlier, one reason could be the attitude of academia on misleading its role and merely trying to catch up with the requirements of industry. This indicates a lack of academics that understand the inevitable transformation caused by the new paradigm of IPD and the collaborative nature of building design caused by it. Regarding this, Mandhar and Mandhar (2013) criticize the way schools of architecture uptake BIM technology for the general misunderstanding of its overall application. They put forward two possible reasons for this problem: the first is the lack of competent staff to teach BIM thinking and the second is the indecisiveness between teaching a software or the technology and process behind it. As the authors state, the implementation of BIM "...can only be achieved with a coordinated effort between teachers, the school, senior management and the university, as pedagogical changes for integrating BIM will need departmental or even inter-departmental restructuring to ensure that it is well integrated within the curriculum and is taught effectively by staff who have specialist knowledge and a background in the subject area (Mandhar and Mandhar, 2013)."

As an example of a slow transformation towards the BIM methodology, Boeykens, et al. (2013) express the case of Belgium as not being able to convert the methodology from mono-disciplinarity to cross-disciplinarity. They argue with reference to and in line with Lockley (from the NBS Building Information Report (Anon, 2011, p.20+21), that the educational institutions have a big role in the transformation towards a BIM based education, which would include learning the mind for cross disciplinary collaboration.

In their systematic literature review, Adbirad and Dossick (2016) indicate that the research articles by the authors who focus on the future of BIM based education in AEC courses were advocating that solely mastering BIM software in a BIM course "is not effective for long-term BIM implementation." But the BIM software skills are desired by the industry professionals as developed in the university education. The authors argue that BIM instructors should cover both (Adbirad and Dossick, 2016).

As Barison and Santos (2010) cite from Taylor et al. (2007), BIM has the potential to take place

throughout the program, which would mean at every level and for many differentiated content. This is where the integrating role of BIM is coming from. However, the research that Becerik-Gerber et al. (2011) conducted in 2009 revealed that BIM was mostly used in design visualization and constructability activities. The most common reason for not having integrated BIM in the curriculum is the lack of the required teaching staff. Kymmell (2008), puts forward another requirement for BIM integration. In his "recipe for successful learning" of BIM, he gives the example of BIM curriculum at California State University, Chico as a developed one. Based on the evidence he gives from that example, he asserts that success in learning to use the potentials of BIM requires motivation and full-heartedness (Kymmell, 2008). This may include the projected learning outcomes be reevaluated for a meaningful integration based on shared objectives where the courses meet at a comprehensive meaning within the students' overall educational experiences. The expected learning outcomes of integrated education would include self-competency resulting from knowing where to find what is looked for and knowing what is missing, knowing how to consult and using a simulation medium to test the proposals.

Another reason behind being late in transition is little or no teamwork or collaboration. However, the opportunities brought by BIM would also have merits for improving architecture students' creative skills. In a previous study, the positive feedback of structuring the design process of ill-defined problems was discussed (Açıköz, 2015). The idea that team working needs a structured process for interactive and uninterrupted communication among the team members to fulfill the opportunities provided with teamwork was supported with the findings of a case study. The findings of that study could also be supportive for asserting that the nature of architectural knowledge is demanding collaborative work for the development of competency through creative act.

7. The risks of fragmented curricula:

Learning in architecture is a personal task (Acikgoz, 2010). It includes students' personal educational experiences, developing their personal libraries; content libraries, portfolios, lecture notes and the like. A student has a set of information and products that belongs to his educational experiences most of which reflect the content of his/her learning. When this is the case, the fragmentation of educational experience provides the students with exhausting and time consuming challenges to

start the technical research for each project from scratch and complete the process mostly without fulfilling the minimum requirements for technical issues.

Türkyılmaz (2016) states that BIM is only used for the design studio practices in architectural education. In line with that, in the course that he explains, the IFC format has a specific place in the curriculum (Türkyılmaz, 2016), but its merits for BIM based multidisciplinary collaboration during the design and construction processes is missing. This indicates the extents to which fragmented curriculum may lead the opportunities provided by the BIM tools towards a misdirection. Deutsch (2011) seems to ask the right question regarding the current curricula about BIM and integrated design: "What, in the learning process, needs to be unlearned?" According to the author, the problem of implementing BIM in education is not about learning software, but about becoming familiar with the collaborative process and the concept of integrated design (Deutsch, 2011).

In order to understand the span of the problem caused by the fragmentation of the content of architectural design, it is necessary to understand the content of student experiences in their educational settings. A comprehensive content analysis was not made for this study, but to draw general perspective, personal experiences as an educator, and a former student of architecture in Turkey, who has experiences of study and work in three different schools of architecture, can be used to pose the question about the problem of disintegrated education. For example, the following picture of student experience is worth of attention.

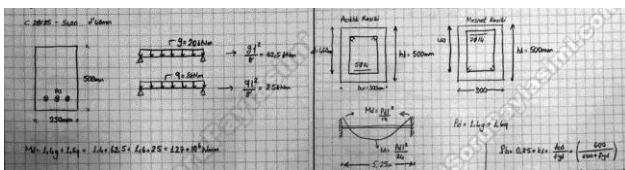


Figure 1. Portions of typical answer sheets of the reinforced concrete elements' section calculations and moment diagram (Source: sorupaylasimi.com)

The third year students of architecture in their course on "structural design in architecture", make the sectional calculations required to understand the dimensions and steel reinforcement, due to the forces acting on a single reinforced concrete element in a written exam (Figure 1). In the same week, they take critics for the solution of a concept design that does not have a structural support system yet for their design studio course. This is the educational realm experienced as a student, and observed as an instructor of 15 years which has not altered a little in this period, and which is

the literal outcome of the problem of disintegrated curriculum. A similar picture can be drawn for the courses on energy efficiency, architectural history, material and construction systems, and even for city planning courses. This is a problem of not acquiring the experience of integrating knowledge, which not only endangers fulfilling the changing requirements of AEC professions. Regarding Kocatürk and Kiviniemi's (2013) argument on how architecture should contribute to the development of BIM thinking, it is possible to think that it also threatens the disciplinary existence of architecture as a profession.

7. Displaying potential for integration through samples of student works

The research method of the study is based on sampling the 3rd and 5th semester student works for displaying their potential for an integrated curriculum design. The 2017-2018 Fall semester was the first semester that the students of the Department of Architecture at Başkent University were introduced with a BIM course in the curriculum which was converted from a former CAD course. It is important to state that none of the students from the 2nd or 3rd year had a previous experience in any BIM software before taking the courses. Fortunately, there were different courses for these two different grades that focused on CAD based representation and modelling. Therefore this semester could be the semester of implementing BIM into the curriculum of the department from scratch.

Figure 2 displays three examples of the works of the fifth semester students, who were 75 in total number. The works are the outputs of the final examination of the BIM course that lasted for 90 minutes in total, in which the students were asked to design a mass model of a high-rise building with a base, convert it to a BIM project and submit in an A0 size designed sheet in pdf format including renders, elevations and plans. 90 minutes is a very short time to prepare and submit a conceptual output when compared with the traditional design and representation media or CAD. The outcomes were mostly valuable because they displayed the speed of working with BIM, which is going to become a fundamental requirement especially in multidisciplinary collaboration.

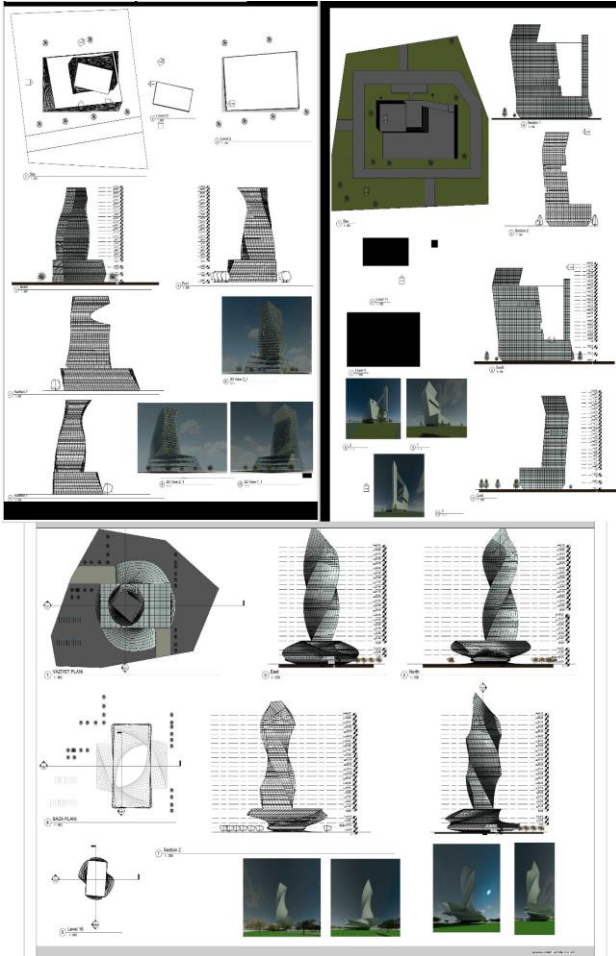


Figure 2: Three of the total 75 5th semester students' final exams' presentations

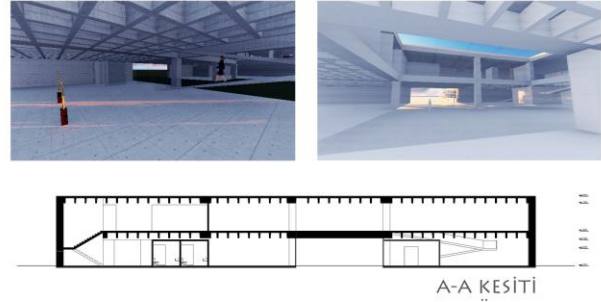


Figure 4: Sample BIM integration in the design studio of 3rd semester students.

In their 3rd semester, the students of architecture take a must course on basic construction principles and solution methods of structural systems including reinforced concrete. In figure 4 a student has integrated her structural design knowledge into her design studio experience through the use of BIM.

The given examples from Başkent University Department of Architecture display the consequences of implementing a BIM course into curriculum. It is evident that the students are enthusiastic about integrating their knowledge base in the design studio, which has been regarded as the core of architectural education for a long time. It is important to note that there was not a specific requirement for this integration by the instructors of the department. The question is what would happen after a fully integrated curriculum in architecture after managing to solve the limitations mentioned above could be overcome.



Figure 3: Sample BIM model renders given to express the solar conditions of the 3rd semester students' final design studio projects.

8. Conclusion:

Being late in adopting the required transformations in AEC education has many disadvantages in terms of catching up with the developed and progressed merits of integrated building design and construction in education and in practice. However, it also has an advantage, which is being able to reach the researches on schools of architecture that have overcome the obstacles of teaching BIM.

One of the most important findings that should be kept in mind is the depiction that academia should take the leading role in determining the development of BIM based integration from industry (Becerik-Gerber et al., 2011). This requires in Adbirad and Dossick's (2016) words, the in-depth analysis of innovative pedagogical strategies to get prepared for coming to the grounds of studying the cross disciplinary collaboration and the realization of its practices in the educational curricula.

Being a BIM instructor of five years' experience, it is possible for the author to argue that the long-term BIM implementation cannot be possible without being competent with a BIM

software at least at the intermediate level, however, the objective to acquire the software skill may have limitations of its own, like feeling limited with the previously reached solutions of the software. Therefore, there should be a practice based instruction on the BIM software, but understanding the BIM thinking is necessary if the students are expected to use BIM as a design tool for creative processes in their own design work. This means that they have to be explorative for differing potentials, opportunities and limitations of the tools that they are using in order not to be controlled by what the tools can do.

However, in order to answer the need for collaborative design experience in monodisciplinary and interdisciplinary educational settings, the curricula should be examined for the existing material to adopt accordingly. For example, As Azhar et al. (2015) put it, BIM provides sustainable design analysis at the pre stages of the design, which is as they put it, the most critical phase for decisions on sustainability features (Azhar et al., 2015, 22).

This is important regarding Becerik-Gerber et al.'s (2011) study which examines the sustainability based courses with their integrating feature, having a relevant solution base to be converted to BIM based courses. The sustainability and sustainable construction courses also have an interdisciplinary span of content.

A BIM based curriculum requires a structured process of collaborative design study. But where this collaboration starts and how the team working experience can be a part of an integrative curriculum are the questions that need to be answered. It is however apparent that BIM can be used as a tool for architectural curriculum to transform from the system of fragmented content to an integrated education. The integration requires experience; students' experiences must be the base to integrate different content. But is this experience only building a BIM model, or building it collectively in the design studio? Kymmell's (2008) recipe for successful learning would not work if the students are more motivated in the design studio than in the courses of other fragmented content.

According to Deutsch (2017) the result of convergence in AEC professions must be more than only increased efficiency, it also leads us to a future where the boundaries between AEC professions are mostly blurred or disappeared. Therefore, assuming the completion of the catch-up with BIM implementation in education and even the state of leading the AEC professions, it would be reasonable to get

prepared for redefining the AEC disciplines including architecture and questioning their fragmentation too.

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Exploring Design Principles of Bioclimatic Architecture and Double Skin Facades as A Convincing Tool for Energy Saving

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ABSTRACT

Different climates of different regions do not provide the required appropriate climatic conditions to ensure thermal comfort all year long. The goal to be pursued is to achieve the best interaction between climate, building and user behaviour. Bioclimatic buildings exploit climate in order to offer their occupants the most appropriate comfortable conditions. Especially, variations in hours of sunshine, in temperature, and rainfall of a particular climate signify establishing various strategies according to seasonal differences of particular region. In winter time assembling most of solar gain, and protecting the users from the cold (heating) are important. In summer; occupants/users need more protection from the sun (cooling). Thus, bioclimatic buildings reside in tune with these natural rhythms through consulting the most of natural lighting. This paper is aimed to enable architects to rediscover the principles of bioclimatic architecture and the modern technical and architectural means to achieve them. The study persuades adjusting the Double Skin Façades (DSF) design as the disciplined approach of ensuring the major strategies of Bioclimatic Architecture. Apparently, the study seeks three delineated bioclimatic approach daylight, thermal comfort and natural ventilation in DSF systems. The study views the DFS systems as the potential inclination for bioclimatic architecture ecological principles. On this basis, a connection between Bioclimatic Architecture and DFS systems are asserted and moderated within a generalized task.

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1. Introduction

Decades, the energy consumption came to the agenda as an alerting paradigm of major global concern. In view this fact; the many researches have accomplished a novel interest in the field of ecological studies in order to provide enhancing approaches and strategies. The building construction sector has been notified as the major fact on energy consuming. Their operational energy is

commonly supplied in the form of electricity, which is engendered from fossil fuels. Overall, studies reported that buildings' energy use constitutes about one third of the global final energy use (G. B. Hanna, 2013). On this basis;

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sustainability spirit in architecture engaged with the manifestation of "more efficient energy use", where an allied relationship through the external and internal environment is adjusted to be asserted. This realm significantly influenced and correlated awareness on the selection of construction type and material use in architectural design, especially façade enterprises. In the explicit of sustainability beyond architecture has imposed various approaches in various scales of illuminating the ecological responsive allocation.

Fascinatingly to address the main paradigm of efficient energy use in design; the bioclimatic architecture appears as the grounded approach that signifies the major spirits (natural ventilation, heating, cooling and lighting) of efficient energy use in building design. Following "efficient energy use" aim of the sustainability in architectural design; the bioclimatic architecture demonstrates a responsive endorsement on indicating efficient way of energy use as a cognitive tool for design. In view of this fact; its principles particularly reside along with a natural dynamic interaction between user, their built environment and the outdoor climatic conditions. However, the determination of bioclimatic architecture can be adjusted either in vernacular buildings, or contemporary buildings without any style or era distinction. In other words; any type of building belonging any time dilemma might be classified as bioclimatic. In order to call a building as bioclimatic architecture; the ecological dimension of the building significantly must met with energy efficiency perspective as naturally achieving the way ventilation, heating, cooling and lighting Olgay V. (1953), Aronin JE. (1953), Arens E et al. (1981), Lima A. (1995), Singh MK, Mahapatra S, Atreya S. (2010).

In recent; a significant interests has growth in Double Skin Façade (DSF) design and its usage due to its pragmatic benefits on energy conservation contributing to the energy efficiency goal of sustainability (N. Safer, M. Woloszyn, J. J. Roux, and F. Kuznik, 2005). In recent demarcation DSF is resided in the definition of multi layer skin construction of contemporary architecture where an external skin adjoined to an internal skin through an intermediate space of airflow (J. Zhou and Y. Chen, 2010). In significant; the efficient energy use ideology is resembled in DSF with evacuating the solar radiation absorb upon a glazing envelope, which enhances continuous ventilation within the building. As a consequence; DSF impulses a minimized

energy consumption use amongst accomplished cooling and heating (Z. Yilmaz and F. Çetintas, 2005). However, its implementation is accompanied by significant challenges due to the complexity of the thermal and airflow phenomena that is involved in its behavior where adaptability is magnified in different climatic conditions (M. A. Shameri, M. A. Alghoul, K. Sopian, M. F. M. Zain, and O. Elayeb, 2011).

This paper investigates pragmatic deliberations of DSF for bioclimatic architecture as one of the most appropriate resided approaches of contemporary design. Thus, the study aims to fragment the DSF key parameters as a matching convincing tool for the design principles of bioclimatic architecture. The key parameters of DSF are demarcated within the framework of the study as daylight, thermal comfort and natural ventilation. The rationalized similarities between DSF and Bioclimatic Architecture are aimed to be met within a collective perspective. The questioned key primitives of energy efficiency in two correlated approaches are drawn to illuminate a utilized scheme as a convincing tool for design of contemporary era and sustainability.

2. Incorporating Bioclimatic Architecture and DSF Principles.

2.1 Bioclimatic Architecture

Bioclimatic Architecture imposes evolving climate responsive implantation in architecture through the use of appropriate project strategies considering the climatic differences of each place, in order to better improvement of the thermal comfort conditions for the occupants (Lamberts, 2006). Based on the global demarcation of international policy-Kyoto Protocol on sustainability; the bioclimatic architecture is identified as the income for reduction of energy use and other environmental impacts in order to obtain sustainability as an outcome within the challenging decade of climate change (Hyde and Rostvik, 2008). In deed; the approach provides an advantage on climate to control the heat transfer process through the right application of design elements and building technology (Goulart and Pitta, 1994; ERG, 1999 op cit). The energy save has mainly promoted with the ensured comfort conditions for occupants/users into building. Extensively in spirit; passive low energy techniques are persuaded for generating environmentally interactive, efficient and contented to human comfort standards (Yeang, 1996). On this basis the bioclimatic architecture principles are

developed on representing energy efficient strategies, while the applicability is modified based on the environmental characteristics of the region and building type (Maciel, 2007).

Various researches are intended to prospect the principles of bioclimatic architecture (Machaira et al, 2012). With all of these perspectives, EDP, Axarli & Teli and Lambertin have made the most comprehensive approach to bioclimatic architecture approach.

Listed below are different set of principles as outlined by previous researchers such as Lamberts (2006) and Axarli & Teli (2008) EDP Energy (2011) (Table 1). According to the set of principles, similarities and dissimilarities can be observed. According to comparing the various principles thermal comfort and natural lighting are the most dominant feature for bioclimatic architecture.

Table 1. Different set of principles as outlined, Lamberts (2006) and Axarli & Teli (2008) EDP Energy (2011)

According to Lamberts	<ol style="list-style-type: none"> 1. Building thermal performance. 2. Day lighting. 3. Heating and passive solar cooling. 4. Natural ventilation. 5. Thermal comfort. 6. Adequate shading.
According to Axarli & Teli	<ol style="list-style-type: none"> 1. Achievement of thermal comfort. 2. Improvement of visual comfort. 3. Creation of acoustic comfort. 4. Improvement of air quality. 5. Improvement of building's energy behavior.
According to EDP Energy	<ol style="list-style-type: none"> 1. Microclimate improvement. 2. Systems and passive cooling techniques. 3. Exploitation of solar energy. 4. Thermal protection of buildings and protection through shading. 5. Natural lighting. 6. Acoustic protection.

2.2 Double Skin Façade (DSF)

DSF can be defined as a traditional single façade doubled inside or outside amongst a secondary airflow break- glazed façade. In other words; The DSF is a system consisting of two glass skins placed in such a way that air flows within an intermediate cavity. The attribution of imposing a skin ideology is illuminative and spirited with the accomplished airflow cavity. A ventilated cavity - having a width, which can range from several centimeters to several meters - is positioned between these two skins. Though the heat extraction, the solar shading devices are placed inside the cavity (Poirazis 2004). Besides the automated equipment-shading devices; motorized openings or fans, are also frequently preferred to be integrated into the façade. The main difference between a ventilated double façade and an airtight multiple glazing lies in

the intentional and probably controlled ventilation of the cavity of the double façade, with or without integrating a shading device in the cavity separating the glazing (BBRI, 2004). In significant, pair of glass called- skins is separated upon a validated air space/ corridor. The main layer of glass imposes the insulation, while the air space/corridor between the layers of glass implements insulation against temperature extremes, winds, and sound. Sun-shading devices are often located between the two skins. All elements can be arranged differently into numbers of permutations and combinations of both solid and diaphanous membranes (Harrison, Meyer-Boake, 2003). Extensively, ventilation of the cavity can be natural, fan supported or mechanical. Apart from the type of the ventilation inside the cavity, the origin and destination of the air can differ depending mostly on climatic conditions, use, location, occupational hours of the building and the HVAC strategy.

2.2.1 The Components of DSF and Passive Design

The DSF incorporates the passive design strategies of natural ventilation and solar heat gain into the fabric of the contemporary building. These are the key components of the DSF regarding to energy efficiency and human comfort that certain types of double skin façades are controlled. These key primitives are daylight, thermal comfort and natural ventilation (Boake, T. M., Bes, B., & Arch, M., 2003).

Solar Heat Gain

In DSFs; the control of solar heat gain is obtained through the use of shading devices (typically horizontal blinds) contained within the air cavity, where the cavity also demonstrates the ability to absorb some of the incoming solar radiation. In significant; the external shading devices claim efficiently reducing the solar heat in highly glazed buildings. Moreover; horizontal blinds allow getting the specific advantages for daylighting.

There are various configurations of horizontal blind shading devices. They can either be fixed elements or, typically, operable units that are either controlled through the occupant or sensors within the building. However; in each type the air cavity space has the ability to draw off some of the initial solar radiation. Convection currents carry the heated air upwards and extracts to the exterior through the venting arrangement at the top of the cavity.

"A double-skin façade reduces heat losses because the reduced speed of the air flow and the increased temperature of the air in the cavity lowers the rate of heat transfer on the surface of the glass. This has the effect of maintaining higher surface temperatures on the inside of the glass, which in turn means that the space close to the window can be better utilized as a result of increased thermal comfort conditions" (Compagno, 1995)

Consequently; the buffer zone allows for increased use of the perimeter zone of the space that typically requires heating or cooling mechanisms against the exposed glazing. Also, with the use of improved solar heat transmission values for glazing the absorption and reflection of heat can be controlled to minimize solar heat gain. This can be accomplished through the use of what is referred to as 'spectrally selective glazing';

Spectral Selectivity refers to the ability of a glazing material to respond differently to different wavelengths of solar energy – in other words, to admit visible light while rejecting unwanted invisible infrared heat. Newer products on the market have achieved this characteristic, permitting much clearer glass than previously available for solar control glazing. A glazing with a relatively high visible transmittance and a low solar heat gain coefficient indicates that a glazing is selective. Spectrally selective glazing use special absorbing tints or coatings, and are typically either neutral in color or have a blue or blue/green appearance. An ideal spectrally selective glazing admits only the part of the sun's energy that is useful for daylighting (O'Connor, Jennifer with: Lee, E., Rubinstein, F., Selkowitz, S., 1997).

Natural Ventilation

Natural ventilation allows cooling and ventilating the space through the use of passive ventilating methods. The passive use of air currents plays a significant contribution on reducing the energy consumption of the building. Within this process; the exterior glazing of the double skin demonstrates a layer of air subsequent to the exterior wall of the building that is not affected by high velocity wind. This buffer zone as a key component to the double skin façade is typically the area admission by the occupants/users for natural ventilation. In some instances; the use of operable windows in the exterior glazing skin is also used for natural ventilation.

"The reduction of wind pressure by the addition of the extra pane of glass means that the windows can be opened even in the

uppermost floors of a high-rise building. Natural ventilation of offices by fresh air is much more acceptable to the building's users and it has the additional benefits of reducing investment in air handling systems and also reducing energy consumption." (Compagno, 1995, p. 94)

On this basis; a typical strategy of the double skin façade is to compartmentalize the buffer zone into separate regions with air supplied by grilles or vents at each level or individual zone. This compartmentalization disregards the impact of noise, sound, smoke and heat transfer from one section, level or room to the next area. The use of vents or grilles allows the control of incoming air by reducing air velocity, protecting from rain and reducing noise transmission from the exterior. Such control allows occupant access to the natural ventilation in constructions. "Most effective ways to reduce building services energy consumption is to exploit natural means and depend less on mechanical techniques" (Farmer, Graham and Guy, Simon, 2003). Extensively; the air cavity space and integrated solar shading devices control the solar heat gains that would typically require the use of mechanical means of air conditioning and air extraction.

Daylighting

Daylighting is important in two ways; first it reduces the amount of artificial lighting required, and secondly the quality of light from daylight is preferential to artificial lighting. The double skin façade with its increased glazing coverage improves the access to daylighting in the space. The increased daylighting component of the completely glazed façade initiates excessive glare and heat at certain times of the day. These increases require advance actions in design to struggle their negative effects. Solar shading devices are designed into the air cavity space to decrease solar heat gain through the glazing and reduce the amount of glare to bring forth by the increased access to daylight.

3. Findings

The indoor environment is always under the intense of to be controlled for providing the users needs by the delivery of different building services such as heating, cooling, ventilation, and lighting. This can be explained from the traditional idea that meeting occupant needs on comfort and energy savings could be met by the formation of a static, ultimate thermal environment. Resembling the ultimate thermal

environment adjustment as the major gizmo; the connections on *daylight*, *thermal comfort* and *natural ventilation* strategies of Bioclimatic Architecture and DSF Design are utilized in below Table 2.

Table 2. Daylight, Thermal Comfort and Natural Ventilation Strategies of Bioclimatic Architecture and DSF Systems.

		Bioclimatic Architecture	DSF systems
Daylight Strategies	Shading	<ul style="list-style-type: none"> • Canopies • Overhangs • Reflectors 	<ul style="list-style-type: none"> • Fixed/Movable Shading Devices contained in air cavity. • Reflectors
	Capturing	<ul style="list-style-type: none"> • Glass window surfaces • Exterior reflections 	<ul style="list-style-type: none"> • Transparent Surfaces
	Penetration	<ul style="list-style-type: none"> • Windows • Shadings 	<ul style="list-style-type: none"> • Glazed exterior and interior skin layers
	Distribution	<ul style="list-style-type: none"> • Windows • Reflectors • Interior surfaces 	<ul style="list-style-type: none"> • Windows • Reflectors • Interior surfaces
	Controlling	<ul style="list-style-type: none"> • Adjustable blinds 	<ul style="list-style-type: none"> • Adjustable venetian blinds
Thermal Comfort Strategies	Heat Capturing	<ul style="list-style-type: none"> • Orientation of the building. • Nature of surfaces and the materials used. • Topography of the site. • Glazed surfaces for direct heat gain. 	<ul style="list-style-type: none"> • Orientation of the DSF. • Glazed surfaces for direct heat gain. • Transmitting diffused solar radiation by glazed layers
	Storage	<ul style="list-style-type: none"> • Selecting materials according to their capacity to accumulate heat. 	<ul style="list-style-type: none"> • Absorptive double glazing
	Retention	<ul style="list-style-type: none"> • Dividing building into different spaces to create distinct temperature zones. 	<ul style="list-style-type: none"> • Compartmenting the buffer zone (air cavity) into separated regions with air supplied by grills or vents.
	Distribution	<ul style="list-style-type: none"> • Thermo circulation of the air. • Powered ventilation system. 	<ul style="list-style-type: none"> • Thermo circulation of the air through air cavity.
Natural Ventilation Strategies	Shading	<ul style="list-style-type: none"> • Permanent/mobile screens • Sufficient insulation • Reflective surfaces 	<ul style="list-style-type: none"> • Shading devices contained in the air cavity.
	Dissipating heat excess	<ul style="list-style-type: none"> • Outlets (chimney effect) 	<ul style="list-style-type: none"> • Air cavity • Outlets / inlets (stack effect and chimney effect)
	Cooling the structure	<ul style="list-style-type: none"> • Increasing the air speed of air circulation (venturi effect, wind towers) • Water features • Plants • Underground ducting. 	<ul style="list-style-type: none"> • Increasing the air speed of air circulation (venturi effect, wind towers) • Air vents • Manually operable windows on interior

Throughout reading the indicated findings from the listed Table 2; the following issues are more extensively and preciously conducted in explanation.

The daylight strategy intents to improve how natural light is captured and allowed to penetrate a space, and to improve how it is then diffused and focused. Controlling light to avoid visual discomfort must also be considered. The intelligent use of daylight allows the reduction of electricity consumption for lighting.

- **Shading and Control:** Excessive daylight penetration can cause visual discomfort. This can be controlled by architectural features like canopies, overhangs and reflectors in Bioclimatic Architecture, and with fixed or movable shading devices which contained in air cavity or exterior layer of DSF systems.
- **Capturing:** Windows into spaces convey a certain amount of daylight. This can be available in Bioclimatic Architecture with

designing required size of windows and reflective surfaces on the ground such as, water elements or paving and also fully glazed transparent surfaces may contribute to capturing more light in DSF systems.

- **Penetration:** The way daylight penetrates into spaces depending on the position, orientation, angle, size and type of glazing which are necessary circumstances for Bioclimatic Architecture, but DSF systems can occur penetration of daylight by fully glazed exterior of interior layer.

- **Distribution:** Daylight can be diffused by an appropriate type of glazing usage or by reflectors that allow light for penetration, both in Bioclimatic Architecture and DSF systems.

The thermal comfort strategy is a response predominantly to winter comfort: capturing the heat from solar radiation, storing it in the mass of the structure.

- **Heat capturing:** Capturing heat in Bioclimatic Architecture comprises of storing solar energy and converting into heat. The solar radiation received by a structure depends on climate together with the orientation of the building, the nature of its surfaces and the materials used, on the topography of the site and glazed surfaces. In DSF systems, orientation of DSF, directs heat gain and transmits diffused solar radiation through glazed layers that can capture heat.

- **Storage:** Heat storage can be accomplished with materials among accumulating heat capacity and absorptive double-glazing for DSF systems.

- **Retention:** Retention is the air-tightness of the building's skin together with the insulation properties of its walls that reduce heat loss in Bioclimatic Architecture; dividing a structure into different spaces for creating a distinct temperature zones. Same idea can be used in DSF systems by compartmenting the air cavity into separated regions with air supplied by grills or vents.

- **Distribution:** Distribution means conveying the air to the spaces. Air (heat) can be distributed with the thermo-circulation of the air (rising movement of warm air). This can be achieved through the air cavity that DSF systems contain where raised air must also be regulated according to the spatial needs and usage that Bioclimatic Architecture claims.

The natural ventilation strategy is a response to the requirements for summer comfort: shading from solar radiation, dissipating excess heat and cooling down naturally.

- **Shading:** Bioclimatic Architecture essentially sets the external shading screens,

which could be permanent or mobile. In DSF systems; shading devices generally arise in the air cavity for creating fully glazed façade without any additional architectural features. In addition to this; sufficient insulation should be used to prevent accumulation of heat.

- **Dissipating Excess Heat:** Dissipating of excess heat can be achieved through natural ventilation by using outlets, where temperature differences create a chimney effect in Bioclimatic Architecture. Likewise; DSF systems can achieve dissipating of excess heat for creating stack and chimney effect through the air cavity by using air inlets and outlets.

- **Cooling the Structure:** Cooling in Bioclimatic Architecture and DSF systems can be easily achieved by natural means. Common solution to ensure ventilation is to increase the speed of air circulation by venturi effect or wind towers created with buffer zone (air cavity). DSF systems also comprise operable windows, which located in the internal layer of the skin and air inlets, both on external and internal layers. In addition to these; some natural features can be used for cooling such as water features, plants and underground ducting, etc. in Bioclimatic Architecture.

4. Conclusion

Bioclimatic Architecture promotes valid major strategies to be considered as a major framework leading the ecological approaches in building industry. The general framework of Bioclimatic Architecture significantly estimates the grounds on understanding sustainability and its ecological implementations in building industry. Bioclimatic Architecture principles and strategies emphasize the pragmatic need for an amalgamated and universal approach on implementing sustainability in building projects. The challenge for the designers is to bring different bioclimatic architecture principles together with contemporary ways. The main challenge with highly glazed buildings lies especially in their ability to respond and acclimatize rapidly to the external environment according to occupants' requirements throughout the year. This is feasible by means of high-tech systems to control temperature, light and ventilation. According to the findings, an excessive correspondence has been comprehended between DSF systems and Bioclimatic Architecture strategies. Reducing heat demand, providing view through highly glazed surface, controlling solar heat gain, allowing natural ventilation with provided thermal insulation barrier, reducing artificial lighting to improve occupants comfort are all

appropriate to be achieved in DSF systems. Consequently; DSF systems of contemporary architecture can be illuminated as the equivalent trend of Bioclimatic Architecture that adjusts its fundamental ecological strategies on daylight, thermal comfort and natural ventilation.

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Investigating the Synergy of Integrated Project Delivery and Building Information Modeling in the Conservation of the Architectural Heritage

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ABSTRACT

Architectural heritage conservation projects are one of the most risky and complex projects in the construction industry. Many studies have reported frequent performance failures in terms of time, cost and quality. To implement a quality management in the conservation projects and enhance their performance; we propose the adoption of two emerging and innovative approaches: Integrated Project Delivery (IPD) and Building Information Modeling (BIM). Through an analysis of literature review (journals, white papers, norms and standards) on the subject, a comprehensive qualitative study in theoretical term has been carried out to define the potential advantages of the synergy between the BIM and IPD to face conservation issues and constraints through project lifecycle. Finally, we draw some general conclusions, summarize the implications for practice and set out recommendations for further research.

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1. Introduction

Architectural heritage building is a complex system that embraces interlinked tangible and intangible values (Attenni et al., 2017). A worldwide awareness calls for the conservation of cultural heritage to preserve, enhance and integrate it harmoniously into the contemporary living environment; and ensure the development of cultural tourism (ICOMOS, 1999). Conservation project is a complex and

sensitive approach required various skills and knowledge; In addition to the risky and uncertain nature of these projects, their fragmented and hierarchical delivering has affected project effectiveness; notably cost

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overruns and delays which are significantly higher in heritage conservation projects than in overall public works contracts (Guccio & Rizzo, 2010).

In this context; complex conservation projects require the adoption of emerging and innovative approaches, it needs more sophisticated project management models with flexible contracts to take care of the contingencies (Debopam & Satyanarayana, 2017); to enhance communication, collaboration and remove obstacles during project lifecycle. Recently, emerging digital technologies are dealing with digital document and interconnected Cultural Heritage information on a variety of delivery platforms, devices and environments; they are changing architectural heritage conservation in increasingly profound ways: functionalities, relationship and roles, to implement a quality approach and eliminate weaknesses in current project delivery systems.

In latest years, the BIM field has become a topic of great interest within the developed technology and methods notably 3D laser scanning and photogrammetry which generating 3D cultural heritage models (Logothetis et al., 2015; Dore & Murphy, 2012; Cheng et al., 2015). The power of BIM is their ability to integrate different skills, information throughout the entire project lifecycle (conceptualization and programming, survey, conservation, exploitation, maintenance). The BIM has a limited use by heritage professionals around the world (Historic England, 2017; Arayici et al., 2017); moreover a few academic researches explore the BIM added value in the management of heritage conservation project considering its whole aspects and process.

To turn into BIM in the construction industry is obviously a process of change not only in execution processes but also in functional capabilities and contractual agreements, it aims to provide better project delivery solutions (Migilinskasa et al., 2013; Hamdi & Leite 2014); nevertheless the fragment of traditional approaches and the fights for individual benefits goes against the collaborative atmosphere for BIM implementation.

Thus, integrated project delivery emerged as an innovative approach and relational alternative delivery methods based on collaborative decision making, shared values and common goals. It can effectively reduce inefficiencies and wastes that are embedded in the current design and practices of the construction industry (AIA, 2007; Kent & Becerik-Gerber, 2010; Azhara et al., 2014).

AIA (2007) indicates that the full potential benefits of both IPD and BIM are emphasized when they are used together; although it is possible to achieve IPD without BIM (Kent & Becerik-Gerber, 2010), many studies stated that BIM is essential to efficiently achieve the collaboration required for IPD.

Despite the complexity of architectural heritage conservation projects and the frequent failures of its management within traditional delivery methods, there is a total lack of research concerning the adoption of IPD in the conservation sector. In this research we intend to highlight theoretically the potential benefits of the synergy between the BIM and IPD to face conservation issues and constraints.

The rest of paper is structured as follows: Section 2 introduces some necessary concepts and definitions related to the architectural heritage conservation projects and highlights related works. Section 3 presents and reviews related works to Building Information Modeling. Section 4 presents the relationship between Building Information Modeling and heritage conservation project. Section 5 presents integrated project delivery and reviews some related works. Section 6 presents the link between IPD and BIM and depicts the benefits of the synergy between them. Section 7 is the core of the paper, it discusses and analyses the benefits of an integrated approach for managing heritage conservation projects based on the junction of IPD and BIM processes. Section 8 concludes the paper and gives prospects to be continued in the future.

Architectural heritage conservation is a dynamic intervention aims to bring out the hidden architectural qualities of heritage; to restore its state of conservation and ensure its sustainability; it takes place in complex contexts involving intricate interactions of multi-disciplinary fields; including architects, engineers, historians, archeologists, chemists, environmentalists, geologist, surveyors, craftsmen, building economist, structural, mechanical and electrical engineers, town planner and other specialists, the involving of the building owner or his representative with all this expertise which demands a high degree of experience, communication and knowledge of building materials and construction improve decision making (Harun, 2011). Unfortunately, literature showed that heritage conservation is fragmented (Azizi et al., 2015; Avrami et al., 2000; Smith, 2005; Ismail & Azlan, 2010; Perovic et al., 2016); and a different organizational cultures and philosophies ranging from

archaeologists/ architect (Kamal, 2008); the developer/ the preserver (Azizi et al., 2015). Several authors mentioned that heritage conservation projects are one of the most risky, complexes and uncertain within the construction industry, they are often confronted by a number of issues which make management of these projects extremely challenging (Azizi et al., 2015). Each conservation project is view as a unique and non-duplicate, involves indeterminate scope, a large number of variation in quantity of work and change orders make during project execution because of unavailability of information about the original structure; and pre-existing and unforeseen site and/or building conditions identified late only once the work is started (Daoud, 1997; Mckim et al., 2000; Mitropoulos & Howell 2002; Zolkafli, 2012; Perovic et al., 2016; Roy & Kalidindi, 2017; Naaranoja & Uden, 2007). As a result cost overruns, delays, level of contingency allocation are significantly higher in heritage conservation projects (Guccio & Rizzo, 2010; Reyers & Mansfield, 2001).

Conservation legislation for historic buildings is not specific and inflexible. Numerous researchers highlighted that conservation work suffers because of unskilled personnel and limited technical knowledge due to the lack of documents and guidelines that defines the purpose of these projects and reflects upon the processes or a methodological recipe for managing it. (Azizi, 2015; Azizia et al., 2016; Barbosa et al., 2016; Worthing & Dann, 2000).

1. Building Information Modeling

The Building Information Modeling is defined as a set of interrelating policies, processes and technologies that generate a systematic approach for managing the critical information within a digital model, it enables all project participants to collaborate more accurately and efficiently than traditional processes forming a reliable basis for decisions throughout the life cycle of a building (Succar, 2009; Azhar et al., 2012; NBIMS, 2007). The first theoretical approach of BIM is mainly the 3D modeling using a computer tool; the term "Building Information Model" was used by Eastman for the first time in 1975. Later, the concept of 4D-modelling (3D + time factor) appeared in research discussion of Rischmoller et al, (2000) and the vision for the 3D to nD project was defined by Lee et al. in 2002 to integrate prototyping platform for the construction and engineering industries. However BIM was adopted in pilot project even mid-2000.

Recently, many cases studies have been adopted in research to define the potential advantages of BIM in construction projects covered operational, managerial, organizational, and strategic factors. Several reviews are highlighting the multiple potential benefits of using BIM environments for different type of projects, actually the term BIM has given rise to other terms like: Existing Buildings Information Modeling (EBIM); Historic/ Heritage Building Information Modeling (HBIM); City Information Modeling (CYM); Urban Information Modeling (UIM); and Green BIM. In spite of this evolution, BIM benefits are not really covered; the BIM implementation is still in its formative stage, and should continue to struggle to achieve lifecycle BIM uses (Shou et al., 2015). BIM implementation has concerned different delivery environments, it acted as a catalyst for change, and as a result, it has received significant consideration in manuals, publications, standards and contracts. Today, the construction industry investigates the synergy between new approaches and BIM to bring other additional benefits of the technology and supporting its implementation; such as Lean (Sacks et al, 2010; Eastman et al. 2010); Agile method (Tomek & Kalinichuk, 2015), integrated project delivery (AIA California council, 2007).

2. Building Information Modeling in heritage conservation project

The BIM technology generates a new evolution of integrated and efficient information management for the conservation process due to its attitude to store semantic inter-related information, on favoring the dissemination of the intangible values of the building during its life cycle (Garagnani & Manferdini, 2013; Brumana et al., 2017; Angelini et al., 2017). The latest years, Numerous studies proposed a methodology for linking together Heritage-BIM and different digital technologies and simulation notably laser scanning and photogrammetry, for the presentation, analysis and document the complicated structures remotely, efficiently and precisely contrary with preceding survey techniques (Logothetis et al., 2015; Dore & Murphy, 2012; Cheng et al., 2015, Gigliarelli et al., 2017). Zhao (2017) considered laser scanning as hot topics related to BIM research. It can be used to capture dense 3D measurements of a facility's as-built condition and the resulting point cloud can be manually processed to create an as-built BIM; Historic England (2017) defined Historic BIM as "a multi-disciplinary process that requires the input and

collaboration of professionals with very different skillsets". Having access to an as-built heritage building facilitates interpretation of the nature of building, monitor its changes and document each investigation and intervention activity in the proposed model, it ensuring the availability, accessibility, consistency, coordination and coherence of all the knowledge related to a historical/archaeological artifact; which supporting the make interventions decisions. In (Simeone et al., 2014, Cheng et al., 2015) authors argued that the identification of emergency situations, the scheduling of intervention activities and the planning of routine management and maintenance artifact increase the productivity, profitability and accuracy of a project.

The application of BIM in conservation has given rise to other terms: Historic Building Information Modeling, Heritage Building Information Modeling, HBIM, BIM for heritage and BIM for historic buildings, they have been used almost interchangeably (Historic England, 2017).

The initial development of BIM in conservation project can be referred to the existing BIM experience from the building industry. The benefits of BIM for managing heritage conservation projects are not currently covered; a few published prototypes with limited use reports the significantly different requirements of BIM in these project (Angelini et al., 2017; Simeone et al., 2014; Arayici et al., 2017; Historic England, 2017).

3. Integrated Project Delivery

As the construction industry has become more complex, specialized, and uncertain, traditional project delivery methods become inefficient and litigious (Azhara et al., 2014; El adaway et al., 2017). Integrated project delivery emerges as a solution of the critical need of alternative relational contracts for reducing current inefficiencies and wastes of the construction industry and makes it more predictable, accurate and responsible outcomes (Matthews et al., 2003; Kent & Becerik-Gerber, 2010; Azhara et al., 2014).

Numerous published articles, reports, and white papers discuss the differences between traditional project delivery and IPD to help owners choosing appropriately for their projects. The traditional systems are hierarchical and fragmented, based classically on transactional bilateral agreement; focus on sub-optimization of project participants, a limited cooperation and innovation. In contrast, IPD is a relational multiparty

agreement between a minimum of the owner, designer or engineer, and builder; it defines the connection point between subsystems and negotiates their interfaces; IPD is a convergence of opportunities brought about by technology and business process innovation, it requires a cultural and organizational change within new roles and competencies for achieving project purposes in a collaborative environment over the individual interest of each one, in an effort to mitigate risk (Autodesk, 2008; Taylor et al., 2012; Neve et al., 2017; El-adaway et al., 2017).

Neve et al. (2017) perceived IPD as a Virtual Enterprise Paradigm on incorporating the five elements of integrating an IPD project identified through the researches of Kim & Dossick (2011) and Fischer et al. (2017), i.e. contract, culture, organization, lean construction and BIM, which interrelate and enhance one another's effectiveness. IPD is not a 'one-size-fit-all' approach, different IPD integration levels are demonstrated, certain characteristics of a particular project or delivery model such as legislative restrictions, policy limitations or cultural barriers may affect the level of integration that can be achieved (AIA 2007; Yee et al., 2017; NASFA et al., 2010; Sive & Hays, 2009; Burcin Becerik et al., 2010).

Many researchers highlighted the advantages of IPD method through different case studies, analyzed for lessons learned and shortcomings of the current IPD practices and adoption; Although there is a large unexploited potential of IPD integration and its adoption is still limited and in its beginning (Yee et al., 2017; Shou et al., 2015; Azhar, 2014), more evidence needs to be searched to prove the fully adopt IPD as a project delivery method (Yee et al., 2017; Kent & Becerik-Gerber, 2010).

4. Building Information Modeling and Integrated Project Delivery

Much of BIM and IPD researches are indicating the several links and the benefits of their synergy. BIM is mentioned in almost all of the documents that discuss IPD; they point that integrated projects can greatly benefit from BIM implantation. However, IPD is suggested by researchers as the best project management method to leverage BIM functionalities.

6.1 The IPD joined to BIM

As mentioned above, the organizational changes required by BIM to implement it effectively are restricted by current contractual arrangements. The IPD seems to be a delivery method that could most effectively facilitate

the adoption of BIM in construction project. The IPD team reaches a clear understanding regarding BIM and leverages the tool's capabilities; the IPD contracts is one of the most effective ways to deal with BIM technical and legal risks (AIA, 2007; Kent & Becerik-Gerber, 2010; Azhar, 2011). While BIM is used the most on IPD projects to a high level of sophistication, BIM or advanced information technology applications are not a prerequisite for IPD, nevertheless BIM is one of the key factors to accomplish effectively the integration required in one database to achieve better decision-making during the IPD project lifecycle (Kent & Becerik-Gerber, 2010; Xie & Liu, 2017); moreover, it can present an important role to leverage the potential advantages of Lean principals (Sacks et al., 2010; & Eastman et al., 2010), and adds major value for IPD public owners in the exploitation phase (NASFA et al., 2010).

6.2 The potential advantages of the synergy BIM/IPD

The successfully implementation of BIM / IPD system is a mechanism for involving all key participants for optimal results (AIA, 2007; Ilozor & Kelly, 2012), the instruction of participants over their roles and responsibilities takes an important place to successfully implement these two innovative approaches (Shendkar & Patil, 2017); it could significantly increase a collaborative supply chain management (Khalfan et al., 2015); enhancing proper communication, collaboration among stakeholder, reduces the confusion between them, supporting decision making process; therefore assuring cost and time optimization (Ilozor & Kelly, 2012; Shendkar & Patil, 2017); reduce the risk of design errors and omissions (Xie & Liu, 2017). Even though, many researches identify the need to verify this synergy through quantitative studies and in the different type of project.

5. Discussion and analyses

Project complexity is one of the key characteristics that should be considered in the selection of the appropriate project delivery strategy by an organization; the complexity of conservation projects which are pluridisciplinary, uncertain and risky may achieving the benefits of deep collaboration generated by the BIM environment and IPD contract. This section discusses and investigates the benefits of using BIM in conjunction with IPD to provide solutions to the problems faced by

the project team on managing the conservation of architectural heritage.

7.1 The conceptualization and the programming phase:

Starting from the beginning of the project, the early involved key participants through a Multi-Party Contract Agreement may define and synchronize earlier participant roles and responsibilities, jointly developed and validated projects objectives and obtain more inputs. The subcontractors and heritage consultants can be brought into the IPD agreement by flow-through provisions in their respective agreements with the contractor and the conservator architect, or can be included in the IPD agreement by "joining agreement" amendments. In this phase, Laser scanners can be used to create an as-built BIM; a primary investigation for the building is established to determine its values, problems, define goals and choose the appropriate type of intervention depending on its condition. If the building is severely damaged, an emergency protection system is considered in the modeling building/site. Preventive measures have to be designed before the initiation of restoration works in order to prevent further damages and enhance safety conditions during the process of examination and have to be applied by the contractor earlier by implementing lean tools.

The schedule and budget will be estimated based on organization's business case and may be linked to the BIM Model to enable rapid assessment of intervention decisions. The IPD contract must respect the specific conservation funding and guidelines, identify the appropriate organizational and business models, consider interests and seek involvement of selected third parties, such as building official(s), local heritage field organizations, associations of the protection of cultural heritage, and other stakeholders. It may identify key communication methodologies, materials, tools and technologies; such laser scanning and photogrammetry; plan the implementation of BIM and facing interoperability issues (protocols and standards, BIM management plan, etc.). Key provisions, regarding compensation, obligation and risk allocation which are due to uncertainties and unforeseen conditions, should be clearly defined and should encourage trust, open communication and collaboration.

7.2 The survey phase:

Professionals from different expertise and interests involve earlier at the appropriate time in this phase which is the key point of the conservation project to establish a detailed survey with great sensitivity, a global and detailed approach to the building starts to identify its problems, so as to preserve and valorize the rare qualities of the buildings materials, architecture and craftsmanship. The contract may contain specifics sections about responsibilities, material and technologies used in the building examination. The 3D model generated by the 3D laser scanner involves a hybrid approach to visualization of heterogeneous datasets; due to its structural, physical, historical and cultural complexity including tangible and intangible values; through a reverse engineering and analysis of existing conditions; each investigation are documented in the as-built BIM, where a massive quantity and stores semantic inter-related information are represented as well as external documents, it integrates of geometric and non-geometric datasets (historic information, photographs and drawings, legacy data, geospatial geophysics and remotely sensed data, etc.)

7.3 The design phase:

During the design phase, an interdisciplinary collaboration/integration between the fields, arts, and technologies of conservation generates and evaluates various design alternatives at an early stage using integration platforms; the BIM model allows to test scenarios for analysis of virtual proposed interventions and determine what the team will accomplish, simplify the task of understanding designs to help client deal with this complex product and a conservation code regulations will be incorporated into the design process. Intervention decisions are made at an early stages where informed decisions have the **greatest effect focusing on "best for project"** basis, In IPD the team develop a commitment to the overall project, not just to their individual component, based on open, direct, and honest communication, ideas are judged on **their merits, not on the author's role or status;** which reduce the differences between engineers/architects, archaeologists/architects, developers/preservers; and augmented opportunities for innovation and improvement; however, detailed decision process and ultimate authority of the participants varies significantly

depend on needs of specific projects and participants; clients or end-users are engaged in simultaneous reviews of different scenarios, due to the digital representation they can more easily identify conflicts between their requirements and the proposed systems will provide. The selected alternative may has both minimum effects on heritage values and is most efficient; this is arguably more important in the case of significant historic assets, where any change in the historic fabric must be carefully considered and justified, the broad experience of the diverse team benefits target value design.

A BIM database that integrates all existing construction interface-related information of subsystems (interface events, interface descriptions, and interface conditions) defined by the collaborative work, and makes verification and validation of the design more efficient with an automated clash-checking to solve interface problems, thereby eliminating unnecessary mistakes and delay at site. Visualization of building model is tied to cost and schedule models, they are better informed due to collaborative approach, to perform based clash detection in addition to the traditional static clash detection, and commitments to them are more firm to allow visualization of deviations from planned sequences and earned values.

All these approaches provide an opportunity to perform precisely and efficiently the environmental performance analyses and sustainability-enhancement measures on delivering modeling protocols contributing guideline and specification to support the LCM across time and reduce life cycle cost of operating heritage building; in addition, the team work provides an opportunity to share knowledge, embrace learning for the repair and maintenance of historic architecture and traditional techniques and augment cultural consciousness.

7.4 The construction phase:

During construction phase, construction administration will be primarily a quality control and cost monitoring function, unlike traditional project where issues are addressed and solutions achieved to actual real-life problems; because of the higher intensity of preceding phases where an efficient information management has provided between the involved participants and conflicts have been resolved virtually; it enables a better understanding of design intent so RFIs are fewer required during the intervention stage. The BIM

model maybe used to augment, manage and enhance the RFI process, less office construction administration effort is required because submittals have already been integrated into the model; enable more strategic use of prefabricated materials and systems to speed construction, less waste and injuries because work is being performed in a controlled environment and more material is factory generated, in addition, modeling the site environment after a collaborative reviews between parties before starting work helps plan logistics, assure good access and egress, and gain control of public protection risks.

Communication between professionals and craftsmen and general laborers enhance understanding of scope of work; nevertheless, the fact that scope definition is often uncertain, inaccurate and new information surfaced during the process of restoration works may affect the original restoration decisions necessitates the continuum of emergency measures even during the application process. In IPD project Work can be organized in small batches to reduce variability and increase the reliability of planning and scheduling of work; BIM advantages presented on an adjusted model based on "as built" conditions, automated quantity take off which is linked to the BIM model improves flow by reducing variability and ensures that the quantities are always accurate when changing the design at a later stage; the online access helps to bring the most up-to-date design information to the work face.

In traditional approach, each party minimizes their own risk, and most of risks are usually transferred to the contractor in most cases; IPD contracts combine the risks of all team members. Contractual provisions in the IPD agreement regarding liability waivers motivated to seek solutions to the increased risks and uncertainties problems in conservation operation rather than assigning blame; increase communication and creativity; reduce litigation costs and limit unnecessary contingencies; in addition the division of project contingency into many smaller allocations impairs effective contingency management.

7.5 The exploitation phase:

After the intervention is completed, the BIM model can be used to compare actual to planned performance; it will be the basis for the monitoring, management and routine maintenance of the building. The IPD team brings more facility management expertise into

the process; a complete building information model will be integrated into the building operating system and provided to the owner for their long term use, the BIMFM system allows facility staffs effectively to identify, track, coordinate, and access facility maintenance work in the 3D environment and used for asset management. However the interoperability provides a potential for interfacing with other enterprise systems such as CMMS, CAFM.

The 3D virtual heritage model opens a wide spectrum of further applications (sharing for education, research, entertainment, tourism purposes, etc.); in addition offers a way to transmit knowledge about heritage places to future generations.

8. Conclusion

This paper has presented a broad overview of the potential advantages of the implementation of integrated project delivery as a delivery method and the implementation of building information modeling in heritage conservation projects. The successfully implementation of BIM / IPD system can deliver efficiency conservation projects and enhance its performance. It is a mechanism for involving all key participants for optimal results where integrate different skills, information and various stages throughout the entire lifecycle of the conservation project (conceptualization and programming, survey, conservation, exploitation, maintenance) to involves the sharing of data-rich 3D models among stakeholder, reduces the confusion between them, enhancing proper communication, collaboration, and supporting decision making process, minimizing risks, and uncertainties, therefore assuring cost and time optimization on eliminating wastes. It is expected that this paper could contribute some benefits to the owners to choose the appropriately method and process to achieving a conservation project of heritage building. Further research is required to discuss the feasibility and the practicability of related concepts to successfully implement BIM / IPD in architectural heritage conservation projects; notably, how certain characteristics of such particular project may affect the level of integration that can be achieved, and what adds to a standard BIM and IPD contract in this context. It recommended to proven the theory by implementing it on some projects. Moreover; it is necessary to identify the potential synergy BIM /IPD in each type of conservation project separately.

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The Use of Textile-Based Materials in Shell System Design in Architecture and an Evaluation in Terms of Sustainability

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ABSTRACT

The textile that has emerged from dressing and protection need of people against the variable weather conditions since the primeval ages, has gained performance characteristics with the rise of artificial fibers apart from natural fiber production and with increasing technology, and has gained a good position in architectural applications. The application areas of the textile, that was traditionally used as gear, as indoor element, and as upholstery on furniture, have been varied by emerge of smart and technical textile and its use in construction sector and architecture has been actualized. The main textile based materials used on building and skin systems are Polyvinyl Chloride (PVC), Polytetrafluoroethylene (PTFE), and Ethylene Tetra Fluoro Ethylene (ETFE). Tent, pneumatic building, canopy, pleated roof, umbrella, parasol, outer curtain, shear wall and façade are structural use forms of textile materials. While the interactions between textile and architecture actualized in visual sense, structure and for, technology, and aesthetic sense, the use of textile with its sustainability in architecture also brings advantages. In the paper Eden Project, Water cube, and Alliance Arena where textile based materials are used are studied. It is seen that the textile material, which is easily applied at long-spans and at forms which cannot be handled with traditional materials, became prominent with its recycling and sustainable features.

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1. Introduction

We are facing with various statistics about the seriousness of adverse contribution of construction sector to the environment, CO2 emissions, and depletion of energy sources. It is known that building construction uses %40 of natural sources, %12 of drinkable water, and %70 of electricity and also causes between %45-%65 of tailing (Yudelsson, 2008). Therefore, the designers increasingly obey ecological designing principals for the purpose of creating

a structured environment more compatible with the natural environment. Concordantly, the manufacturing materials are evaluated by continuously being improved and re-designed to be more sustainable. The textile material, one of these materials, is playing an important role in sustainable architecture, and is potently

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used in architecture with its features of manufacturing and transportation facilities, need of less supplies, and less energy source.

Textile based materials are used in architecture with their potential to decrease artificial energy requests, to alleviate cooling loads, and solar energy gain. With this usage in architecture, obtaining low energy costs in buildings is provided. For example membranes, which are a textile product are designed as to be easily disassembled and assembled via their flexible structure, are reducing waste amount by recycling after construction. Textile based materials also became prominent with aesthetic contributions to modern architecture along with their countless efficacies at saving natural sources and transferring them to posterities. These materials which are work of advancing technology provide an easiness to convert the structure to an intended form, inspire to exciting new forms with their texture, color, and shape, and add brand value to the structure.

2. Improvement of Textile Use from Past to Present

Textile material has emerged since the existence of human being by the need of protection against heat, cold, and climatic weather conditions. Traditional textile materials used for dressing and protection at the beginning have started to be used for aesthetic and visual quality purposes in the following periods. Developing technology by the invention of synthetic fiber has emerged a different type of textile. Technical and functional features have taken precedence over aesthetic and decorative features. This category has been accepted as a follow up of traditional textile industry as a separate field of industry and started to be used in architecture (Arslan, 2009).

3. Use of Textile in Architecture at Structure and Skin System

3.1 Material Characteristics of Textile Used in Architecture

There two basic materials used in skin system. They are classified as coated and uncoated. Uncoated ones have thin fiber and woven into the raw material at the places where coating will be applied. Coated materials; glass fiber coated PTFE (Polytetrafluoroethylene), polyester coated PVC (Polyvinyl Chloride), and ETFE (Ethylene Tetra Fluoro Ethylene) are the most widely used ones among the membrane materials. Coated materials make %90 of all

membrane materials used in modern architectural projects (Drew, 2008).

3.1.1 PVC (Polyvinyl Chloride) coated polyester PVC (Polyvinyl Chloride) and its derivations PVDF (Polyvinylidene fluoride), Teflon coated Fiberglass and silicon coated fiberglass are located in among the types of membranes that measured up themselves by their price and performance, and mostly used in construction sector (Pecina, 2012). Working life of PVC coating material is more than 25 years. Coating material is durable and have self-cleaning features. It is cheap and can be find in different colors. Polyester materials coated with PVC and PVDF are the most common waterproof materials. They can be used as weather protection at outdoor areas. Providing a good light transmission, they allow diffused natural light to fill the area to eliminate the need of artificial lighting. They have a good resistance and have a transparency between zero to twenty-five percent (Krüger, 2009). These types of textiles are successfully used for residual-permanent structures with its elastic cracking resistance. Coated textiles practically never necessitate any maintenance. By virtue of being recyclable, they also ensure to reduce the environmental damages. PVC coated polyester textile materials are very sufficient for demounted (removable and attachable again) structures with their foldable, movable, and storable features (Drew, 2008).

3.1.2 PTFE (Polytetrafluoroethylene) coated fiberglass

Glass fiber coated PTFE which is accepted as one of the membrane materials with its durability feature is the most recommended material for residual projects. It is expensive comparing to others. The material that has a good light transmission provides perfect long term protection and resistance against pollution with mechanical resistance of glass fibers (Beccarelli, 2015). At extreme climate conditions, it is a long term building material convenient to buildings necessitating long span. It is less affected from environmental conditions and ultraviolet lights. With its fire-resistance feature and over 30 years proved working life, PTFE membrane material has a good durability. It's not molded and paled under the atmospheric impacts. It doesn't hold rain water on it via its self-cleaning features. Because of its rain impermeability feature, it can be used as a weather protection for long spans and big scale modules. It is a textile material that has been advantageous with its

textile material protection, resistance against chemicals, super incombustibility, ultraviolet light resistance and light reflection features. It has a very high UV resistance (Krüger, 2009).

3.1.3 ETFE (Ethylene Tetra Fluoro Ethylene) coated foil

It is the most used coating material of today (Beccarelli, 2015). ETFE is a material that has high translucency, economic, easily applicable, and has the best features at high scale projects. ETFE based membranes can be used in two different ways such as single layer or ETFE foil pillows. Single layer ETFE provides low insulation, but light transmittance is (%95) more. They can be manufactured at any form and size. Adding ETFE foils to the material, light transmittance and solar heat can be controlled. Multi-layer ETFE pillows can also be manufactured. Pillows are flexible with their geometric structure, and provides financial and energy conservation with their light-weight.

Not requiring advanced steel frames while applying ETFE material with its lightness and very similar glass look on long spans contributes to being frequently preferred at new buildings (Drew, 2008). ETFE material has mechanic feature and a good incombustibility (Beccarelli, 2015). It is a preferred material with its self-extinguishing feature. This type of textile material can be designed to provide compatibility and control against bright solar light, and patterns can be printed on to reduce the brightness. With its over 30 years working life, ETFE isn't affected from environmental weather conditions and pollution. Isn't paled or becomes embrittled in time, in turn, it shows that it is a long-lasting building material. Despite PVC and PVDF are a bit low-priced than ETFE and known better, ETFE is increasingly more demanded in construction sector because of the features it has (Krüger, 2009).








As the best known examples of ETFE material used buildings, Alliance Arena Football Stadium in Munich, Water Cube Olympic Swimming Pool in Beijing, and Eden Project in Cornwall can be counted (Drew, 2008).

3.2 Utilization Types of Textile in Architecture

Having various features and application potentials, textile is an important sustainable building material in architecture, especially for building shell. Textile materials are used for protection against weather conditions, optical protection, and privacy purposes throughout the history. When people adopted a sedentary life in time and started to construct more

durable buildings, their utilization purposes became varied. Miscellaneous applications built in past have inspired the new, contemporary utilizations. Utilization areas of architectural textile on building and shell are given below (Table 1).

Table 1. Utilization of Textile on Building and Shell in Architecture

TYPE	SAMPLE	MATERIAL	FIGURE
Tent	German Pavillion at Expo 1967	PVC-coated polyester	
Pneumatic Structure	Tea House, 2007 Germany	PTFE	
Canopy	King Abdul Aziz International Airport Hajj Terminal, 1981, Saudi Arabien	Teflon coated fibreglass fabric	
Retractable Roof	Quba Mosque, 1987, Saudi Arabien	PVC-coated polyester	
Umbrella	Osaka 1970 Expo, Umbrella, Japan	PVC	
Exterior Curtain	Curtain Wall House, 1995, Japan	Curtain woven textile	
Curtain wall/Facade	Zenith Concert Hall, 2007, France	PVC	

4. Visual Interactions between Textile and Architecture

There is visual Interaction between textile and architecture by means of production and aesthetics, and they also share their technology and information. These two disciplines have inspired each other in terms of visuality and form throughout the history.

4.1 At Buildings and Forms

While effecting today's architecture on thought and shape by its utilization way, the textile which has been used as shelter cover since the primeval era also enabled obtaining extraordinary forms in architecture via performance features that were added to it. By the utilization of textile in architecture, it is benefited from the ability of material to create any type of free form. This provides a flexibility level that can be adapted to sculpture form or works of art (Heybroek, 2013).

An example to this is the work of sculpture of Indian origin English artist Anish Kapoor named

“Marsyas” at Tate Modern Turbine in 2002. It was made by stretching PVC coated polyester textile membrane to three steel rings forming the frame like a skin (Garbe, 2008).



Figure 1. Marsyas Membrane [Uri 1]

4.2 At Technology

By the development of fiber and emerging of smart textile and technical textiles, the textile material have been started to be used in architecture. Glass, ceramic, aramid, carbon fiber, liquid crystal polymer and polyethylene, along with PVC, PTFE and ETFE are being used in composite buildings, thus, they are enhancing the quality and performance of the building. Via textile, it is becoming possible to obtain forms that cannot be possible with traditional materials. The features such as shape, color and odor of smart textiles are being able to vary according to the heat, and the textile that has function of screening on building façade is becoming deflectable according to the angle of sun, to hour, and to weather condition. Printing applications are easily done on high performance smart textiles (Figure 2) (Tani, 2015).



Figure 2. Facade print [Uri 2]

4.3 Aesthetic

Textile and architecture are two disciplines that have inspired each other throughout the history. There are marks of architectural era and buildings at fashion parades done by fashioners such as Gianfranco Ferre, Paco Rabanne and Huseyin Caglayan who had architectural education. While the fashioners

are preparing their creations, from time to time they adapt from eras such as baroque, gothic on their pattern and forms. Similarly, architects such as Zaha Hadid, Frank Gehry have profited by the curled forms of textile on their buildings.

Draping or wrapping the architectural buildings with textile material the buildings were brought motion and aesthetic, and sometimes to get a message across to the public was provided. Reichstag German Parliament building was built in 1894, and has been the symbol of German democracy. By the works of artists Christ and Jean-Claude, 100.000 sq. woven polypropylene thick textiles have been dressed to the parliament building. The fabric which was specially woven for this project and exhibited for 14 days was two times more than the building surface. The curled structure of the fabric was used to emphasis the building, to make it magnificent (Figure 3) (Heybroek, 2013).



Figure 3. German Parliament Building [Uri 3]

5. Sustainability in Architectural Textile

As a concept, sustainability is a phenomenon which doesn't consume itself and its environment while producing something, and which protects posterities' right to live and their habitat. This concept that gained importance after the world was threatened by problems such as environmental pollution, global warming, deterioration of ecological balance, and waning of water and energy sources, is important for all sectors. Main concerns of the textile used in architecture are:

- Recycling,
- Energy conservation,
- Necessary heat isolation
- Control of solar radiation (of gaining solar heat)
- Control of light transmission into indoor areas
- The best comfort conditions for the users in indoor life spaces,
- Resistance to self-weight, static snow load and dynamic loads (wind, earthquake, shock)
- Resistance to fire,

- Impermeability when wind and rain water are effective together,
- Control of vapor diffusion and vaporization occurrences,
- Noise insulation value,
- Ease of textile mounting and installation,
- Ease of cleaning and maintenance, (Motro, 2013).

6. On Textile Architecture Application Samples

The use of ETFE foil textile material on building shell of Eden Project in England, Water Cube in China and Alliance Arena Stadium in Germany has provided awareness in the world on both visual aspect and in sustainability issues.

6.1 Eden Project



Figure 4. Eden Project [Url 4]

Eden Project is a textile building which was built in Cornwall province of England in 2001 that features the largest greenhouse of the world. The purpose of Eden Project is to teach the vital relation among the flora, people and sources, and to direct them to a sustainable life by encouraging individuals to this. The "textile shell building" made with ETFE material aiming to draw attention to the copula between human and plant ecology, is placed like a chain of soap bubble on to the land 8 crossing domes having 18 to 65 meter radii (La Cuyet, 2008).

Material's high level elasticity has provided the most excellent realization of extraordinary shape of greenhouses and perfect heat isolation. Holding the air between two layers of ETFE, Hexagonal pillows on the top of steel construction in biome to keep the plants warm features a good isolation material. When Eden building was designed, it was thought that double-glassed domes as structural elements wouldn't be that much sufficient to fulfill the need to have the highest transparency, thus, ETFE foil which is 100 times lighter than glass is used and the transparency of this material made gathering more light and heat possible (Heybroek, 2013).

The improved isolation features of ETFE significantly reduce the necessary energy to heat two biomes. This recyclable material also helps to keep indoor hotter in winter and cooler in summer (Drew, 2008).

6.2 Beijing National Aquatics Center (Water Cube)



Figure 5. Water Cube [Url 5]

Water Cube building built in Beijing in 2003 is another important example to new generation buildings that have used ETFE air pillow systems just like it was in Eden Project to raise the efficiency to the highest level. Despite its brittle in appearance, it is ideally rationalized to seismic conditions at Water Cube building in Beijing, and it is seismically the most resistant building in the world (Le Cuyet, 2008).

To wrap inside and outside of the building, four thousand ETFE cells were needed (total of 100,000 sq.). ETFE has special features such as semitransparency, high radiation absorption and low UV absorption. Foil provides more light go inside and is a better isolation substance than glass. Coefficient friction of the material prevents dust collection process, cleans itself at every rain, and is more resistant against corrosion effect of solar light. Since airbags also function as sound absorber, this feature provides a significant benefit in terms of the noise created by the pools inside (Gonchar, 2010).

Semitransparent and recyclable ETFE panels provide visual comfort and visual connection with good illumination of the center via sufficient light level throughout the day. Passively heating the building and pool water, and converting the building to a magnificent glasshouse, double shell provides up to %30 saving comparing to high heating costs of indoor water sports centers. Water Cube holds %20 of the solar energy the building receives, consequently, reduces energy consumption at the rate of %30. The coating, with successive savings up to %55 at energy usage, also provides a good illumination of indoor during the day (Le Cuyet, 2008). Double layer façade

has three different climatic operating modes. During temperate mid-season, the air is let inside by opening the vents in skin. Fresh external air enters in through the outer skin, preheated by the sun in the cavity between skins, and then fills into the pool areas. During summer, when there are hot and humid conditions outside, internal air vent kept closed. Air cooled by passing over water around the building's perimeter enters the cavity through a 1 meter high bank of vents, heats up, rises and is exhausted by roof vents. In winter, both skins are closed to achieve zero heat loss through infiltration, to maximize thermal performance. To reduce daily and seasonal temperature alterations, the heat flow of the pool water and the concrete pool and building structures are utilized to absorb the sun's heat during the day and radiate it at night. By virtue of its permeability, the building is substantially illuminated by natural light, and illuminating cost is reduced in half (Moolman, 2007).

6.3 Allianz Arena



Figure 6. Allianz Arena Stadium [Url 6]

Allianz Arena that its construction was completed in Munich in 2005 is the largest football stadium having the biggest textile (membrane) skin (İtkib, 2005). In the shell of the construction 2.874 diamond shaped pneumatic ETFE textile foil (pillow) are used. Both to protect the audience against possible external damages, and to make use of solar energy most efficiently, inflated ETFE pillow is used on roof and façade (Orhon, Altın, 2014).

There are light effects illuminating the entire building at Allianz Arena. ETFE foil is programmed to reflect the colors football teams which are using the stadium by illuminating with red, white and blue colors of home football teams (Bayern Munich and TSV 1860 Munich (Jeska, 2008).

To create the light show more than 4000 energy saving LED lamps are used. Digitally controlled LEDs provide %60 energy saving and 362 tons of CO₂ savings comparing to traditional illuminating methods.

0.2 mm thick ETFE membrane with %93 light transparency used on roofs and façades make the solar light available for the lawn in the building. To provide shadowing for the audience, the pillows are either transparent, or printed according to the location of the area. The horizontal tents extensible when necessary provide additional support for solar protection (Le Cuyer, 2008). Partly retractable tent system is equipped both with reflection and noise absorption features to cope up with solar radiation. ETFE membrane is fire resistant and has self-cleaning feature. Maintenance costs are less comparing to traditional construction forms (Flett, Schelbert, 2009).

7. Conclusion and Evaluation

In this paper, choosing architecture and textile that affect each other, the relation between these two separate fields. Today textiles that are produced with technical and performance features they have along with their aesthetic and decorative features have found an immense opportunity to use in architecture and construction sector.

The utilization types of textile made of enhanced materials are tent, pneumatic building, canopy, pleated roof, umbrella, parasol, outer curtain and shear wall/façade. With the utilization of textile in architecture it has been possible to give any type of free form to the building, an identity has been brought to the buildings by the help of technology, different appearance from other buildings have been provided to them.

Aesthetically the textile makes the building one of a kind by rendering it attractive.

Three samples concerning utilization of textile based material on shell design in architecture are studied in the paper. These are Eden Project in Cornwall/England, Water Cube in Beijing/China, and Alliance Arena Football Stadium in Munich/Germany. The forms that are unrealizable with traditional materials have been implemented easily with these ETFE textile materials used on shells, roofs and lateral walls of these buildings. They have many favorable feature such as being recyclable, having very good insulation feature, reducing energy need by making use of optimum solar energy, fire resistance, self-cleaning feature, necessitating less maintenance cost comparing to traditional buildings. Unique worldwide samples composed by textile materials intensively used with these aspects attract millions of tourists by carrying brand value, and become the symbol of the city they situated.

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The Role of Advance Composite material In Contemporary Buildings

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ABSTRACT

Composite materials have been used from the earliest times, from wood, which is a naturally occurring composite of lignin and cellulose, through straw reinforced clay bricks to reinforced concrete. In the 20th century, a new breed of composite materials was developed using polymer matrices with high performance reinforcement fibres. The great effect and uncompromising properties of advance composite materials has enabled the emergence of composites cut across all fields of application and all areas of work, just to mention a few aeronautic engineering, automobile engineering, and medicine, military and building construction. Therefore, with emphasis on building construction, advance composite material has played a vital role in today's contemporary building construction method, by presenting its self as an alternative building construction material, its application has made the contemporary building construction much more flexible and achievable, compare to traditional building materials and its methods of construction. It further offers the building construction industry the technical know-how of having new possibilities of design styles, shapes and forms. Therefore, advance composite material proves its self to be a better and a new alternative building construction material that remains construction friendly and flexible based on its properties. This study therefore tends to provide an overview on advance composite material, its application as well as its role in today's contemporary building.

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1. Introduction

The human race has contributed tremendously to the improvement and processing of elementary building materials, they have become the reference point to mark the early stages of mankind discovery, invention and development, such as Stone Age, Bronze Age, Iron Age, etc. However the beginning of the recent hundred years positioned building materials to become more multifunctional and

as well required the optimization of different properties. The evolution and concept of building materials has also been driven toward composite materials whereby two or more different material parts are being joined

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together to provide a better combination of properties (Wegst et al. 2015). However, the rapid growth in technological development of the 21st century played a great role in the emergence of advanced composite materials and its construction methods. It has also presented its self to be more dynamic, and as well made contemporary buildings to be more attractive and unimaginable, therefore based on some of the outstanding attributes advance composite material portray, the use and application of traditional building material and its construction method tends to decline with time in the nearest future (Karbhari, 1998). Advanced composite material has therefore presented its self with a much greater value and sustainability; the impact of these materials has also made contemporary buildings and their various design type embrace a much more dynamic and flexible system of construction.

Building Materials can be described as the embodiment of a building or a structure, and its production accounts for 30-50% consumption of raw materials worldwide (Tagnit-hamou and Soliman, 2018). The early discovery of building materials cannot be undermining rather it can be registered as one which has gone through a unique and extraordinary historic path of discovery, starting from the early civilization of the cave men who had to source material like wood, stones strands to create shelter that can stand as a form of protection from the harshness of the weather and harmful element of the environment of stay.

Ever since then man have never remained seldom in the search for possible innovative means to create materials that can go in hand with it environment, though the 19th century remains a remarkable era that can be remembered for its industrialization and the expansion of modern construction technological development which majorly had a great influence on building materials and its method of construction (Zabihi, 2010). Though the acceleration in advancement in technology of the past and much more innovative ideas today has lead in the creation of building materials that are gradually coming to the lam light. Today advance composite material can be regarded as one of the product of effective technological development of the 21st century (Ljungberg, 2007). These innovative building materials tend to play a great role in contemporary buildings, in terms of environmental friendliness and sustainability and as well tend to bridge the

gap between already existing traditional building materials.

1. Materials and Methods

This research employed the case study method for identifying various buildings across the world that have employed the instrumentality of environment friendly materials for construction and composition. The sources of the identified buildings are the internet and other archival materials which considers the use of sustainable construction materials for the purpose of their composition. A checklist was also prepared for the purpose of obtaining up-to-date information about the selected buildings and also prepare a basic appraisal and evaluation criterial for the purpose of determining the extent of sustainability of the identified buildings.

2. Discussions

The awakening of 21st century paved way to vast technological advancement. However, these technological advancements majorly cut across the construction industry, by influencing its building material types as well as its methods of construction. This advancement further brought about a dynamic change in the building industry, by therefore producing innovative building materials (advance composite material) that offer unique properties as well as wide variety of functions, and structural performance qualities that are sustainable and environmentally friendly, and are as well very much impossible to archive with normal traditional building materials (Akadiri et al., 2012)

in terms of it:

- New aesthetic possibilities and ability to mould complex fluid and create design of different forms, shapes and styles
- Being able to Provide special integrated surface finishes and effects
- Being able to provide significant savings in weight usually up to 15%
- Being able to ensure superior durability with degradation through life
- Being able to provide Rapid installation and cost on site
- Being able to Unlock the possibilities of architectural design
- To ensure Temperature and chemical resistance
- To ensure Flex performance
- To ensure Dimensional stability.

With the above mentioned qualities, architect, designers and engineers tend to play a vital role with the use and application of

contemporary building material. They are therefore exposed with the challenges of new idea, as well as new knowledge and understanding of the nature of these new material, such as their physical and chemical properties, their structural properties, their characteristics in fire, their interaction with other material as well as their anticipated durability for any given situation, cost, maintenance requirement and potential for recycling and other environmental issues such as embodied energy. However, it also further relates to its impact in terms of health and safety, as well as its multiplicity towards aesthetic properties.

Advance composite materials as a contemporary material are mixture of two or more materials to form a composite material. It is classified as an advance composite, because they are determined by unusually high strength fibers with high stiffness or modulus of elasticity characteristic compare to other materials or composite, such as fiberglass and concrete. Advanced composite systems are divided into two basic types, thermosets and thermoplastics. Thermosets are by far the predominant type of composite in use today while Thermosets are subdivided into several resin systems including epoxies, phenolic, polyurethanes, and polyimides. These, epoxy systems currently dominate the advanced composite industry today.

The first inception of advanced composite materials can be traced back to the past 50 years with a wide range of demanding applications. However, one of its very first commercial application was noted shortly after the Second World War, with a USA Company named Mine Hunters, which introduced advanced composites into military vehicles, as well as opened doors to the multiplicity of a much more advanced composite material that are now applicable in different forms and functions in today's modern world. Advanced composite materials are now the common material for high performance super yachts, large wind turbine blades, modern aircraft, and sports and leisure equipment including ski's, snowboards and surfboards. However, they are also being widely used in construction, because they tend to offer significant weight savings and their ability to form complex shape, give architects greater freedom in design. (Nguyen, Mendis, Ngo, Tran, & Nguyen, 2013), noted that the applications of advance composite material has witnessed and reflected a great shift in the construction industry through series of research and project

carried out since the 1990s. However, its market share distribution has risen more than 25%, therefore projecting the construction industry as the second largest field in the application of advance composite, See Fig.1.

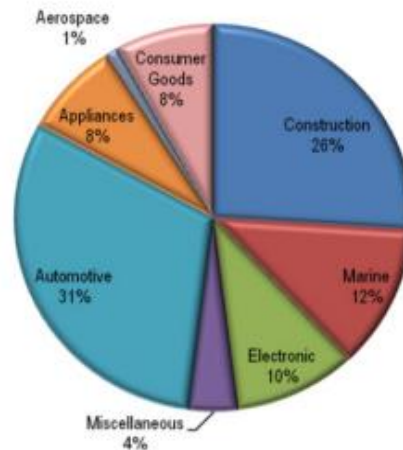


Fig.1: Shows a chart showing the differential scale in the application advance composite material (Nguyen, Mendis, Ngo, Tran, & Nguyen, 2013).

An example of such is exhibited in Heydar Aliyev Center designed by Zaha Hadid Architects. The building which is a contemporary building characterized with a complex geometry, it also represent a wide contrast from traditional building materials, because some of its major construction material used were advance composite material in form of Glass Fibre Reinforced Concrete (GFRC) and Glass Fibre Reinforced Polyester (GFRP), they were chosen as ideal cladding materials, because they allow for powerful plasticity in building design while responding to very different functional demands related to a variety of situations, see Fig 2



Fig.2: The representation of Heydar Aliyev Center Azaebarjan designed with advance composite material. Designing with advance composite materials opens up a wide range of design possibilities, it can also optimize the performance of a structure by the modification of the building blocks of the materials. The chemistry of the

resins can as well be modified to produce materials with specific characteristics for specified use.

3.1 Characteristics of advance composite material

([Nguyen, Mendis, Ngo, Tran, & Nguyen, 2013](#)), described Advance Composite materials, to possess high advantages in strength, stiffness, low density, as well as manufacturing flexibility; therefore, their potential in replacing traditional building materials (such as concrete, aluminum and steel) in building construction has become attractive. Advance composite materials are not only limited to building material alone, rather their use and application also have a broad and proven application in design flexibility as well as dramatic shapes, styles and forms in architectural aesthetics, interior finishes and landscaping design etc. one of The biggest characteristics of modern day advance composite materials are the fact that they are light in nature but also very strong to stand the taste of time. They are also innovatively driven by the choice or specification of an appropriate combination of matrix and reinforcement materials. It can therefore be made to exactly meet the specified requirements of any particular application. However, based on its outstanding attribute, advance composite materials tend to plays a vital role in taking construction, design, aesthetic and remodeling forward in this contemporary era. Therefore, with recent technological advancement, advance composite materials are now designed to respond with various stimuli which are changed significantly into predictable manner in response to the environment.

3.2 Aesthetics possibilities with advance composite material

Aesthetic problem due to complexity in design and architectonics has been notable in the construction industry, as a result of the low level of technology involved in traditional building material and its method of construction. Architects, designers and engineers show great interest in the use of advance composite materials in the formation and composition of contemporary buildings, to advance composite material for the ability to allow cost effective realization of unique shapes, styles and forms as well as flexible aesthetics, while accommodating architectural designs and needs. The long-term durability, weathering resistance, and the exceptional mechanical properties have recently suggested the

adoption of advance composite material for building façade systems in an increasing number of buildings worldwide ([Berardi & Dembsey, 2015](#)).

However contemporary buildings and structures built from advance composite materials has revealed and proven its flexibility by allowing all forms, shape and style of aesthetics to be achievable with high durability and tensile strength. Nonetheless Designs with advance composite materials are easily archived in time and safety. Advance composite materials are innovative candidates to be used in contemporary building façade and aesthetic systems because they offer excellent performance and cost effectiveness in aesthetic and complex designs.

With the benefits of high strength and stiffness, low density, and highly flexible shaping, advance composite material become potential candidates in the replace of traditional building materials (such as aluminum and steel) in civil applications. For example, advance composite materials contribute up to 50–70% weight reduction as an alternative to traditional metal-based materials. In addition, the manufacturing flexibility of advance composite material products is well-suited with the demands of architects and engineers in designing complex building structures such as the façade systems while maintaining mechanical properties and durability. Therefore, it can be noted that one of the major roles advanced composite material play in contemporary buildings are the possibility of new aesthetic. However this can be considerably high due to the vast use of advance composite materials in the twenty-first century buildings and structures. Since the introduction of advance composite material in buildings, it has paved way for some many fabricators to produce composite materials from recycled and renewable materials in other to create building elements for buildings facades and the general aesthetics of buildings and its environment.

Composite materials, such as Glass fiber reinforced polymers (GFRPs), carbon fiber reinforce polymers (CFRPs), possess the advantages of high strength, stiffness, low density, and flexibility; therefore, their potential in replacing traditional materials (such as concrete, aluminum and wood) in building aesthetics and facade has become an interesting and attractive one in the building industry today. See below Fig.3, Fig.4 and Fig.5

- The use of sandwich Glass fiber and epoxy resin combine with a lightweight

foam core that is use for the finishing of the facade of the Harman High speed Rail station in Medina.



Fig.3: The representation of the Haramain high-speed rail station. (www.burohappold.com.)

- The use of Glass fiber reinforces concrete columns of greater surface finishing and aesthetic compare to concrete and more timeserving in construction.



Fig.4: Show the representation of columns constructed with composite of glass and steel. (www.strombergarchitectural.com)

- The use of Glass fiber reinforced polymer to create the design of a museum with great surface finishing, and a façade of free flow of form without column support.



Fig.5: Illustrate the aesthetic possibility of FRP on the city museum façade with free flow of form without column supports.

3.3 The influence of advanced composite material in existing buildings and structures
Advance Composites materials are one of the most widely used materials today, because of their innovative and sustainable adaptability to different environmental and structural condition. It also allows for the combination with other materials, so as to serve specific purposes and exhibit desirable properties in existing buildings and structure. Therefore, it uses and application in buildings and structures they are selected carefully based on it intended required purpose for the repair of damaged elements in buildings or structural elements, so as to help prevent futuristic occurrence of failure of any kind in the long run use of the building or structure. However, the use and application of advance composite materials in existing buildings are to enable performance quality, structural stability and a functional structure that can stand the taste of time.

Advanced composite material like fibre reinforced polymer are proven technology used for upgrading and strengthening of concrete, masonry, timber as well as steel structure. Generally advance composite materials have exceptionally high strength, yet they remain very light and easy to work with. it application has cut across all areas of construction ranging from increase in capacity of existing buildings, bridges, seismically upgrading structure, correcting design or construction error and allowing for further modification or change in use. Fig.6 & 7 shows below some of the application of fibre reinforced polymer and some of it advantages



Fig. 6: shows repair of concrete beams with ACM.



Fig. 7: shows the repair of concrete column with ACM.

Some of the advantages of fibre reinforced composite are:

- Economy and durability
- Ease of application
- Extremely high tensile strength
- Outstanding fatigue behavior
- Absolute resistance to corrosion
- Ability to upgrade structure while in use
- upgrade possibilities even with limited access

A rhetorical studies conducted by ([T. Keller, 2001](#)) has proven that Fibre-reinforced polymers (FRP) have found increased application in bridge and building construction in recent years. This is predominantly due to the advantageous properties of these materials, such as low self-weight, high strength, free formability and substantial resistance to corrosion and fatigue. Chiewanichakorn & Toranzo, ([2011](#)), also pointed out that a comprehensive study on *Seismic retrofitting of st. Joseph Hospital* revealed the use and application of advanced composite materials for the enhancement of column, slab, wall and beam elements. It also further depict the practical use and application of advance composite material in archiving certain structural standards as assigned by the united states government, see below fig.8, fig.9.



Fig.7: depict the use of advance composite in the healing of concrete spall on wall ([Chiewanichakorn & Toranzo, 2011](#)).

The application of advance composite material enabled protection against concrete spalling and as well as reduced the possibility of body injury. Basically the use of advanced composite material can contain any form of damage to the concrete that could occur during a seismic event.



Fig.8: Depict the use of advance composite in the healing of concrete spall on wall ([Chiewanichakorn & Toranzo, 2011](#)).

Columns are retrofitted with advance composite material. Advance composite wraps are applied in circular direction to supplement the transverse steel reinforcement and to as well increase the shear capacity of the columns and to provide plastic hinge confinement.

3.4 Advanced composite material as an innovative and sustainable building material for the feature

Advance composite materials are currently revolutionizing architecture and design. Their applications in the field of construction have allowed the progressive replacement of traditional materials and many barriers that designers used to find when implementing projects with a futuristic design have disappeared. Up until now, advance composite materials have been more commonly used in repairs, secondary structures and huge self-supporting structures, such as domes. However, it's innovative drive open door for architects and engineers to develop more complex works which will satisfy the creativity of some designers and architects. It also offers the desire to challenge the established certain canons when designing buildings and unique works, These which are only possible with composite materials, since we take advantage of the combination of the low weight of these materials and their ability to be molded in such complex shapes ([Isabel&Soler, 2016](#)).

3. Conclusion

The emergence of composite materials in the building industry came as a result of certain limitation and factors over traditional building material. However based on the versatility of advance composite materials, a wide range of construction development has been achieved ever since its inception in to the building industry. The use and application of Advance composite material enables broad and proven application in contemporary building, it flexibility in design also enables great achievement in complex geometric shapes, styles, and forms as well as a much more flexible method of construction

Design complexity can be resolved with the ability of advance composites materials. However it further plays a very unique role in the repairing of existing buildings and structure due to its unique characteristics over traditional building materials with high flexibility characteristics. There is a great possibility of achieving new aesthetics in construction and in repair of old buildings.

Advance composite materials tend to offers a very wide range of applications, properties and advantages in present day building technology which are far impossible with traditional building materials such as new aesthetic possibilities, abilities to mould complex fluid and creative form which integrate special surface finishes and effect, significant saving in weight usually up to 15%, superior durability with degradation through life cost on site and less degradation, flex performance, dimensional stability, rapid installation as well as unlocking the possibilities of architectural design. Therefore,

composite material can be assessed as a new intervention in the modern day building industry with so many credits against traditional building material.

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A Comparative Analysis on User Satisfaction in Closed and Open Office Buildings: Case Study of Some Selected Buildings in Abuja

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ABSTRACT

Many organizations and industries around the world have their own preference of office type base on the nature of services to be rendered. Office building without employee's satisfaction can adversely affect their performances at their places of work. Open office is an office that has large open space with no partitionable walls but providing workstation for each employee within the open space while close office is the type with solid walls or frames as partitions with doors which open to each office. It is in the light of this that the design of office becomes imperative to both employers and architects. The aim of this study is to investigate user satisfaction and preferences in office buildings, in other to proffer appropriate design suggestion and recommendation that can be used when providing office to employees. A survey is adopted through the aid of administrated questionnaire to respondents, and the results are therefore analysed using simple statistical tool. Findings from the study reveals users satisfaction and preference for open office layout, it further reveals efficiency in users productivity due to its effectiveness in communication, knowledge sharing, space saving, cost saving and flexibility in managerial activities. The study therefore creates a correlation between findings conducted by other researchers over the years concerning the provision of office for employees their preference and satisfaction for open office buildings.

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1. Introduction

An office or office building, is represented as an office block and a business center. Office buildings are known with different forms, and are characterized as buildings that contains mainly designed spaces used for offices (Brookes & Kaplan, 1972). The primary purpose of an office is to provide a workplace and working environment primarily for administrative and managerial activities (Wineman, 1986). In the words of office design consultant and author Francis Duffy, "The office building is one

of the great icons of the twentieth century. Office buildings and towers dominate the skylines of cities in every continent and are represented as the most visible index of economic activity, social, technological, and financial progress, they have come to symbolize much of what this century has been about." (Peponis et al., 2007).

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Office building as described by Brill (1984), is the most tangible reflection of a profound change in employment patterns that has occurred over the last one hundred years. In present-day America, northern Europe, and Japan, at least 50 percent of the working population is employed in office settings as compared to 5 percent of the population at the beginning of the 20th century. Office architecture has undergone many interconnected phases and have withstood both discontinuity and inconsistencies. Influences from the past can be found in contemporary office designs just as Prevailing political and social conditions as well as the development of technology further explains changes in the form and use of office spaces (Wineman, 1982).

Through successive trajectory in office design, concepts and high performance Moore et al., (1985), describes an office as a space which is capable of offering both owners and users increased working satisfaction, productivity, improved health, greater flexibility, enhanced energy and environmental performance that is safe, healthy, comfortable and aesthetically pleasing. The Concepts towards office designs are every day evolving and office spaces are becoming layout set to induce interaction and face-to-face knowledge and information exchange Abuja being the capital of Nigeria, is embraced with lots of office buildings, most of the office buildings have various design patterns and concepts (Wineman, 1986). Office buildings in Abuja tend to symbolize the dominance of work force as they reflect in the efficiency and growth of economic activity, social, technological, and financial progress. However a comparative study on user satisfaction in closed and open office buildings in Abuja will further throw more light on the dominance of office design patterns and concepts, as well as preference and satisfaction for office building types.

2. Methodology

In a bid to actualize the comparative study between closed and open office layout, the study tend to adopt a qualitative approach. The approach is however much appropriate for the study and thus was effectively used to investigate, analyse and evaluate user satisfaction in closed and open office buildings. The total of 100 structured questionnaires were formulated and randomly distributed amongst respondents (staff) of Airtell call office premises in Abuja which operate an open plan office settings and the federal secretariate office which operate a

close office plan settings. The derived and retrieved data is quantitatively analysed using Statistical Package for Social Science (SPSS) software program. However descriptive statistics is further used to summarize and evaluate the data based on the results obtained from participants of the study.

3. Literature Review

3.1. Results and Discussions

From the questionnaire administered to open plan office users in Airtel call centre Abuja, twenty five of the questionnaire were returned out of the thirty administered to respondents, while one hundred questionnaire were administered to open office users with eighty five returned. They are to chose from the following options on how they feel about their office whether poor, good, very good or excellent. Questions asked were how satisfied they are in their own office, how effective is their communication within group, interaction with colleague, visual privacy in their office and acoustical privacy.

3.2. Satisfaction with own office

Satisfaction in an office is relative to individual. However, it shows how happy or contented an employee is in his place of work or work station, his views on office setting ranging from furniture arrangement, types of furniture, size and shape of the office. The figure below shows the states of satisfaction with own office in open and closed office. The figure shows that 40% of open office users are satisfied with their own office against the 12% percentage of the users who rate their satisfaction with own office as being poor. Greater percentage of the respondent are satisfied because it allow them to learn from their colleagues while 47.1% of the close office users are not satisfied with own office because it does not allow them to interact well with their colleagues.

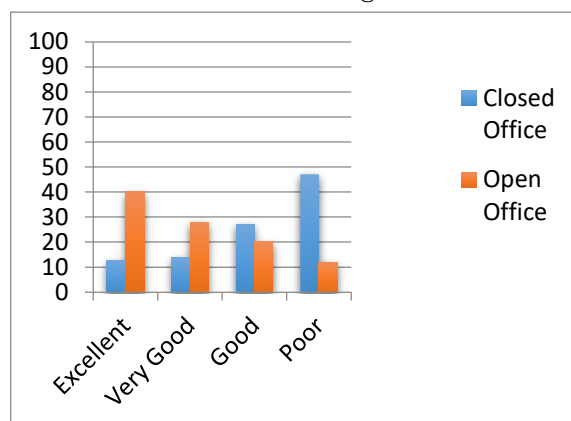


Figure 1. Satisfaction with own office Source: (Author, 2012).

3.4. Communication within group in office

The effectiveness of information gathering and dissemination depends on how closely employees are to each other in their places of work Oneil, (2008). and help in managing the day to day activities in the office, its increases efficiency and effectiveness of the staff, allow room for easy feed back on issues that needs prompt attention, hence help in achieving the organizational goals and objective within a limited frame of time. The figure below shows the percentages of how the rate communication within a group in an office.

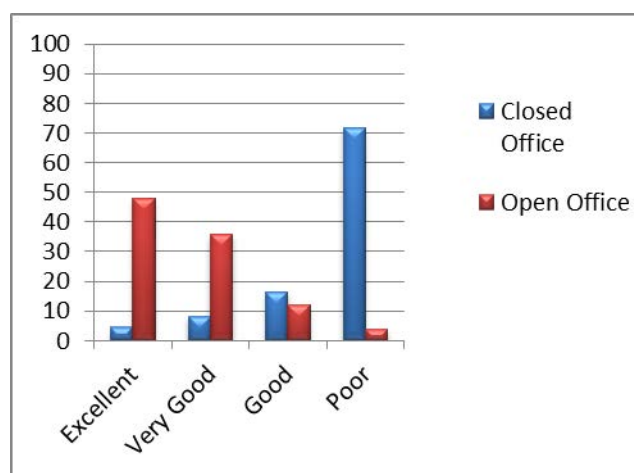


Figure 2. Level of communication of employees within a group. Source:(Author, 2012).

The figure above showed that 70.1% percentage of close office users opined communication within a group is very poor because of the barrier created by partition walls which separate them from each other while 48% percentage of open office users said communication with colleagues is excellent because they are closely seated together in an open space without any form of barrier separating them from their colleagues. From this we can deduce that workers relate with each other better in open office than in closed office.

3.3. Interaction with colleagues in office

Study conducted by Robert, (2008) on users satisfaction in open office layout revealed that employees that work in open office interact with their colleagues and are more flexible with their superior than those who work in close office environment, this is because information are share among all the staff inrespective of status in the office, however that those not means that subordinate look down or disrespect their supervisor or superior but relationship is cordial among all members of

staff, interaction enhances good relationship and reduces rate at which employees keep grudges against one another thereby reduces rate of fighting or having misunderstanding among them. The figure below shows the level of interaction among employees in open and closed office buildings.

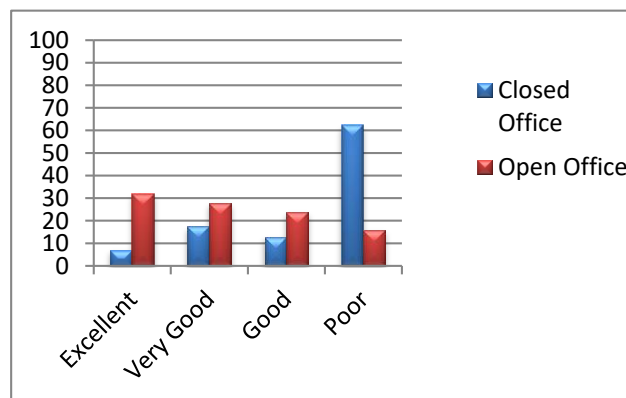


Figure 3. Level of interaction with colleagues in closed and open office. Source: (Author, 2012).

From the figure above 32% of open office users said interaction with colleagues is excellent because the employees are always together in one place while 12% percentage are of the pinion that interaction is very poor possibility because they do not often agree on some issues. 62.4% of the respondent in closed office rate interaction with colleagues as poor because the staff are staying in their own office and it will be cumbersome for them to be moving from one office to the other.

3.5. Visual privacy of the office environment

Serene view of the surrounding help in reducing stress in an office environment, however this depends on the quality of landscape employed on the surrounding. Soft landscaping elements like flowers, shrubs, lawns, vegetations, water bodies, rocks and trees gives the building a sence of nature. Yildirim, (2007). In open office, its become difficult for all employees to have a look at this nature and sky view because majority of the sitting arrangement are within the centre of the office while the remaining ones at the edge are limited, who have this rear opportunity of sky view and landscape elements. While in close office every employee have the oppurtunity of looking out through their windows when ever they are tired of work to feel relief from stress not only that but their efficiency and performance in office increases, that way close office plan has more visual privacy than open office plan. The figure below shows the

reaction of employees to visual privacy of their environment.

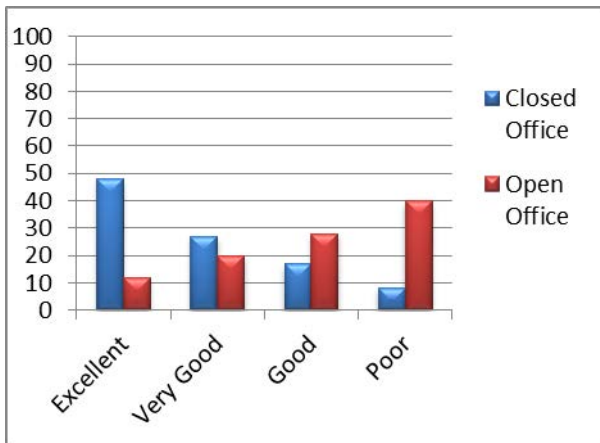


Figure 4. Level of interaction with colleagues in closed and open office. Source: (Author, 2012).

One advantages of closed office to open office is out door view of the office environment as can be seen in the figure above 48.2% of the respodent said visual privacy is excellent as agaast the 12% of open office users who said out door view of their office environment is excellent, this is because they are restricted in one open space with on a few number that have their work station located along the window side while most of them have their work station station far from the window and door which do not allow them to have a sky view.

3.6. Acoustical quality of the office

Noise reduction is a major consideration that one has to take when ever a design is being proposed. Perceived individual privacy facilitate and enhances the desired activities within a confine space Barrett, (2002). Most people desire to work alone in an office hence prefer close office layout plan compare to open office plan, its is essential since the nature and type of work they do strongly influences their choice of office type. For example an architect, medical doctor, nurse, pharmacy, lawyer, and computer programmer whose work required a lot of concentration and thinking prefer to work in an open office environment when compare to system analysis, banker, broker, social welfare workers whose work require interaction among them for easy sharing of informations.This can be reduce when designing for ceilings, walls, and floors by replacing them with acoustical materials to reduce the noise in design of close office. The figure below showed the acoustic quality of open closed office.

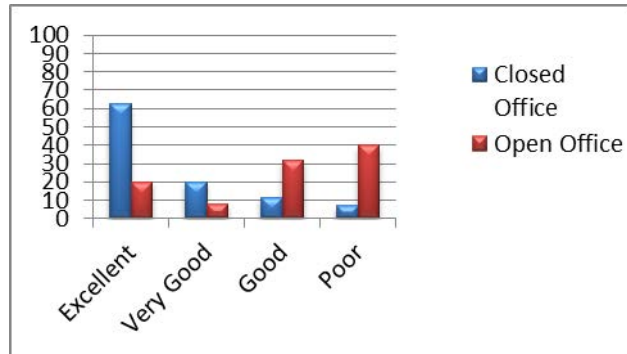


Figure 5. Acoustical quality of open and closed office. Source: (Author, 2012).

From the figure above 61.2% of closed office users said acoustical quality of their office is excellent while 20% of the open office users said is excellent, also 40% of the close office users said acoustical quality of their office is poor against the 7.1% in closed office, this could have been to attributed to the fact them in open office employees are much and there is high tendency of noise among colleagues when compare to closed office were employees are few.



Plate 1. Acoustical quality of open and closed office. Source: (Author, 2012).

The picture above shows workers in an open office layout. Each worker with his own work station separated from his colleague by his desk, chair, computer and their accessories on his table. Here all workers can view each other since they all operate in an open space hence supervision of workers performances becomes easier by their superior.

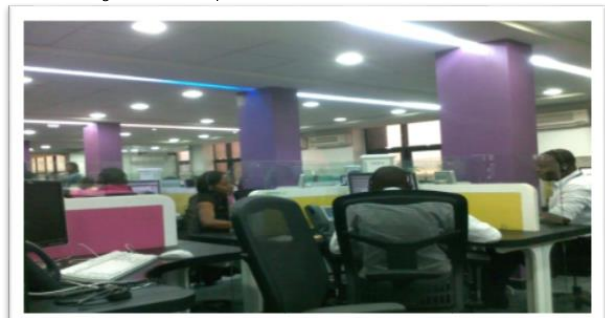


Plate 2. Acoustical quality of open and closed office. Source: (Author, 2012).

The picture above shows the an employee workspace provided for him in an open office which he controls as his own domain.He is separated from his colleagues by glass frame.

4. Recommendations and Conclusions

Previous studies have documented that open office layouts increase interaction and communication between employees. However, such layouts can also increase visual and noise distractions, reduce perceived privacy and hinder employees' ability to concentrate on their job tasks when needed. It appears that the open and closed offices have benefits and drawbacks. An assessment of the organizational goals, group objectives and individual responsibilities is needed to decide the right mix of open and closed spaces for a given work area. Sit-stand adjustable furniture that promotes postural changes and body activity can improve employees' perceived energy level and mood state after a day's work.

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Embracing today's Economic and Technological Reality: What It Means for Design Professionals

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ABSTRACT

History has shown that technological advancements alter the way we produce, exchange, protect, consume and save all kinds of goods. The First Industrial Revolution, for example, has been named as such since it indeed revolutionized everything related to daily living including art, culture, economy and politics. History has also showed that most cultural actors are reluctant to embrace advanced technology at first as they might see it as taking away something at the core of humanity. Arts and Crafts movement for example, grew out of a concern for the effects of industrialization on design, on traditional skills and on the lives of ordinary people. Today, economists, scientists and policy makers in developing countries are talking about the coming of the fourth industrial revolution and the Second Machine Age, that not only will redefine the way humans live their daily life but also the very definition of human beings. The aim of this study is to discuss the effects of these changes on theoretical and practical issues related to design professionals and education, including advanced technologies available and social and cultural implications of their use. The paper will argue that today's economic and technological reality will alter the design profession from its education to its implementation.

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1. Introduction

The rate of change in all areas of human life has been increasing ever since the First Industrial Revolution. Today not only the rate of change is drastic but also the number of changes that are taking place are numerous. It has been discussed that we are entering a new era in human history where digital technologies are creating new life practices altering our very way of life and revolutionizing everything related to art, culture, economy and politics. Today, economists, scientists and policy makers in developing countries are talking about the coming of the fourth industrial revolution, termed as Industry 4.0 in 2011 in the Science Fair

in Hamburg, Germany, and the Second Machine Age, that not only will redefine the way humans live their daily life but also the very definition of human beings. Internet, the new renewable energies, and 3D-printing are the keys for the Third Industrial Revolution that was initiated after the 1970s which are increasing their effect on human lives.

History has also showed that most cultural actors are reluctant to embrace advanced technology at first as they might see it as taking

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away something at the core of humanity. Arts and Crafts movement for example, grew out of a concern for the effects of industrialization on design, on traditional skills and on the lives of ordinary people. However, their idea of art for the people could not be accomplished because their exquisitely made and decorated pieces could only be afforded by the very wealthy.

Today's technological advancements offer new perspectives and opportunities that already started to affect all areas from archeology to medicine, from construction to heritage. More importantly, the Industry 4.0 signals the end of capitalism as economist Jeremy Rifkin (2016) suggests, while a new economic paradigm is emerging which he calls collaborative commons which will transform our way of life. The aim of this study is to discuss the effects of these changes on theoretical and practical issues related to design professionals and education, including advanced technologies available and social and cultural implications of their use. The paper will argue that today's economic and technological reality will alter the design profession from its education to its implementation.

2. Literature Review

2.1. First Industrial Revolution and Architecture

At the time when James Watt invented steam engine in 1765, architects were almost unaware of its implications for architecture. Architects were more interested with finding the appropriate 'style' for emerging functions such as banks, libraries, hotels, museums, opera houses, train stations etc. due to social changes taking place. In this period known as Neo-Classism, architects' discussions were focused on finding 'the style' that would fit better into these new functions based on the ideals of their newly established nation states. Italian architects were considering Roman architecture more appropriate to them, for example, while Gothic was declared as the most British. America, on the other hand, decided Greek architecture more appropriate for their newly established democracy, while Baroque was found more appropriate for Paris Opera House by French architects as a place of human emotion and drama.

Technology, however, was already on its way to produce new materials and techniques that would alter architecture drastically. It would take some time for architects to accept and use these new technologies and materials available as representatives of the new age. It required not only the availability of these new materials

and technologies but also acceptance of them by architects first and also by the society leading the way to consider technology as the "cultural manifestation of modern man."

One of the earliest examples of steel columns, for example, is in a public library in Paris, Bibliothèque Sainte-Geneviève (1843-1850). Designed by Henri Labrouste, the building (Figure 1) is a representative of how inexperienced and noncreative architects' of the period were. They were hesitant and non-imaginative in using new materials such as these slender cast-iron columns shaped as sort of Corinthian columns having set on stone pedestals. From the outside the library just looked like traditional stone and brick buildings without ever indicating the use of iron columns and beams inside.



Figure 1: Bibliothèque Sainte-Geneviève (1843-1850).

The architects' preoccupation with style and lack of interest with the technological developments are reflected most clearly in the story of the world's first temporary exhibition building, the Crystal Palace in London. The building's story starts when the world's first developed colonial power Britain wants in 1850 to organize the world's first expo to showcase the latest technologies and innovations from around the world titled 'The Great Exhibition of the Works of Industry of All Nations.' In January 1850 they announce a competition and form a committee to select the winning design. The structure had to be as economical as possible and be built before the exhibition was scheduled to open on May 1st, 1851. Within 3 weeks the committee receives 245 entries, all of which are rejected. None of the designs would satisfy the requirements until a gardener Joseph Paxton, who happened to be in London and heard about the difficulties, visits Hyde Park and quickly doodles his famous concept drawing of the Crystal Palace for the committee (Figure 2).

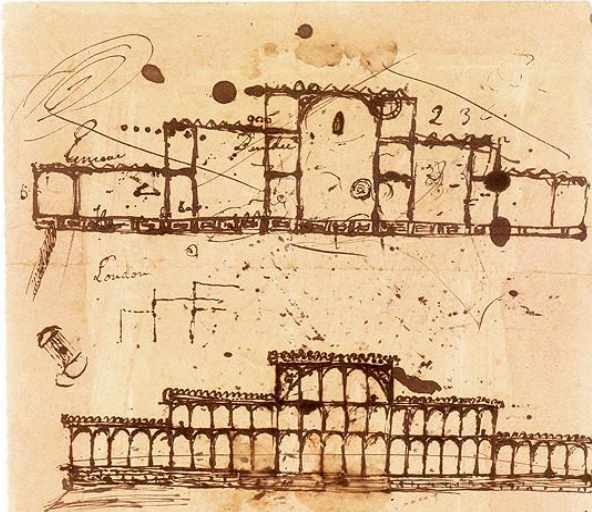


Figure 2: First sketch for the Great Exhibition Building by Sir Joseph Paxton (1850).

Paxton was just a gardener who started to work in 1823 at Chiswick Gardens, then in 1826 appointed by the Duke of Devonshire as head gardener at Chatsworth House. Here Paxton designed gardens, fountains, a model village and an arboretum. Paxton's interest of building greenhouses led him to be interested with the new technological developments as well. It is known that he was friends with engineers of the period such as Robert Stephenson. Using combinations of prefabricated cast iron, laminated wood and standard sized glass sheets, he created the 'ridge-and-furrow' roof designs. In 1836 this system was used for the first time in the 'Great-Stove' the largest glass building at the time.

Paxton's experiments with glass and iron to build greenhouses were reflected in his concept drawing for the exhibition hall which included all the basic elements of the building. The design was a vastly magnified version of his lily house at Chatsworth. It was cheap, simple to erect and remove and could be ready quickly. Its novelty was its revolutionary, modular, prefabricated design and the extensive use of glass, and very low cost. The committee accepted Paxton's innovative plan.

Despite widespread cynicism amongst press and public of the period, when the Great Exhibition opened in May 1851 it was an enormous success. The satirical magazine *Punch* named the building as 'Crystal Palace.' Crystal Palace (Figure 3) resembles a giant greenhouse covering 77,268 sqm area. A total of 3350 cast-iron columns were used in the building, 1851 of which stood at the longer side representing its construction year. Its glass walls and roof cover an area of 83,700 sqm. Paxton's ingenious design created an unprecedented

exhibition space. The construction, acting as a self-supporting shell, maximized interior space, and the glass cover enabled daylight. The method of construction was a breakthrough in technology and design, and paved the way for more sophisticated pre-fabricated design.



Figure 3: The Crystal Palace in Hyde Park for Grand International Exhibition of 1851.

Between May and October 1851 millions from across both the UK and the world visited the Crystal Palace. In October, Paxton was knighted by Queen Victoria when he got his Sir title as well as the title of architect. By the time exhibition closed its doors, much of the British public had grown exceptionally fond of their 'People's Palace' and there was great concern that the temporary structure was about to be lost forever. Thus, it was re-erected in Sydenham in south London in June 1854, where it remained until it burned down in 1936.

Starting with the second World Expo Paris 1889, we see architects and engineers designing together such as the 'Galerie des Machines' designed by architect Ferdinand Dutert in collaboration with engineer Victor Contamin. The marriage of architectural ideas with new materials made available by the new technologies had to wait until the pioneers of modern architecture put them into use. It required not only the availability of these new materials and technologies but also acceptance of them by architects first and also by the society leading the way to consider technology as the "cultural manifestation of modern man." Gropius's glass skyscraper and Le Corbusier's idea of undivided screens were among the first steps. The time gap between the demise of modern architecture and the technological innovations of first industrial revolution-mass production of glass and steel-is about sixty years.

2.2. Technology and Architecture Today

Today, economists, scientists and policy makers in developing countries are talking about the coming of the fourth industrial revolution, termed as Industry 4.0 in 2011 in the Science Fair

in Hamburg, Germany, and the Second Machine Age that not only will redefine the way humans live their daily life but also the very definition of human beings. Internet and the new renewable energies were the keys for the Third Industrial Revolution (TIR) that was initiated after the 1970s. Another major development in TIR is the 3D-printing. This new technology changed the manufacturing process from 'subtractive manufacturing' into 'additive' one that will cut down the materials used to produce goods as well as energy used during the process.

The development of new materials and technologies are at an unprecedented speed in contemporary period. Though there are some architects playing with the possibilities of emerging third industrial revolution much focus is needed within architectural discourse on the possible effects and interplays between architecture and the emerging new era with its new economic social and political agenda.

There are new avant-garde projects already experimenting with the application of the 3D printing technology. One of such as project is Amsterdam's 3D-printed steel pedestrian bridge that spans one of the city's old canals (Figure 4). The innovative Dutch construction company Heijman's Innovation Manager Jurre van der Ven suggests that we need to start looking at design in a completely different manner since in 3D printing design and construction operate hand-in-hand. Multi-axis industrial robots will construct the pedestrian bridge using cost effective and scalable technologies creating an automatic construction site.

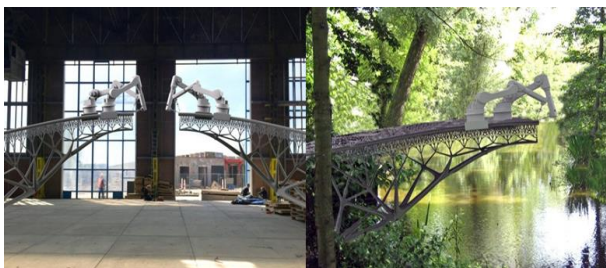


Figure 4: Amsterdam's new 3D-printed steel bridge.

A new Ukrainian homebuilding startup company called PassivDom uses 3D printing robot that prints 20cm-thick walls, roof and floor of 380 square foot house in about 8 hours. The materials used include carbon fibers, polyurethane, resins, basalt fibers and fiberglass. The windows, doors, plumbing and electrical systems are for now added later on by a human worker. PassivDom's houses are now available for preorder online in Ukraine and US. Their designer Maria Sorokina adds that the homes

also offer the possibility of living off-the-grid providing an opportunity to live in nature away from civilization but having the traditional house's comfortable conditions.

One of the world's largest architectural firms, Foster and Partners and a UK based 3D printing company called Monolite have teamed up with the European Space Agency to explore the possibility of using 3D printing to construct a permanent base on the moon. The buildings would be printed using lunar soil as the feedstock. The goal is to construct lunar habitats with locally sustainable materials found on the moon in order to avoid the logistic cost of shipping in materials from Earth.

The developments of Industry 4.0 are way on its way and it will alter many professions and similarly the way we live including the way we produce goods and the way we use them. Digital technologies available are also increasingly getting faster and more developed each day: Limits of image resizing and processing are increasing, new ways for image storage and retrieval lead to new image databases and faster access to images, many documents are digitized for public access including rare books and manuscripts, digital access to many photographic collections are made available each day.

3. Discussion and Conclusion

As discussed above, we have already entered what has been called 'The Second Machine Age.' The Industry 4.0 signals the end of capitalism as economist Rifkin (2016) suggests, while a new economic paradigm is emerging which he calls collaborative commons that will transform our way of life. Today we have more powerful computers, cheaper mass storage, higher band-width for internal and global networks, and more importantly soft-wares and file formats are becoming standardized thus enabling sharing.

The different historical layers of the city could be made available as cultural restitutions through digital surrogates. VU City project developed by Gordon Ingram and James Hotown Associates might be a good example for understanding these surrogates. They already digitally scanned and produced the city of London as a case for smart city data, i.e. large data readily available for live use. It is a case where city modelling is at a new level; you can see timeline of buildings in London as you desire for example

We need to evaluate theoretical and practical implications for many disciplines including art, architecture and heritage as well as education in all disciplines. Today, digital technologies such

as the 3D printing and 3D laser scanning might be in still developing, but their properties as well as usage will grow exponentially in the coming two decades as they becomes increasingly efficient and cheaper. Low cost techniques on 3D representation and 3D printing have already started to effect heritage preservation. Many European research projects are already completed such as VITRA (Veridical Imaging for Transmissive and Reflective Artefacts), VASARI, International Dunhuang Project, VU City and Collect Britain. British Library pronounced that the aim is to help people advance knowledge to enrich lives by aiding scientific advances, adding commercial value for businesses and contributing UK's 'knowledge economy' via innovatively exploiting it collections as a resource for the nation and the world. Some of the

To conclude, digital technologies are new tools that are providing new means for us in our work on cultural heritage as well as via internet platforms getting faster and better we have new ways to share our work with the rest of the world, and we may also have new educational tools soon using 3D virtual reality-VR, augmented reality-AR and mixed reality-MR technologies. We already started to have virtual collections available online. All together they can aid us in creating new ways of communicating to increase much needed intercultural dialogue that fosters understanding and peace among different cultures.

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Optimization of Urban Street Lighting Conditions Focusing On Energy Saving, Safety and Users' Needs

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ABSTRACT

The outdoor lighting constitutes a significant part of the night activities of people in contemporary cities. Nevertheless, in many cases, this may result in the increasing and irrational use of it affecting the users of public areas, the environment and driving safety. The subject of this paper is to extend the discussion on the subject, to provide answers and to suggest methods for the improvement of the existing conditions in urban street lighting through the use of new technologies and smart lighting management systems, with the aim of achieving a smooth relationship between the user's needs, safety, sustainability, quality of life and energy saving.

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1. Introduction

Optimization is defined as "the action of making the best or most effective use of a situation or resource" (<https://en.oxforddictionaries.com/definition/optimization>). In the case of urban street lighting, optimization constitutes the correlation of design with the restrictions of the lighting Regulations while using the latest technologies and "smart" lighting management systems. The purpose is to achieve the maximum possible energy saving and reduction of CO₂ and at the same time ensure better living conditions to the users of the city; both drivers and pedestrians. Therefore, apart from the benefits

on environmental issues, the study focuses on its effects on driving safety and the reduction of car accidents, the increase of drivers' and pedestrians' feeling of security, and urban crime in general. The ultimate goal of the research is to get a wide knowledge on the effects of the optimization of urban street lighting in all aspects of urban living conditions in modern cities.

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2. Methodology

For the purpose of the study, the scientific material used focuses on primary sources, European and International literature, scientific articles and papers related to the subject and a wide analysis of various case studies using applications from all around the world, mainly Europe and America. A critical composition of the findings leads to conclusions as well as in methods of improvement of the existing street lighting conditions, on the basis of the users' safety, the energy saving possibilities, and also the creation of fair, in terms of lighting, urban areas in connection with the least possible environmental impact.

Primarily the problems of "bad lighting" in urban areas are defined, then optimization methods are suggested in order to upgrade urban environments and in the end the impacts of optimization in the categorized problems are analysed.

3. Literature Review

3.1. The definition of "bad lighting" in urban areas.

"Bad lighting" is when the final lighting outcome in the streets causes problems to the users or to the city itself. "Bad lighting" can be caused by inappropriate design, wrong maintenance of the system or no maintenance at all. The role of the European Lighting Expert in projects is crucial (<http://europeanlightingexpert.org/en/>), as this person has the knowledge to best design a lighting system by using the Lighting Regulations appropriately, while integrating all other relevant parameters that need to be taken into consideration in each specific case.

"Bad lighting" design can have a negative impact on the environment (i.e. excessive energy consumption and carbon emissions, exacerbation of the phenomenon of light pollution and the impact of lighting on flora and fauna in protected areas). Furthermore, "bad lighting" can have a serious effect on peoples' health (disruption of the human circadian system), peoples' safety (i.e. risk in driving safely, lack of orientation and visibility, weakness of the eyes to adapt to sudden changes in environmental illumination, lack of face recognition and sense of security for pedestrians). It has been proven that serious car accidents happen when lighting is not appropriate or there is no lighting at all, having as victims' pedestrians too. Another serious aspect that might be correlated with "bad lighting" is crime. Of course, not all the factors co-exist at the same time, but in each specific

case some of them tend to cause problems in the smooth operation of urban areas.

While living in a period of unusual urbanization most people consider as very important to live safely in attractive and friendly environments in modern cities. The growth of the urban population offers great opportunities for economic and social development, while at the same time it presents enormous challenges.

3.2. Optimization techniques in order to improve street lighting conditions.

"Good lighting design" based on Lighting Standards and the use of new technologies and lighting management systems are the two main parameters that will rule the whole discussion in order to examine the impact they have in the urban environment. Additionally to the above, "good lighting design" serves functionality that meets the needs of each case, while using good quality fittings in the right position, the appropriate colour temperature and many other parameters that need to be taken into consideration in order to obtain the ideal solution.

3.3. Designing according to the Lighting Standards.

The necessity of the rational use of street lighting to the safety of users, drivers and pedestrians at night imposed to the European Committee for Standardization (CEN) the need for the institutionalization of the Lighting Standard EN 13201 in 2004. With the evolvement of technology, the installation of innovative lighting solutions and the integration of street lighting control and management systems, was considered necessary to revise the existing standard. Therefore EN 13201:2014 has been published by the CEN/TC 169 in December 2014 which is based on the Technical Report of CIE 115/2010. The revised EN consists of five parts.

The whole idea of the CEN/TR 13201-1 (2014, p.5) is "to specify the lighting classes and give guidelines on the selection of the most appropriate class for a given situation". It also introduces Adaptive Lighting and dimming techniques in order to further reduce energy consumption and improve environmental conditions under reduced traffic volume during certain periods of night or under varying weather conditions. While adaptive lighting is applicable, luminance or illuminance levels can fluctuate but the other qualitative features such as uniformity and the threshold increment (TI) for disability glare as defined in EN 13201-2 remain unchanged.

EN13201-2 (2015, p.6) "defines performance requirements in order to cover the visual needs of road users and considers environmental aspects of road lighting". EN13201-3 (2015, p.6) "specifies conventions and mathematical procedures to be adopted in calculating the photometric performance of road lighting installations", while EN13201-4 (2015, p.7) "specifies measurement conditions and procedures for measuring the photometric quality parameters of road lighting installations". Additionally, the conditions that might lead to inaccuracies are identified and precautions are provided to minimize potential errors. Finally, EN13201:5 (2015) introduces the Energy Performance Indicators of the designed system using the calculated Power Density Indicator (PDI/Dp) and the calculated Annual Energy Consumption Indicator (AECI/De), in order to compare the energy performance of different lighting solutions and choose the best one for each specific situation.

The Standard categorizes the streets into three classes (M class for motorized traffic, C class for conflict areas and P class for pedestrian and low speed areas) while introducing additional categories and criteria; the SC class for pedestrian areas for improving facial recognition and increase the feeling of safety and the EV class for situations where vertical surfaces need to be seen. In some cases, it is also necessary to take measures to control disability glare and/or control obtrusive light (EN13201-2:2015).

3.4. Designing with LED technologies and "Smart" Lighting Management Systems (Adaptive Lighting)

At a time when energy adequacy is imperative, lighting has turned towards saving energy, discovering and developing modern, environmental friendly lighting technologies with a special type of light source, Solid State Lighting (SSL). Light emitting diodes (LED) is a promising technology and a new trend in the lighting industry.

LED lighting systems surpass other lamp types, especially for their high energy efficiency, operational lifespan (up to 100.000h), directionality of light output that reduces undesirable environmental impact and increased glare. They have the ability to adapt

to the spectral content as they are available in a CCT range, ensure lighting requirements with half the power of HPS lamps and are working with suitable lighting systems in order to meet the actual lighting needs ("The Realized Results of LED Streetlights: Seizing the Opportunity", 2017). They are also considered environmental friendly without containing mercury, IR and UV radiation and show resistance to high temperatures. They can be produced in a variety of sizes, they have the ability to switch colors without using filters and provide a wide range of dimming settings. It is a technology that is constantly evolving and its cost and performance are areas of continuous improvement (Brodrick, J. 2017).

LED technologies, optics and control systems provide the necessary tools for achieving high-quality public lighting installations. The luminaires can be equipped either a) with built-in luminous intensity control systems, b) with pre-set luminance adjustment scenarios or c) communicate with a central remote control system. The right amount of light related to traffic density, road and weather conditions, where and when it is needed, is the preferred practice compared to any other method that requires switching off the lights. The combination of increased safety and return on investment due to energy saving makes adaptive street lighting technology the best solution ("The Voice of the Lighting Industry in Europe", 2016).

4. Urban Street Lighting Optimization

In the following sections, the effects of the optimization of street lighting by using LED technology and "smart lighting" management systems are investigated and analyzed with regards to energy saving, light pollution, car accidents and crime.

4.1 Optimization and Energy Saving

The large proportion of electricity consumed globally where combined with installation and maintenance, is one of the major costs of each society. This fact makes the use of new technology along with "smart" management systems necessary, in order to achieve the best possible energy saving, to avoid light pollution and at the same time reduce CO2 emissions.

According to a study from International Energy Agency (IEA), lighting contributes up to 20% of the worlds' electrical usage. If efficient lighting systems apply worldwide, it is estimated that the world's electricity bill can be reduced to one-tenth

(<http://www.revolite.com/energysavingprogram.html>).

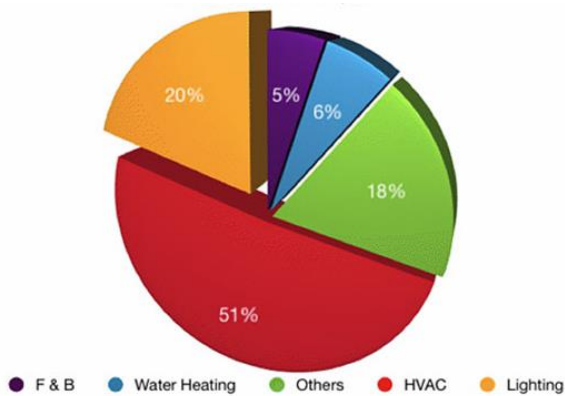


Figure 1. Global Electrical Consumption (<http://www.revolite.com/energysavingprogram.html>)

At the same time while global climate changes, the rising cost of electricity and the need to reduce CO₂ emissions are some of the key issues that the modern city is facing.

In 2010, the European Union has set as ambition for three energy targets to be achieved by 2020; a) the increase of energy efficiency by 20% from lighting, b) 20% reduction in CO₂ and c) 20% of produced energy to come from renewable sources (["Lighting the Cities - Accelerating the Deployment of Innovative Lighting in European Cities"](#), 2013). Moving forward, the European Parliaments' new goals for 2030 are: a) a 40% reduction in Greenhouse Gas (GHG) emissions, b) at least 30% renewable energy sources and c) a 40% target for energy efficiency ([Erbach, 2014](#)).

Especially for street lighting, energy saving potential is expected to rise to 80% by 2020 (["World on the Edge by the Numbers – Shining a Light on Energy Efficiency"](#), 2011), in order to save €85 billion annually for European consumers and at the same time reduce emissions by about 200 million tons of CO₂, equivalent to 270 less power plants (["The Voice of the Lighting Industry in Europe"](#), 2015). By 2027, LED and smart streetlights are projected to reach 89% and 29% of the total streetlight market, respectively (["Global LED and Smart Street Lighting: Market Forecast 2017-2027"](#), 2017).

In most countries there is an obligation the design to follow the Lighting Standards with particular emphasis on energy saving. In 2008,

a research towards this direction took place from the first major European Research Project, the E-Street project, for which representatives of the lighting industry, national energy organizations and some European municipalities have cooperated. The survey concluded that authorities across Europe could reduce street lighting energy bills by an average of 66% if they manage road lighting with flexibility, either by adjusting the light levels or by replacing old fittings with new LED systems (["Substantial savings from smarter street lighting"](#), 2015).

4.2. Optimization and Light Pollution

For three billion years, the daily shift from light to darkness on the planet was governed by natural celestial sources, especially the moon, the airglow, the stars and the Milky Way ([Kontorigas, 2007](#)). The great revolution in artificial lighting that took place in the 19th century has led to the changing of the urban cities at night.

Light pollution describes the phenomenon of excessive outdoor lighting emitted to the sky, either directly or indirectly through reflections. The intense glare of street lighting, the over lighting of shopping windows, the advertising billboards and the increase of urban lighting for safety reasons, has led to the increase of the light glow of the sky and represents a profound change in the fundamental human experience. Even small increases in the sky brightness can deprive people from the opportunity to see the night sky.

Studies show that over 80% of the world and more than 99% of the US and European populations live under a light-polluted sky. Milky Way is not visible to more than a third of humanity, including 60% of Europeans and nearly 80% of North Americans Falchi et al, (2016)

According to the International Dark-Sky Association (IDA), light pollution is a multidimensional problem of our days with serious environmental consequences on humans, flora and fauna, but also of economic importance. Scientific evidence show that artificial light at night has negative and sometimes fatal effects on many living beings (amphibians, birds, mammals, insects and plants), causing their disorientation or problems in reproduction. Light pollution also affects the environment from the uncontrollable electricity consumption that leads to the depletion of energy resources and the direct increase of the carbon dioxide emissions (<http://www.darksky.org/light-pollution/>).

Additionally, the phenomenon of light pollution does not leave astronomy unaffected (Walker, 1973).



Figure 2. Before and during the 2003 Northeast blackout, a massive power outage that affected 55 million people. Photo by of Todd Carlson (<http://www.darksky.org/light-pollution/>).

The exposure to high light levels during the night has also a negative effect to humans on the transition to the normal stages of sleep as it contributes to the complete decomposition of circadian rhythm. Studies show that the circadian rhythm cycle controls 10-15% of our genes, therefore by interfering to that many health problems can be caused (Chepesiuk, 2009).

Lastly, light pollution can cause driving safety issues. Extremely high light levels in the streets can lead to the decrease of object visibility due to the reflection generated by bright light sources, with a direct impact on the driver's inability to locate pedestrians and adjacent obstacles, especially when the surrounding area is dark. Due to the above, serious car accidents may occur (Kraus, 2016).

Unlike many other forms of pollution, light pollution is reversible, therefore it should be addressed effectively. The basis for truly effective protection is (Walker, 1973), (Chepesiuk, 2009), ("Guidance Notes for the reduction of light pollution", 2000):

- The applicable street lighting design based on lighting classes as defined by the Standards
- The installation of high quality lighting fixtures that reduce energy consumption by 60-70% can save billions of money and reduce CO2 emissions
- The use of fully shielded and full cut-off luminaires in order to reduce direct light emissions on the horizon while at the same time minimize the light reflected from the illuminated surfaces. In order to

eliminate glare, the beam angle of the luminaires should be kept below 70°, as well as the position of luminaires in high poles to allow for lower beam angles. In areas with low level of ambient light, special care must be taken into consideration when installing and orientating the luminaires in order to minimize disturbing reflections.

- The use of warm white LED lamps ($\leq 3000K$) in order to avoid blue light that creates intense brightness in the sky and makes viewing more difficult at night.
- Turn off lighting when used for decorative purposes or when it is not required for safety reasons.
- The installation of lighting management systems, presence/motion sensors and timers that help reduce average light levels and save even more energy.

4.3. Optimization and Crime

The sudden rise in crime that has been observed in recent decades in many countries worldwide has led to systematic measures in order to prevent it. The optimization of urban street lighting is intended for many purposes, one of which is the prevention of crime, towards people and properties in public areas. The correlation between urban light levels and the reduction of crime is the focus of long-term research.

A credible survey through experiments that has followed high-quality methodologies, was developed by UK Police College researchers to sum up the "best available" assessments of effective street lighting in relation to the reduction of crime levels. The study has shown that improved street lighting has a positive effect on reducing crime, such as burglaries and theft. However, it did not have any positive effect on violent crimes. Taking into account all the data of the survey, a relative 21% reduction of crime was found in the areas where light optimization was performed compared to similar areas where there were no corresponding interventions in lighting conditions ("The effects of improved street lighting on crime: What Works Briefing", 2008).

Regarding the correlation between street light levels and the reduction of crime, two main theories were developed. Firstly, improved lighting in urban areas contribute to the increase of surveillance, while the guarding by police is much easily achieved. Adequate lighting increases the risk of identifying and arresting the offenders. At the same time, people tend to use more the public spaces,

increasing the number of potential witnesses in any violation that might take place. Secondly, the installation of efficient and effective lighting signifies and upgrades the marginalized areas, having as a result the minimization of criminal behaviors (Farrington and Welsh, 2008). However, as every area is unique, studies should clearly describe the nature and intensity of lighting improvements, the general neighborhood conditions, and other crime prevention actions in order to have reliable results (Clarke, 2008).

Most studies that analyze the relationship between the optimization of road lighting conditions and crime are mainly conducted by criminologists and not by lighting experts. Consequently, very few studies take into consideration street lighting designed according to the current Standards. In these cases available information usually refer either to the upgrading of lighting or increased light levels, better uniformity and colour rendering.

In conclusion, by improving street lighting in an area, an upgrade of local community is achieved and at the same time a sense of security is provided. In other words, improved lighting is not a natural obstacle to crime, but contributes to the reduction of delinquent behaviors and can work as a catalyst for social action and cohesion but also as a mechanism that will contribute to further environmental improvements (Farrington and Welsh, 2008).

4.4. Optimization and Car Accidents

Through the research that has been carried out to date it is obvious that driving outside the daily hours is more dangerous. Only one fourth of all car drivers move between 07:00pm and 08:00am, and during this period of time 40% of fatal accidents and serious injuries happen ("Road Safety factsheet: Street Lighting and Road Safety", 2017).

Also, age range and the capabilities of nighttime drivers are different from those at daytime. For example, elderly people with visual impairment often avoid driving at night, while there may be more road users who have consumed alcohol or drugs or are simply very tired at night. In addition, average speed tends to be higher at night, partly because there is less traffic. Furthermore, there is likely to be a strong interaction between road lighting and the prevailing headlight technology of vehicles, causing accidents. The brightness of the headlamps has increased by about eight times over the past 60 years and at the same time street lighting has increased dramatically during the same period (Gaston et al, 2014).

According to European Commission statistics published on road safety in 2016, 25.500 people lost their lives in the EU streets and 135.000 people were seriously injured, 37% of which on average occurred in urban areas ("Road Safety factsheet: Street Lighting and Road Safety", 2017). Additionally in Switzerland, the number of fatalities with pedestrians as victims at night is 60-70% higher (Ghazwan, 2014).

The US Pedestrian Traffic Accident Report investigated data from 2006 to 2015 and found that during this ten year period pedestrian deaths as a percentage of total motor vehicle crash deaths increased from 11% to 15% in 2014 and 2015. About half of the pedestrian fatalities in 2015 occurred between 06:00pm and midnight, with 74% occurring after dark (Retting & Schwartz, 2016). Similarly, the same conclusion came from a survey conducted by the University of Manchester's Institute of Science and Technology where it was found that low light is an important factor contributing to night time mortality. In particular, on motorways that are already lit, 2.6% of accidents are fatal compared to 4,3% of accidents where there is no illumination ("Road Safety factsheet: Street Lighting and Road Safety", 2017).

The effect of lighting on road accidents also depends on several factors, such as the street type, the speed limit, the traffic volume, the junction density and the traffic composition, always depending on the requirements of each lighting class. Additionally, visual performance while driving is a complicated issue as it is associated with a variety of elements such as uniformity, object visibility, visual targets, lighting of surroundings, weather conditions etc. (Ghazwan, 2014).

In a pilot study that took place in New Zealand's urban areas to assess the relationship between light levels and car accidents, it has been proved that the increase in traffic accidents is a matter of visibility and is associated with a reduction in the contrast between an object and its surrounding. The achieved average luminance or average illumination was important in all cases. The Threshold Increment (disability glare) was also an important factor in all experiments performed. The lower value of the TI in conjunction with the achieved light levels is the second basic parameter for reducing accidents, while energy efficiency and uniformity levels were not statistically significant in any of the tested models. (Jackett and Frith, 2012).

Empirical evidence and a comparison of road traffic accidents revealed that the optimization

of road lighting can actually prevent car accidents, as satisfactory light levels provide users with the ability to react faster and more accurately on the road surface. It also provides time to identify potential risks and the ability to react in a timely manner to prevent serious injuries. Particularly (Gastons et al, 2014), (Crabb and Crinson, 2017):

- Road lighting on an urban road network can achieve an average reduction in accident rates of around 30% as an average percentage worldwide
- The benefits are directly connected with the parameters that determine the lighting class of the street
- Road lighting seems to have an impact on reducing the severity of accidents, and in particular on pedestrian-related accidents and not the car occupants
- The impact of road lighting is intensively reduced in conflict zones
- There may be hedging effects, in which lighting can lead to increased speeds and reduced concentration, but these effects are likely to be small
- The installation of lighting posts is an additional risk that is often involved in a significant number of injured accidents, but it cannot be a reason for not installing lighting in the area.

5. Analysis of worldwide case studies

In our days, cities tend to consume 40% of their annual budget on electricity, while most road installations are outdated and extremely inadequate. There are about 300 million luminaires worldwide, most of them in urban areas and only 10% have been changed to LED. At the same time, the need for driving and pedestrians' safety is growing rapidly (Marino et al, 2016). Therefore, it is of great emergency to upgrade old installations with new technologies by using smart management systems.

For the purpose of this research, implemented cases have been studied such as Birmingham (UK), Mechelen (Belgium), Lyon (France), Tilburg and Eindhoven (Netherlands), Albertslund and Copenhagen (Denmark), Glasgow (Scotland), Gothenburg (Sweden), Helsinki (Finland), Norway, Canada, USA and others, in order to investigate the connection between theory and the real effect of lighting interventions in the urban environment and on users. The worldwide representative examples had as common the use of LEDs and dynamic lighting systems designed to be a key tool to make cities more "smart". Each case had its

own targets to achieve according to its needs and used new technology for different reasons. In the analysed case studies, more than 100.000 luminaires were replaced in European cities and over 170.000 in America. The improvement of the lighting systems results in the following, without mentioning separately the benefits of each case.

a) Instant Cost Savings

The renewing of the street lighting systems with LED fittings and automations, correspond to direct cost savings from energy but also from system conservation.

All the cases achieved 30-60% energy saving while most of them between 50 and 60%. When adaptive lighting is also used, further reduction to energy consumption is achieved, as in some cases luminaires are dimmed down to the least necessary levels.

Additionally, the new LED systems have extended lifetime (60.000-100.000 hours) compared to conventional lighting and extremely low failure rates, therefore it is expected immediate cost savings from reduced maintenance requirements. However, this will give accurate results after some years of operation.

The Light Savers Technical Advisory Committee (2017) evaluated 12 LED lighting fixtures in 7 cities worldwide. The scope of coverage included 29 different LED lights and adaptive lighting technologies used in parking areas, pedestrian paths, urban roads and high speed lanes. The results have shown that more than 70% of the new technologies have achieved at least 50% energy savings. In addition, the failure rate for all luminaires tested was 1.8% for an operating time between 4.000 and 6.000 hours, significantly lower than the typical HID failure rate of 10%. In cases where LEDs were combined with adaptive lighting systems, they showed, at least, an extra savings of 20%. Also, the majority of pedestrians and drivers agreed that visibility improved significantly ("The Realized Results of LED Streetlights: Seizing the Opportunity", 2017).

b) Environmental Benefits

The expected reductions in CO2 emissions can be calculated on the basis of the resulting energy reductions and the volume of carbon emitted from the electricity produced and varies between installations. Furthermore, when warm white colour temperature is used ($\leq 3000K$) LED lighting systems emit more "friendly" light and cause less problems to the nature equilibrium. Additionally, due to the directionality of LEDs, there is less light pollution on roads and the problems of unnecessary

diffusion and undesirable glare are reduced (["Road, paths and squares"](#), 2014).

c) Reactions of the Road Users

Using LED lights usually increases light levels and achieves better lighting quality that improves visibility and thus drivers and public safety (["Road, paths and squares"](#), 2014). In some cases there has also been observed a reduction in crime rates between 07:00pm and 07:00am; in crimes such as vehicle theft, burglary, robbery and vandalism. Additionally, the positive contribution of light bulbs with a recommended color temperature of 3000K indicates that lighting can improve safety and driving safety, as well as contributing positively to the health of road users.



Figure 3. Before and after the refurbishment in a street in Bielefeld, Germany (["Road, paths and squares"](#), 2014).

Apart from the key benefits mentioned above, each case had additional benefits due to the objectives that have been targeted in each individual case.

In the case of Lyon (France) for example, by using proximity sensors on the pedestrian bridge of Passerelle St. Vincent, the light levels were reduced to 10% when there was no pedestrian in the area. Additionally, the main street light levels were reduced by 60% overnight and they achieved a reduction in power consumption of more than 65% (["Lighting the Cities - Accelerating the Deployment of Innovative Lighting in European Cities"](#), 2013). In the case of Eindhoven (Netherlands), street lights were programmed to blink red to alert residents to floods or storms. In the same way, they indicate an emergency evacuation route for traffic in case of a flood of the road or natural disasters (["Intelligent Road and Street Lighting in Europe"](#), 2008). In the city of Patras (Greece), intelligent parking and smart lighting systems with specific sensors were installed in selected points so that drivers are immediately informed of the availability of a parking space (<http://www.ypodomes.com>). In

Norway, when snow covers the streets, the need for lighting is lower so the light levels are reduced (["Intelligent Road and Street Lighting in Europe"](#), 2008).

The analysis of the implemented cases confirm the contribution of LED lighting systems into the creation of viable "smart cities", with optimal conditions for street users, the environment and the least possible energy consumption.

It is very important before an installation to have a pilot study, in which people also participate in order to analyze the real needs of each case. As it is shown above impacts on visibility, energy savings, capital costs, safety and environmental protection cannot be optimized with a single solution for all systems. New management lighting systems make it possible to adapt lighting to different needs at a time and place.

6. Discussion

Light contributes to the creation of the nighttime appearance of the city, which is depicted in a variety of ways according to its social, political, economic, cultural and geographical context and the current way of living. The purpose of this research was to find out the benefits of the optimization of street lighting conditions to the needs and reactions of users, to driving safety and the environmental effect. Key benefits of efficient urban lighting are demonstrated and information on International Standards and Regulations are provided in order to define a common framework for the development of street lighting with the ultimate goal of improving human life.

Improved lighting provides a sense of security and reduces offending behaviors, without being proved to be a physical obstacle to crime. An urban space that provides the feeling of safety can act as a catalyst for social action and cohesion but also as a mechanism that will contribute to further social upgrading and environmental improvement.

Similarly, empirical evidence has shown that properly designed areas in an urban road network can achieve a reduction in accident rates of about 30% worldwide. The benefit is directly dependent on variables related to the achieved light levels and the respective needs of the users. At the same time, the use of energy efficient light sources along with "smart lighting" management systems provide the possibility of creating a dynamic urban lighting that respond to the needs of each specific case and time, enhances energy saving and the reduction of CO₂ emissions.

Furthermore, the need for immediate action for the minimizing of light pollution is imperative. With careful selection, installation and targeting of modern light fixtures, the negative effects of the phenomenon can be avoided.

7. Conclusion

7.1. Outcomes from optimizing urban lighting conditions

In response to the queries that have been stated at the beginning of the study, it has become obvious that flexible LED lighting solutions combined with a holistic approach of "good lighting design" according to the Lighting Standards provide to the urban road network excellent flexibility to the final outcome. This ability leads to a shift from "quantity" to "quality" that offers people and society a great deal of benefits. By summarizing, the benefits from the optimization of the street lighting urban network are listed below and are divided in three sections:

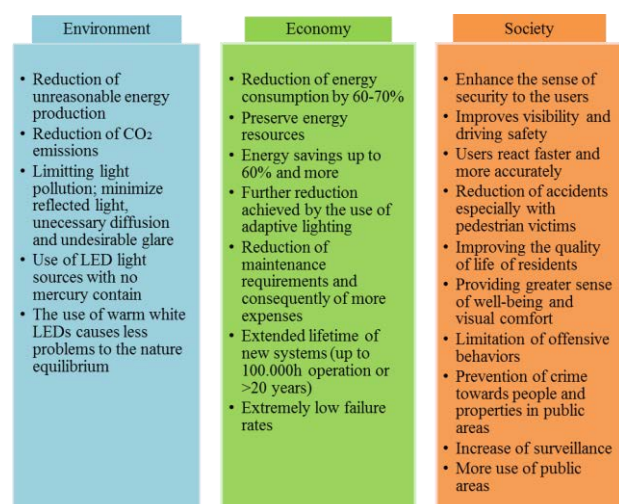


Figure 4. Street lighting optimization expected results (Developed by the Authors)

With this background and an interdependent relationship between lighting needs and aesthetics, the night-time appearance of the modern urban road network can become a new experience where visual comfort, safety and the opportunity to explore the urban environment can prevail.

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Evaluation of the Thermal Comfort in the Design of the Museum Routes: The Thermal Topology

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ABSTRACT

Museums are nowadays among the most popular projects for the public, the concept of thermal comfort in museums is often treated after the realization. Even if in the design, the architect shows a particular intention to work with daylight which is considered for these projects as main, the architect often considers certain elements that have an influence on the energy balance of these projects such as: orientation, building materials. The museum route is the key to the success of any museum project, it is the space of the visitor, the space in which he is invaded by sensations. In this study, we will first evaluate the thermal comfort in the museum as a whole (building) and then through its route. The objective is to guide reflection in the design of the museum towards the route in order to reduce energy consumption. In order to carry out our study, some European museums were analysed by means of simulation, according to the thermal comfort of their designs for the most unfavourable conditions, then by a thermal analysis of the museum route according to the segmentation principle using the average radiant temperature. This method allowed us to bring out correspondences between the architectural form and the route. Finally, the segmentation method constitutes the basis of a new methodological approach called "thermal topology" based on the discontinuities of the temperatures in the route.

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1. Introduction

The birth of architecture had always been linked to the human being and his needs. Theories on the architectural space have

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passed from the metric dimensional character to the ambient psychological character. Reflections on the human body have shown that the body does not stop at the surface of the skin, it has an immaterial boundary called bubble that is located in close proximity to his body. (J.Cousin, 1980)

Thus, it will be necessary to imagine that the body is included in a bubble which is also composed of several layers taking the form of a protective eclamptic sphere. Man is thus surrounded by several spheres of variable dimensions; these variations are due to his way of moving in space and the route between several spaces. These variations affect human man's behavior and his ways of appropriating space. The requirements of the human being as to his space are multiple, it can be noticed that from our reading, there are three ways of appropriating the space, a very personal way making it private, a way slightly personal making it semi-public, and a not personal way making it public.

The house is currently considered as the private space of the human being, many are the research works that deal with its aspects, however there are also projects that are considered by the human being as private with varying degrees of change such as offices, or work offices or even schools, hospitals ... in our era there are also many project intended for the general public, we find shopping centers, theaters, museums...

The museum has a public character because it is designed and intended since the beginning of its appearance to the public, however it also has its private property and many characteristics in relation to its user who is its visitor. Visitors must be transported by their emotions and live a very personal adventure in a space intended for the public

2. Literature Review

2.1. The museums a "place" for the public:

Previously, the architecture of the museum, directly inherited from the great princely residences, had been adapted to become at the same time the setting, the decoration of a private collection; then a public, and place of its ideal contemplation. The laws derived from the theories of "Gestalt" have developed the design of these spaces. They are not the only ones, there are also the various studies carried out in the company of visually impaired people, which made it possible to establish some rules in the perception of space. Certain principles of the psychology of perception can

also find an application in architecture and especially in museum architecture.

For a person who has all his senses, the experience of architecture is primarily visual (sense of movement). The movement of the body, even if it is not one of our five senses, offers us the measure of things and space. The route, the visit, allow the appreciation of the grandeur. We note that the exploration of a space is carried out by simple gestures such as approaching, moving away, going around, going up, going down, penetrating, etc. These actions invite us to control what we want to see, hear, smell, taste, touch in a given environment.

During an exhibition, the visitor perceives and appropriates an ambience, and at the same time, "dialogue" with what he sees, hears, or touches, etc. It is no longer in a "space" (quantifiable volume, whose physical dimensions and surface can be determined), it is located in a "place" that has a history and that we will discover. The "place" is the result of a state of mind, a feeling of well-being or malaise, a feeling.

2.2. The design of contemporary museums:

In this paper we will focus on contemporary museums, with an overview of the steps that the museum has taken to reach its present complete form, and finally, the relationship between its external and internal aspect thanks to the notion of the route.

2.2.1. An overview of the evolution of the design:

The appearance of the museum design had evolved, according to I. Bayón Juan (2013) in the city of the 19th century, the museum was consolidated as an important building in the urban context with a social function, the consolidation of several elaborate and defined models generated new typological qualifiers i) the Museum-temple, ii) the Museum-palace, ii) the Composite Museum.

The great social and cultural transformations of the 20th century changed the concept of the museum, its social function and the way it was exhibited. The museum will no longer be a national sanctuary of art or science, but a tool for the conservation and transmission of knowledge. (I. B. Juan, 2013)

In the post-war period, a new type of museum appeared, the museum as a "white cube" of modernity, linked to the universal space of Mies van der Rohe. The first reactions against the white cube and the museum's association with the mausoleum began to appear in the 1970s.

Van der Rohe's ideas for spaces have been taken up by a new generation. The museum had ceased to be a temple or a treasure house, the best example of these new ideas was the Centre Pompidou opened in 1977.

In the 21st century the museum surpasses all others in its symbolic character. For this, the architecture of the museum has become a gigantic sculpture on a tray or a recognizable silhouette tower. The most representative museum of this new image of monumentality and the media is the Guggenheim in Bilbao. (I. B. Juan, 2013)

The design of the museum went through four main stages: i) The collection of objects as a sacred act: one rarely exposed to the public that during the festivals according to the period and the dominant religious belief of the time, it was practiced at temples, churches, While the collections were in the hands of the church, exposed in temples and cloisters, there was no need to create special spaces for them, ii) Presentation to the public: Everything changed when collectivism became secular and began to be exercised by princes and nobles. This is how the need to develop new types of spaces to preserve and exhibit is born. this period of visual design appears according to the historical chronology: the studios of the Renaissance princes, the palaces of Belvedere, the galleries, The creation of object cabinets, iii) as varied function : Baroque art brought a flourishing of the art by encouraging the spaces of exhibition for a better valorization of the collections, it is at this time that one conceived the first architecture for the conservation and the exhibition of the collections, The museum opened in 1683, and had to wait until the 19th century so that the operation of removal of the collections can be carried out iv) varied design: according to the content, the architectural form and the current of the architect; according to the routes,... (I. B. Juan, 2013)

In the contemporary museum the concept of the route is the key element of the design of the museum since its appearance, we will now see how it is treated in the museum.

2.2.2. An interior design and the notion of the route:

Le Corbusier (1977) had highlighted the fact that architecture is a journey, with its concept of "architectural walk". If villas, religious buildings, etc., offer architectural walks, it is obviously the museums that are the clearest examples. Jean-Raphaël Pigeon (2013) notes that it is only possible for man to visualize himself in his route if he becomes aware of his

environment through his body, this awareness allows a better understanding of architectural space. The first relationships between man and the route refer to visual abilities, man tends to understand the environment in which he finds himself and appropriate it through decoding information that space sends him.

J-R-Pigeon (2013) evokes the works of J Cousin, the use of the bubble by the latter can better define the relations between man and his space and beyond the route, the bubble is much more than a series of layers extending on the periphery of the human body. It does not have fixed dimensions or a particular shape, but changes in the spatial route according to the movements of the body, it marries the body at a certain distance, but can expand, widen, or also compress itself according to the context. The location of the components of the architectural route (such as transition and intermediate spaces) have a particular importance and influence on the users of the route. However, the direction taken in the user's route, through the spaces, influences the perception of the latter.

The concept of route is not easy to define, because of its polysemy. We can adopt, for example, the definition of LAROUSSE (2009, p. 356): "it is the route or route followed to go from one point to another". Common sense gives various meanings. Showing the complexity of this term: (path, circuit, route, triathlon, course, crossing, stage, etc.). For some researchers, the route represents the movement of the body in space. For others, it is described as a design-visit interaction, the route being taken into account according to the context. With the route, the simple act of moving begins to make sense.

Many solutions to traffic principles have been developed; they fall into three categories according to their form (Mariani. R, 2000). (i) The "linear" route: an obligatory scheme, (ii) The "labyrinth" route: no traffic constraints, (iii) The "centered" route: The public is free to choose the route of its visit.

This typology proposed by Mariani. R (2000), is very complete if we associate it with the one proposed by Jean Davallon linked to the three levels of exhibition: i) the conception (thought route), ii) the setting in exhibition (proposed route), iii) and the visit (lived route).

However, this typology proves insufficient if we compare it to the work carried out by A. Borie and al (1985) and P. Panerai and al (1983), we have noticed for the same typology several other sub-typologies are associated, and after a reading of the two proposed typologies we

summarized them as follows (Table 1):

Table 1. Different route configurations.

Integral Configuration	Linear configuration			
		Curvilinear 	segmented 	with branches
	Cantered configuration	Radial 	Arborescent 	loop
	Ribbon configuration		Spiral 	Broken line
Partial configuration	Labyrinth 	Regular 	Irregular 	

2.3. The notion of comfort in the museum and thermal comfort:

If we take the research carried out on museums from the angle of comfort, we will realize that the first aspect of comfort that researchers deal with is visual comfort, this is due to the initial function of the museum, which is the exhibition of works of art, if the visitor is there it is to visually appreciate the exhibition. The element of ambience linked to the visual comfort that is often treated in museums is the light, it is studied not for the comfort of the user and the success of the exhibition but also its influence on the works of art (deterioration). However, despite the importance of light and visual comfort, there is also another type of comfort that can influence the success of the exposure is thermal comfort. This comfort is linked to the thermal environment often very much influenced by the architect's choices during the design with regard to the choice of materials... it is mainly linked to the conditions of temperature, humidity and wind as the users are exposed, but it also concerns the works of

art and their lives, since in the museum it will be necessary to maintain a precise temperature and relative humidity for the maintenance of the works. It is very important to specify that the thermal performance will say as much about the energy performance, generally expressed in kilowatt-hours of primary energy consumed for 1 m² and over a year (KWh-ep/m².an), the energy performance of a building designates its ability to limit energy consumption within a project, taking into account the quality of its heating equipment, but perhaps above all, its thermal behavior. The latter refers to the evolution of temperatures inside the building. (H.T Minassian, 2014)

Returning to thermal comfort, and starting with the users, the first essential condition to provide thermal comfort to a person is to balance his energy balance. The calorific power produced by the metabolism must be equal to the power dissipated in the environment by the five exchange means. (M. Le Guay, 2009) Thermal comfort is linked to energy performance, we are now seeking to make energy performance

optimal, and it is by improving thermal comfort that this will be done.

Research in the thermal field concerning the museum without very rare and since we are interested in contemporary space we quote the work of Philippe Rahm (2005) in which he speaks of the birth of a new thermal approach with the free plane of Le Corbusier, he begins from the observation that the way of heating a space passes by heating each sub-space separately, and therefore he proposes with the same principle of the free plan or everything communicates to try to think of the whole house as a global atmosphere, this led to the birth of a new concept which is the thermal landscape.

Philippe Rahm had first of all tried to found a new architectural language linked to the thermal aspects and inspired by the values of the invisible. He then adopted the concept of the Gulf stream which is based on: i) the creation of an invisible, complex and rich thermal landscape, defined according to multiple zones of different temperatures as many climates, sensitivities, territories, ii) In this architectural design process, an atmosphere is created first, before the program, before the spatial forms, iii) It is then that the program is placed in space, looking for sensual thermal conveniences that cross localized ambient temperature criteria, clothing, physical activity. (P. Rahm, 2014)

In the case of museums, we can mention his work on the THERMAL DISTORSION for the Contemporary Art Gallery in Grand Palais (Paris, 2009), which first takes place through the zoning of activities, defining space by nuance of heat that generates different zones and functions (Working seated: 21°C, visiting walking: 16°C, Storing: 12°C). He therefore established from these needs a design according to the temperatures of the space to be designed.

Rahm's work is more than interesting insofar as he begins to analyze before designing and according to that he designs. The observation made on the case of European museums is that the thermal comfort component is often linked to the construction phase, the architect chooses the materials, proposes a particular orientation of the projects and the interior spaces, sometimes use software for the calculation and estimation of the energy balances related to the heat of his building, except that the real heating and air-conditioning powers to install his estimate once the project is completed.

In the case of museum projects realized with a particular architectural form, is there a relationship between the chosen form and thermal comfort for the most unfavorable conditions (daily and seasonal? and how does the choice of the course participate to make the thermal comfort during the visit better? Can better thermal comfort conditions be expected from the project design phase?

3. Methodology and case study

3.1. Methodology

The element that we will use to evaluate the thermal comfort in this paper is the mean radiant temperature (MRT). This last represents from a theoretical point of view one of the elements with major influence on the comfort, it is the average of the surface temperatures of the walls which surround the person, it allows to give an idea on the resulting temperature of the comfort which is calculated by the relation: $\text{Resulting temperature} \approx (\text{Ambient} + \text{mean radiant temperature}) / 2$

3.1.1. Evaluation of the comfort of the building:

We first calculate the different coefficients of form, of compactness and the ratio surface loss / living area in order to obtain information on the thermal capacities of each architectural volume.

We modelled after reduced models of our case studies with their real dimensions, their climatic files and all the characteristics of the construction materials and the context. We then simulated the thermal comfort as a function of the mean radiant temperature using the Ecotect 05 software, the simulation was carried out in several stages as follows:

- The plan views of the analysis grids for the critical hours of the most unfavorable day according to the season, we obtained 6 representative results by plan views. In this regard, we cite the case of the first floor of the Acropolis Museum in Athens (Table 2).

Table 2. Variation of the mean radiant temperature in the Museum of the Acropolis of Athens

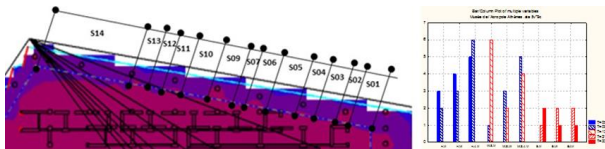
Ground floor	Morning	Noon	Afternoon
21 December			
21 Mars/ 21 September			
21 June			

- We determined the recommended radiant temperature and compared it with the simulation results to obtain the percentages of the temperatures in the interior building spaces that respect this temperature.

The correspondence between the different case studies allowed us to make a first reading.

3.1.2. Assessment of thermal comfort in the museum route:

We then took the schematic results of the resulting mean radiant temperatures and on these we drawn the route, considering each colored part of the plan with a temperature as



segments a part, we calculated the number of segments for each temperature and from this calculation we determined the temperature

Figure 1: Schematic segmentation, and graph of number of segments by temperature (source: author, 2018)

3.1.3. The correspondence between the two methods of analysis:

It is by means of the Statistical 07 software that we will proceed to carry out correspondences between the various parameters analyzed by means of a multivariate analysis. All methodology had been explained in Figure 02.

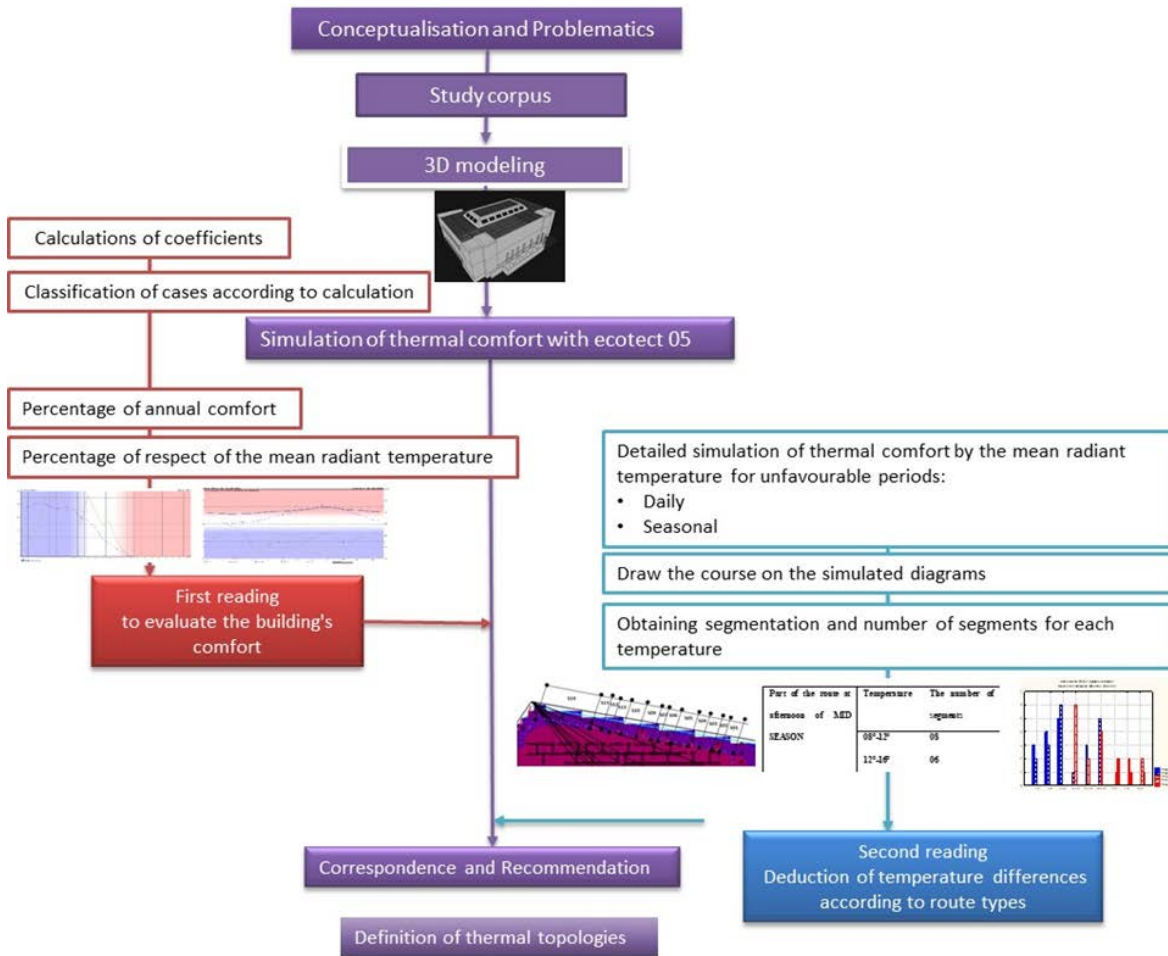


Figure 2: Methodological principle (source: author, 2018)

3.2. Case studies:

We have chosen our case studies according to a selection criteria grid, and we quote to this effect.

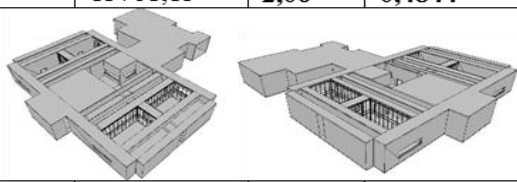
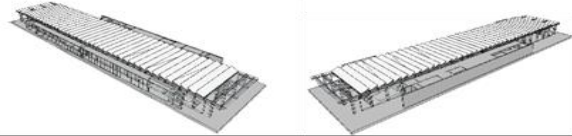
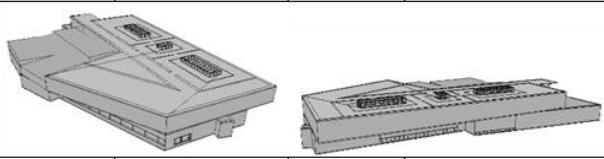
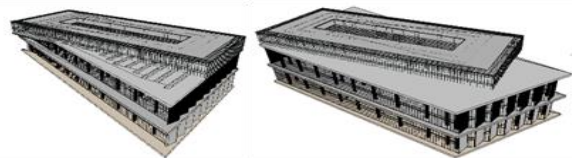

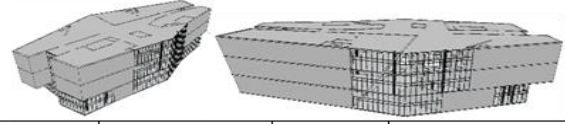
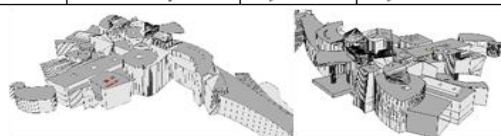
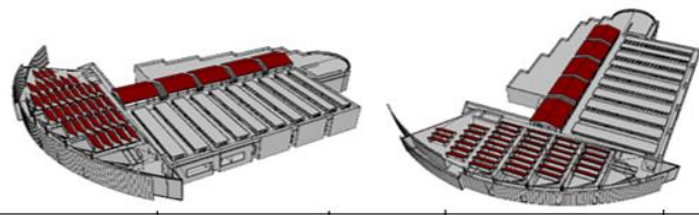

3.2.1. Architecture and architectural form: It should be noted that the selected museums all belong to the same historical period (1980-2008), museums where the architect had tried to display a particular intention to work with the daylight given the function of exposure (orientation, materials, daylight,) which will have a particular influence on thermal comfort. For the plan shape based on the optimum which varies according to the latitude of place. Our museums are all located on latitudes between (37°N_59°N) and altitudes which vary between 0 and 300m.

3.2.2. Geometry, shape and compactness coefficients: The size and geometry of the building partly determine the heating and cooling requirements. We have therefore classified our selected cases according to their

shape coefficient, representing the ratio between the surface of the envelope and the habitable volume (m²/m³), it indicates the degree of exposure of the building to climatic factors, it is a very important criterion in the thermal evaluation of the building but delicate to apply because it depends on several factors, such as the geometric shape, the size and the mode of contact of the buildings. (Roger Camous et al, 1979).

3.2.3. The orientation: The southern exposure is interesting because the sun is high and it is easy to protect oneself. It is the most favorable exposure in summer after full north, while being the best in winter. For that we chose museums oriented South or South-East or South-West. So, we have proposed, according to the architectural form and in relation to thermal comfort, 09 museums presented in the table 3:

Table 3. Summary of case studies and coefficients.

The museum	Area (m ²)	Volume (m ³)	Cf	C compactness V/A	Af/Ah
Prehistory departmental museum (France) Roland Simounet Île-de-France paris 48°51'24"N 2°21'03"E 35m	6666,5	13761,15	2,06	0,4844	3,148
					
Beyeler Riehen Museum (Switzerland) Renzo Piano Bale 47° 34' 01" nord, 7° 34' 59" est 254m	9540,4	18409,2	1,93	0,518	2,383
					
Centro Gallego de Arte contemporaneo(Spain) Alvaro Siza Coruña 43.37°N 8.40°W 309M	18161	37136	2,0448	0,49	3,91
					
Acropolis Museum Athens (Greece) Bernard Tschumi 37°59'02.3"N 23°43'40.1"E 70M	13577,6	69120	4,84	0,206	2,355
	5202	21924			
	18779,6	91044			
					
Jewish Museum Berlin (Germany) Daniel Libeskind 52°31'00"N 13°23'20"E 34m	17958	79560	4,430	0,225	1,805
					
Hergé Museum (Belgium) Portzamparc Christian 50.671115°N 4.612809°E 50m 2006	7878	35640	4,520	0,221	1,287
					
Guggenheim Museum Bilbao (Spain) Frank Gehry 43° 15' 25" nord, 2° 55' 24" ouest 19m	14970,18	130351,7	8,707	0,11	0,574
					
	15120	102222	6,670	0,147	0,665
Grenoble Museum of Fine Arts (France) Olivier Félix-Faure, Antoine Félix-Faure et Philippe Macary 45° 11' 16" nord, 5° 43' 37" est 204 m					
Museum DE MAXXI (Italy) Zaha Hadid Rome 41°54'N 12°30'E 21M	17145,6	107427,2	6,314	0,158	2,003
	1230	8610			
	18375,6	116037,2			
					

4. Results and discussion:

4.1. Evaluation of the comfort of the building: In relation to the coefficients

For the coefficient of compactness, we found very varied results, the Bilbao Museum presents the lowest coefficients (0,11) compared to the proposed museum, however the Jewish Museum of Berlin and the Hergé Museum and the Maxxi and the Acropolis Museum Athens have a coefficient in the same interval (0,15 and 0.25). The prehistoric departmental museums, the Beyeler Riehen and centro Gallego de Arte contemporary have practically the same coefficients (0, 5).

In the case of the ratio of loss area to living area, we did not find any relationship between the results obtained for the different case studies. We go from 0,5 for the case of Bilbao to 1,2 for the Museum of Hergé, 1,8 for the Jewish Museum, the Museum of the Acropolis Athens, the Beyeler Riehen between 2 and 2,3 .and finally the great values for the Prehistoric Departmental Museum and centro Gallego de Arte contemporary ≤ 3 .

These coefficients do not give us a plausible reading of the thermal quality of buildings, the most interesting from a scientific point of view is the ratio surface loss / living area, but for our study cases there is a variation between the floor area and the footprint which makes the relationship between the results very subjective. However by the coefficients of form we can already classify our museums into three formal categories: i) museum of simple form ($Cf \approx 2$): Prehistoric departmental museum, the Centro Gallego de Rate contemporaneo and the Beyeler Riehen, ii) Museums of simple form modified to 50% (see ≈ 4 to 5): the Jewish Museum of Berlin, the Hergé Museum and the Museum of the Acropolis Athens. And finally, the museum with complex form ($Cf: 6,3$): the museums Guggenheim Museum Bilbao, DE MAXXI and Grenoble Museum of Fine Arts.

4.1.1. The percentage of annual thermal comfort and the respect of the MTR:

After the simulation we obtained the percentage of the overall comfort (Table 4) of the building and we can say that for all museums there is no particular relationship being the results all museums achieve almost 50% percentage of comfort.

The museum	period	MRD recom mende d	TRD Percentage respected	Percenta ge and Hours of annual comfort	Graph
Prehistory departmental museum	winter	10°	40%	44.8% 2126 Hrs.	
	mid-season	16°-18°	90%		
	summer	24°-26°	70%		
Beyeler Riehen Museum	winter	10°	20%	33.4% 2926 Hrs.	
	mid-season	14°-16°	100%		
	summer	22°-24°	70%		
Centro Gallego de Arte contemporaneo	winter	10°-12°	30%	51.2% 4486 Hrs.	
	mid-season	14°-16°	70%		
	summer	24°-26°	100%		
Acropolis Museum Athens	winter	10°	90%	47.6% 2143 Hrs.	
	mid-season	14°-16°	60%		
	summer	24°-26°	40%		
Jewish Museum Berlin	winter	10°-12°	70%	46.4% 1953 Hrs.	
	mid-season	14°-16°	80%		
	summer	22°-24°	45%		
Hergé Museum	winter	10°	100%	45.3% 1816 Hrs.	
	mid-season	14°-16°	70%		
	summer	22°-24°	40%		
Museum de MAXXI	winter	10°	60%	40.6% 3559 Hrs.	
	mid-season	14°-16°	80%		
	summer	26°-28°	50%		
Guggenheim Museum Bilbao	winter	10°	60%	48.8% 2818 Hrs.	
	mid-season	14°-16°	90%		
	summer	24°-26°	50%		
Grenoble Museum of Fine Arts	winter	10°-12°	30%	44.6% 1721 Hrs.	
	mid-season	14°-16°	80%		
	summer	22°-24°	60%		

Table 4. Annual thermal comfort and the MTR For the unfavorable period of the winter, for museums whose coefficient of form is around 2, the percentage of the mean radiant temperature in the global building for the winter period is respected with a percentage less than 50%, such as the case of museums: prehistoric departmental, the Museum Beyeler Riehen and Centro Gallego de Arte contemporaneo, (Figure 03) for museums whose coefficient is equal to 5, the percentage

of the respect of the mean radiant temperature is higher than 50% we quote the example of the Museum of the Acropolis Athens, and for the museums or the coefficients is higher than 6 the percentages approaches 50%.

For the unfavorable period in mid-season, there is no variation for the percentage of mean radiant temperature, in all museums it is greater than 50%.

For the most unfavorable period of the summer, we notice a percentage exceeding 50% for museums where the coefficient of form is equal

to 2 such as the case of the Centro Gallego de Arte contemporaneo, for the rest of the cases it is considered as average approaching 50%. This reading does not offer any particular information with regard to the notion of comfort from conception, and despite the disparities that may exist, it does not present any particularity of thermal point specific to the museums in the corpus of study.

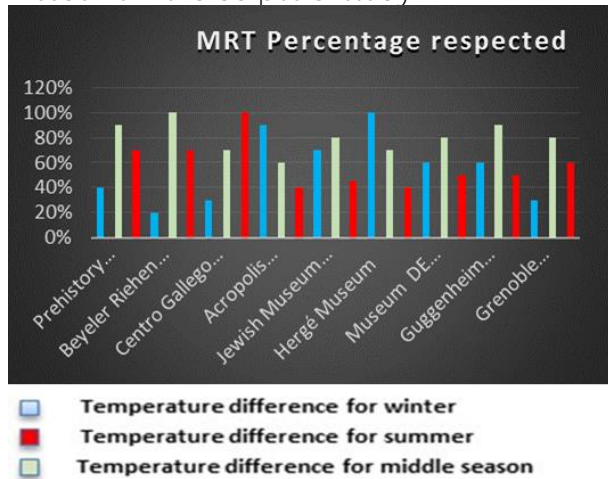


Figure 3: Diagram of the percentages of the MRT in the study cases

4.2. Assessment of thermal comfort in the museum route:

4.2.1. Differences in mean radiant temperature in winter:

The differences of mean radiant temperature are present within the route of two museums of case studies which are: Museum of the Acropolis Athens, and the Prehistoric Departmental Museum. (Figure 04) These differences characterize the three periods of the day when we passed for example in the case of the Acropolis Museum from 03 segments of 05° and 02 segments of 09° in the morning of the coldest day to 04 segments of 05° and 03 segments of 09° at noon, and 05 segments of 05° and 06 segments of 09°. The correspondence also shows the total absence in these cases of a study of radiant mean temperature differences for the summer period.

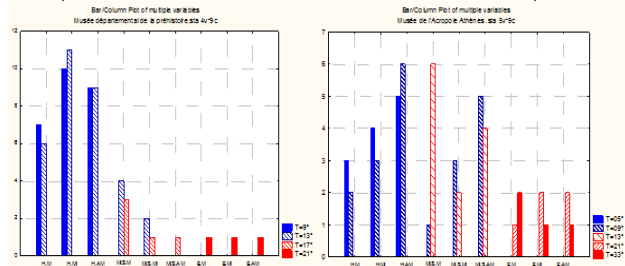


Figure 4: Diagram of variation in number of temperature segments, daily and seasonal variations

If we return to the initial segmentation of the route according to temperatures, we will notice that for these two cases (Figure 05) the visit begins from the same point and also ends in the same point, the route is considered linear for the visit but from a conceptual point of view it is rectilinear centered.

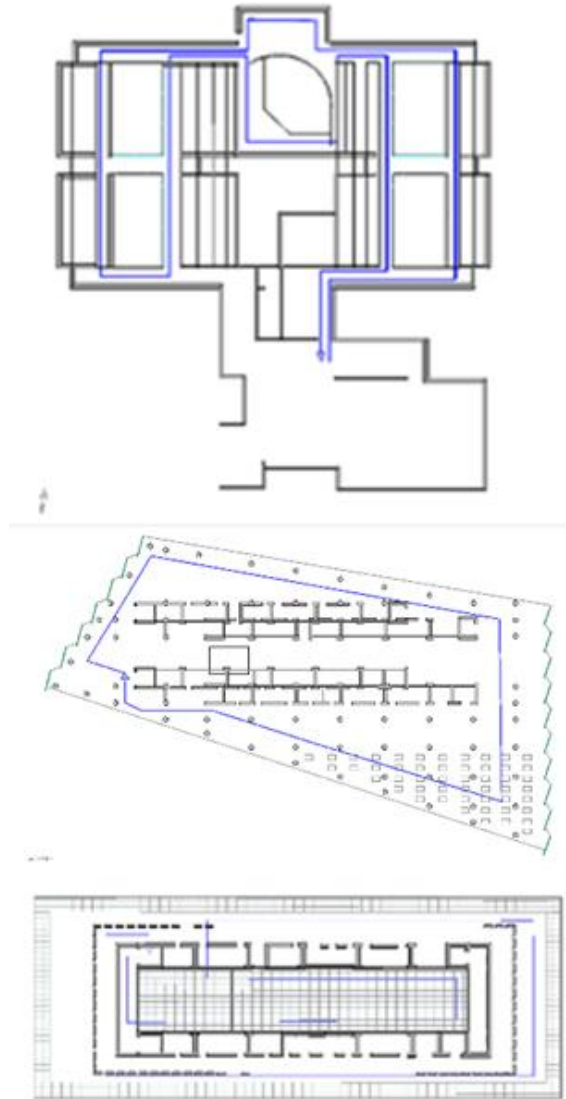


Figure 5: the route plan for the case of Prehistoric Departmental Museum and Museum of the Acropolis

4.2.2. Differences mean radiant temperature in summer:

These types of Differences characterize three museums of our case studies which are the Beyeler Riehen Museum, The Centro Gallego de Arte contemporaneo and the Hergé Museum, with a total absence of temperature differences during the winter period (Figure 06). We cite the case of the Beyeler Riehen museum, where we notice according to the graph that for the morning of the hottest day the route consists of 03 segments, a first one with a mean radiant temperature of 18°, and

02 segments where the temperature is 22°, at noon for the same day the route will have 03 temperatures, 18° on a segment, 22° on 10 segments, and finally 30° on 07 segments. For the afternoon of the hottest period we will have 02 segments of 18°, and one at 22°.

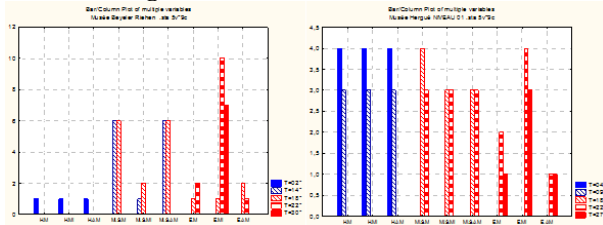


Figure 06: Diagram of variation in number of temperature segments, daily and seasonal variations

The route for these three case studies is of the same nature as it appears in the Figure 07, it is considered linear for the visitor, from the conceptual point of view, the linearity of this route can be in the case of the Museum Beyeler Riehen segmented, the Centro Gallego de Arte contemporary adopt the form of a zigzag and finally the Museum Hergé be labyrinthine in nature.

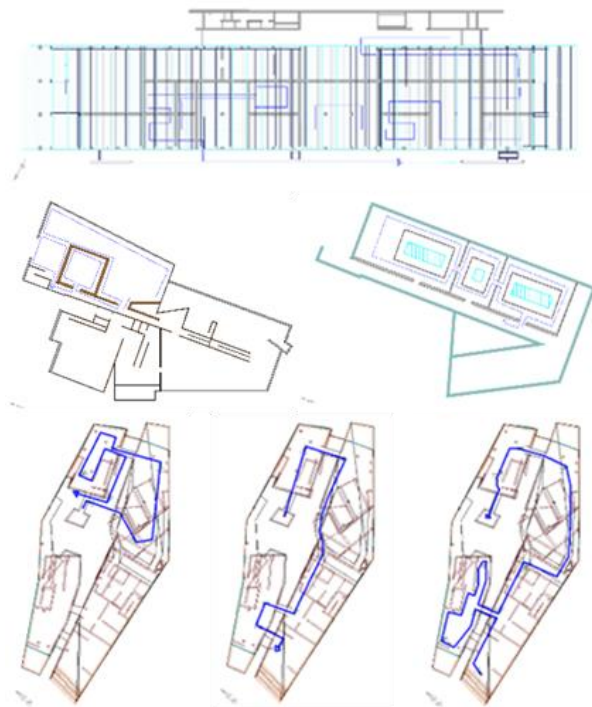


Figure 07: the route plan

4.2.3. Differences in the mean radiant temperature in mid-season:

These differences are the most important for our study cases, given the fact that they can extend over a long period of the year that is 06 months, there are two groups of this type of difference completely opposite, the first is the one where the differences of the mean radiant temperature are present, it includes the Jewish

Museum in Berlin and the MAXXI Museum in Rome (Figure 08).

For this purpose we mention the case of the Jewish Museum of Berlin or for the two periods of the mid-season, for the morning 02° and 08°, at midday the distribution will remain with equality but we will have 04 segments of each temperature 02° and 08°, the route will be composed of 04 segments, divided equally on two temperatures, for the afternoon we will have three temperatures, 02 segments of 02°, 07 segments of 08° and 06 segments of 12°.

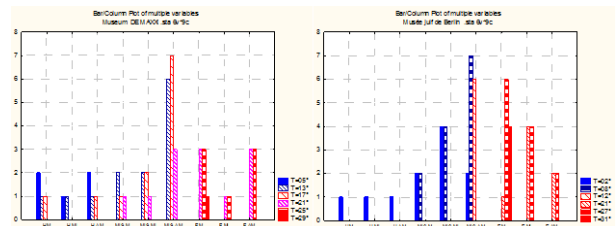


Figure 08: Diagram of variation in number of temperature segments, daily and seasonal variations

The second group is the one where these Differences are absent and we find two types of museums in this category, the Museum of Modern Art and Architecture in Stockholm and the Guggenheim Museum in Bilbao.

In the case of the Guggenheim Museum in Bilbao, the route consists of a single segment with a mean radiant temperature of 09° and those for the three periods of the day. In the case of the Museum of Modern Art and Architecture in Stockholm the route consists of 05 segments spread out at 03 over a temperature of 05° and 02 segment for a temperature of 09°.

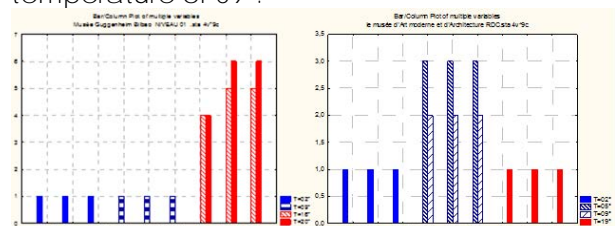


Figure 09: the route plan

For these four types of museum buildings in Figure 10, the route is labyrinth type, however for the Maxxi and the Jewish Museum this labyrinth has a conceptual character of linearity, and for the Museum of Modern Art and Architecture in Stockholm and the Guggenheim Museum in Bilbao, a perfect labyrinth.

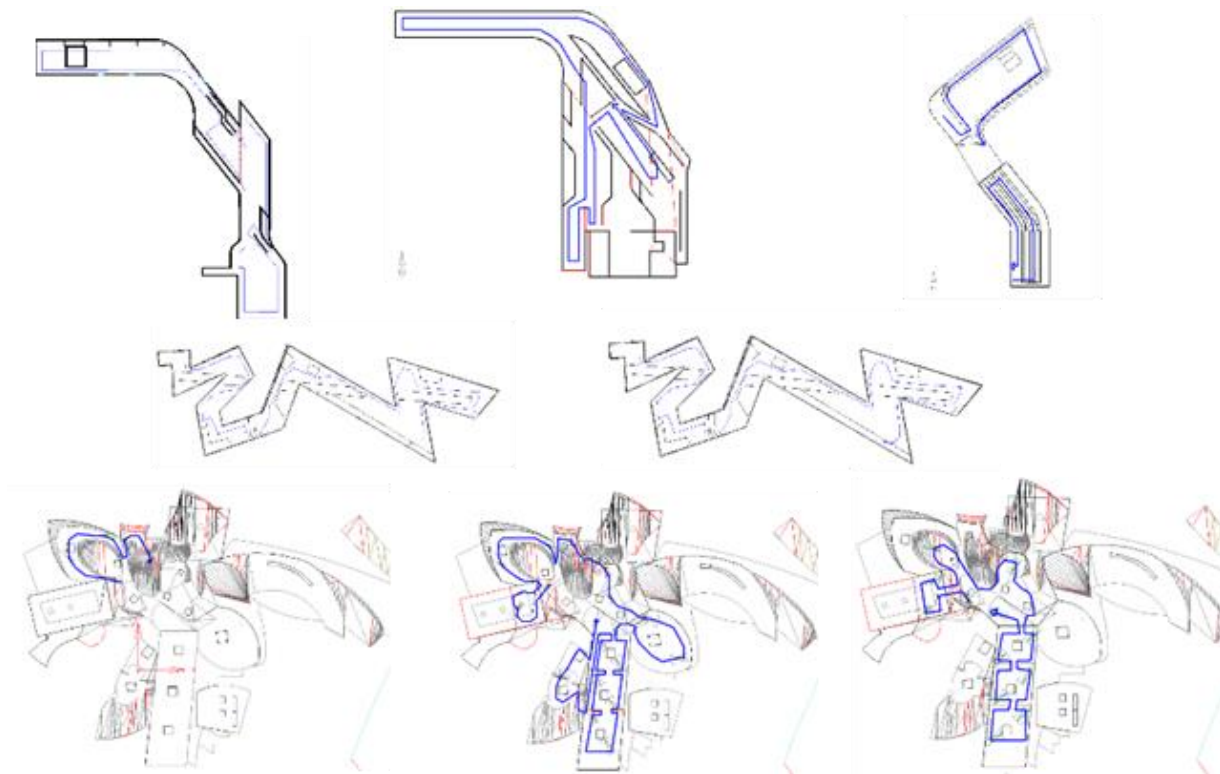


Figure 10: the route plan

4.3. Correspondence and Recommendation:

First, we studied the correspondence between the comfort of the building and that of the route with the software statistica 07. This recommendation concerns directly the museums of our case studies and those of the same formal configuration, the recommendation will take effect if we respect from the design: Optimal shape / appropriate route / optimal mean radiant temperature:

- The optimal architectural form is the simple form (primary), simple forms are characterized by the existence of temperature differences that will last no more than 03 months (the time of a season). For the type of route, we recommend a route with Full Configuration, all varieties are required (simple, centered, or zigzag).
- The mid-season differences which can affect the museum route over a period of 06 months, very often characterize the architectural forms having kept 50% of their simple primary form, it will be necessary to propose the most compact architectural forms possible and without disengagement, as far as the route is concerned, we propose the routes with Integral Configuration.
- The mid-season differences are also absent in the case of museums with complex shape (organic form), or the

route is often labyrinthine or mixed type seems the most appropriate, it will however be necessary to find solutions for the winter and summer periods.

4.4. The birth of the thermal topology:

The segmentation method we have proposed in this paper has nothing to do with metric dimensions of space, it depends on changes in temperature in space. While looking for a meaning of this segmentation in the field of thermal, we found that this segmentation corresponds to what O. Gregory and A. Kumbaro (2013) had named the "thermal topology".

The thermal topology has not been evoked where to present in various works of urban planning or architecture, however it is related to the field of the physics of the buildings. The notion of topology designates the thermal balance, it is related to them different regimes of heat flow in the wall or within the space itself. Topology is used in Thermomotor simulations to qualify color (pixel) variations for each image rendering and each temperature. If we take the museum route in relation to the visitor's movement, we will notice that each segment corresponds to a specific temperature, or we pass from one temperature to another through a transition (a thermal event corresponding to the change in temperature) the segments in this case can be called "sequence", and we can thus define thermal topology as the transformations or

discontinuities affecting the mean radiant temperature throughout route and we can then propose a new method of analysis based on temperature variation named sequential analysis. This new way of reading the space topologically will allow to qualify the architectural space from the thermal point of view "topologically", or within the route we can find several discontinuities based on the variations of temperatures.

This new methodological approach, linked to the thermal environment, can support simulation in order to improve the thermal performance of a design, or the study of a possible correction based on the micro (detail) and not the Marco (the whole project). The method of sequential analysis of ambient topologies (Saraoui.S, Belakehal, A, and al, 2018) had already been tested on the museum route for the sound and light ambiances.

5. Conclusion:

Museums are very important projects in our time, their importance emanates from the architectural aspect of the external form which plays a very important role in contemporary museums. If from a conceptual point of view the architect displays a particular intention for visual comfort and daylight in museum, the concept of thermal comfort remains ambiguous and often treated after the realization. However, it is essential to know how to choose the appropriate forms so that the piece of art do not deteriorate under the effect of variation of temperature and humidity.

The museum route is the link between the external architectural aspect and the interior of the museum space, whether it is an architect's choice, an imposed constraint or a result. It is the visitors' space on which the whole visit rests, the space in which visitors are invaded by sensations. This route can also be the place of variation of an essential element of comfort which is the mean radiant temperature influencing the visitors' feeling.

In this paper we have taken as elements to analyze the mean radiant temperature which gives an overall idea on the thermal comfort. We first analyzed the thermal comfort of the museums in question as a building, the results of this part seemed too general and without any particular relationship. The evaluation of the museum through its route, allowed us to detect the temperature differences that can characterize each type of museum, first for the periods of the most unfavorable days, then for each season. This allowed us to make

recommendations for the choice of the form and the typology of route which goes with, this reflection related to the design of the museums makes it possible to reduce the consumption of energy.

Approaching the museum route by means of the segmentation method by mean radiant temperature interval, put the emphasis on a new methodological approach that can bring a new definition to the museum space based on the discontinuities or temperature differences that can characterize the route, This new way of reading space we have called "thermal topology" can define new spatiality of architectural space other than that based on dimension.

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A Discussion on Affordable Housing Projects; Case Study Mehr Housing, Iran

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ABSTRACT

Housing is one of the basic needs for humans. Families in different countries with various cultures, who have different life styles respond to their individual needs including physical and mental in a safe place that is called house. The world population is increasing day by day. In parallel to this population growth, housing demand increases rapidly. Thus, different countries try to meet the needs of housing by creating multifarious housing policies. Generally, these policies have been developed according to countries' special conditions and the developments in the world. Iran is also a country, which has a rapid population growth and has developed series of policies to solve the housing problems. Affordable housing is one of solution for providing the house by governments. These type of houses is the ways to answer the demand for low-income people or the people that their income is not sufficient to own a house. Since 2007, government has built new type of affordable housing in different cities of Iran. These houses are named as Mehr Housing, which are generally medium and high-rise buildings for low-income people. In this study, it is intended to make an evaluation about the strengths and weaknesses of Mehr Housing projects in Iran in terms of housing quality. In order to evaluate the architectural quality of Mehr Housing projects in Sarvestan, Abadeh, Nourabad, Firoozabad, Hashtgerd, Zahedan, Tabriz, Hadishahr, Marand, Zanjan, Yazd and Natanz physical analysis method is used as well as literature review. These analyses are mainly done based on location and accessibility, safety and security, public open spaces and recreational activities, plan layout of housing units and physical features. By this discussion, it is expected to create a guidance for the policy makers, designers, users and other shareholders.

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1. Introduction

From the ancient time till now, one of the most important needs of human after the food is shelter. Dwelling could protect people from cold and hot weather, risk of animals and in other words a safe place for resting and comfort (Weihe, 1990). Besides, housing meets

the psychological and social needs of users (Evans, 2003). Due to increasing population of

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the cities and suburban areas after the Industrial Revolution, the housing become one of the most important and essential problem of people (Aldrich, 1995).

The most important factors, which help to solve lack of housing is supplying the land, attention to the construction material and powerful management (Mazloom Khorasani, 2011). Housing problem exists in every country. However, it is more serious in third world countries related to political, economic, social and cultural factors (Pour Mohammadi, 2014).

From the other point of view since the adoption of the Universal Declaration of Human Rights in 1948, "the right to adequate housing" was introduced as an important component of "good living standards" (Assembly, 1984). Thus, each government imposed special rules and regulations in field of housing (Schill, 2005). They take action to establish ministries of housing in order to allocate funds and policy formulation, regulation, programs and special projects in the housing sector (Hulchanski, 2002).

As a developing country, Iran also has special effort on housing problem. The first attempt in this way is creation of the Ministry of Prosperity in (1964). After that, the Department of Housing and Urban Development was established in 1974 (Rasoolimanesh, 2013). Furthermore, according to the agenda of Second Conference on Human Settlements (Habitat 2) United Nations Ally, which was organised in Turkey in 1996. Islamic Republic of Iran as a member accepted some commitments. These can be summarized as regarding the right to adequate housing, enabling all people have access to appropriate shelter. The other factor in this agenda is to provide legal security for land ownership, mobilizing financial resources and credit and other sources of private and government sectors for social development access to efficient technologies and effective practices (Nastaran, 2010). The right of housing in the constitution stated clearly in Iran. According to 31th of the constitution of the Islamic Republic of Iran, it is the right of every person and household in Iran to have a house. Government is responsible for those, whose need according to priority. Workers and villagers are the first ones that can benefit from the implementation of the realization of this principle (Saremi, 2012).

In socialist countries, despite they produced too many houses but based on increasing housing demand, they still have lack in housing. On the other hand, qualitative indicators in the houses are not suitable (Pugh, 2001).

Housing in developing countries also has problems. The fundamental issues of these

countries which is the result of use of poor materials in construction, insufficient access to electricity, water and sewage systems (Okpala, 1992). Most of these countries face by the housing illegal production. Sometimes this figure reaches 50 to 75 percent of urban housing units (Azizi, 2004). One of the countries which is faced the housing problem in recent decades is Iran. This problem happened especially after the land reform in 1962 and after the changes in production methods with the growing trend of urbanization (Hesamian, 2004).

With the revolution in Iran in 1979, there is no any control on the spread of the cities. Housing in the suburbs gets much more flourished and the tenants that renting the house had much more problem with the rent price. The immigrant from the rural part get settled in the suburb areas (Sharifinia, 2012). In that period house is constructing for personal use not for giving to rent. After the Islamic revolution in terms of quantity the construction of the houses increased but the amount of investment decrease. Because the size of the houses got smaller. With the imposed war the building activities decrease and investment get lower than before in the years 1982 and 1983 (Ahari, 1996). There are five programs which were developed after the revolution that in first program the goals are related to the changing the composition construction practices to reach the durable buildings, promotion of housing inventory per capita in the country and directing the production of better quality housing with less infrastructure. The goal of second program is clean policy that is consisting of saving, mass construction and miniaturization (Ghanbari, 2010). The goal of third programme are reducing the average floor area of housing and reduce destruction of dwellings. The goal of fourth program are balance to adequate housing among groups and regions of the country, provide housing for low-income households, provide housing for youth and female headed households and industrialization of the houses construction. The goal of fifth program are housing for low-income people, safe and durable housing, market regulation and coordination between housing policies and land use planning and development in policies and reducing regional disparities (URL1).

Provide housing in recent decades, have been one of the most important problems of various segments, especially for low-income families. Population growth and increasing tendency to urbanization and migration from villages to cities after the revolution in Iran, use of less

durable materials, the entrance of young age of applicants to mortgage market and optimum combination of investment and regional disparities shows housing problem more acute than ever (Rezaie, 2015). Due to the conditions, which is mentioned above, caused to raising affordable houses as a solution for this country in the second and third economic development plan which is related to the social and cultural rights. Mehr housing is an affordable type of house which is belong to the fourth development plan (Saeedi, 2011). Base on this argument, is to analyse Mehr housing projects in terms of safety and security, location and accessibility, plan layout of housing units and physical features, public open spaces and recreational activities. Finally, a discuss is done on the weakness and strengthens in these projects.

2. Literature Review

2.1. Theoretical Background

The best definition for affordable housing is related to the description which is done by the Department of Housing and Urban Development (HUD). It is defined as a type of house that bring ability to the households to bring the opportunity to have a house (O'Neill, 2008). By this opportunity the household shouldn't pay more than 30 percent of the house price (Kutty, 2005). There are different plans for affordable housing that is categorized as: 1. homeownership assistance, 2. rental assistance and 3. Land use and regulatory incentives. In these three models, governments are helping families to have a low-income renting house. Also, it is preparing the low-interest loans to get easier homeownership (Katz, 2003).

There are different studies related to the affordable and low-income housing in the world. Devrim (2016) studied the transformation of Toki houses in last twenty years. These types of houses have a unique demographical distortion of the morphological texture in big contemporary Turkish cities. One of the weaknesses of TOKI houses is the similarities in architecture and urbanity. These projects are governmental profit-oriented. Wang and Murieh (2011) mentioned about the policy change in China had effect on social housing system. It gets more active and the marketing gets dynamic. However, it has brought problems in characteristic of market economies.

Satisfaction in residents can be used as a key predictor of a personals realization of the "quality of life" and also inadequate in their housing environment and progress to the status

quo. It is also key predictor of success of private and public constructors. Finally, it has affect on housing demand and neighbourhood change (Djebuarni & Al-Abed, 2000).

The study related to the satisfaction done by A.M.M. Liu in 1999. It was related to the Post occupancy evaluation in satisfaction. The paper study the social and physical factors that influence the satisfaction in housing estate, Hong Kong. The comparison between the private and public housing dissatisfaction were done about the housing occupants.

Abedini (2013) study which is titled as "Assess public housing policies in relation to afford urban low-income households in Iran (Urmia city), is analysed the Mehr housing in relation to the afford of low-income families in the Urmia city. Also, the public housing policies which is applied by the government for low-income people were discussed.

2.1.1. Mehr Housing Projects in Iran

Mehr housing is a kind of project which were started to be designed in 2007. The main goals are to bring equality in between supply and demand for housing by omitting the land price, housing for low-income people and poor people, control and prevent the skyrocketing the prices of lands and housing, housing boost production and increase production volumes of housing and reducing the cost of housing (Rent, mortgage and buy). Also, it is aimed to give solution for the future housing needs, justice in access to adequate housing. Consequently, poverty reduction and housing for youth was raised (Karshenasan, 2013). Mehr housing projects are mainly located in three regions: New cities, Lands around cities and old areas to facilitate modernization and improvement (Rezaie, 2015).

Mehr housing is a big project that will be consist of one million and five thousands of housing units. These amount of units will cover six million population of the country, which is approximately 12% of urban population. Mehr houses are constructed in collaboration with various organizations such as: Ministry of Housing, Housing Foundation, Ministry of Cooperatives, Central Bank, Municipalities and Central Insurance (Shahri, 2015).

Zanjani (2011) in his research mentioned the principles which were considered in Mehr Housing plan. 1. The Mehr houses should be constructed like mass housing production. 2. They are downsizing. 3. Some of them are high rise buildings which help to have more unit. 4. These projects aim to saving construction site and energy. 5. It is aimed to reduce cost by using technical principles. 6. They use public

space and common space. 7. They have good views.

The ones that have responsibility of Mehr housing construction projects are members of housing cooperatives and is mainly concerned with their own participation. Besides, the government by giving them free land as well as granting long-term loans plays supporting roles (Isalou, 2014). They try it to do it by mass housing construction in the form of cooperatives housing for 50 to 500 people. 20 percent of primary cost of this type of housing is financed through savings and participation of applicants (Zanjani, 2011).

3. Methodology

The data for this study is collected based on literature review, observation and physical analysis. The cities of the projects are selected due to their size and location (Table 1). Sarvestan is a rural-city. Hadishahr and Natanz are small cities. Abadeh, Nourabad and Firoozabad are medium size cities. Hashtgerd, Yazd, Zahedan and Zanjaan are large cities and Tabriz is categorized as a metropolitan city. However, these cities are belonging to different province from North West to South East part of Iran. Sarvestan, Abadeh, Nourabad and Firoozabad, are four cities which belong to Fars province. Hashtgerd is from Alborz Province. Zahedan is from Sistan and Baloochestan Province. Tabriz, Hadishahr and Marand, are from Azarbajejane sharghi Province. Zanjaan is from Zanjaan province. Yazd is from Yazd province and finally Natanz is from Esfahan province (Fig.1).

This study is intended to define the general weakness and strengthen point of the selected Mehr housing projects. The architectural quality of Mehr housing projects are aimed to be evaluated in terms of location and accessibility, safety and security, public open spaces and recreational activities, plan layout and functions, physical features.

Table 1: Selected cities (population and size)

Cities	Population	Category
Sarvestan	18.187	Rural-City
Hadishahr	34.346	Small city
Natanz	42.239	Small city
Abadeh	100.831	Medium size city
Nourabad	117.527	Medium size city
Firoozabad	121.417	Medium size city
Marand	156.873	Medium size city
Zanjaan	521.302	Large city
Zahedan	587.730	Large city
Hashtgerd	650.000	Large city
yazd	682.582	Large city
Tabriz	1.558.693	Metropolis



Figure 1: Selected cities on the map of Iran.

4. A General Discussion on Architectural Quality of Mehr Housing

4.1. Location and Accessibility

There are three type of location in Mehr housing Projects as mentioned before in this study. Some of them are located outside of the cities (Fig.3) and some of them are inside the city (Fig. 2).

In Mehr housing projects the ones that locating inside of the cities have much more benefit than the ones that are located outside of the cities. They have better access to transportation facility but Mehr houses that are located in suburbs suffer from the lack in transportation facility. The users are complaining about shortage in different type of transportation system. Most of the tenants in Mehr houses in suburbs are workers in other cities and the big cities next to these suburbs projects. Karimzadeh (2015) study Abadeh and Sarvestan Mehr houses, Droudi (2014) study Pardis Mehr houses and Rafieeyan (2014) also study the Zahedan Mehr houses. All of them mentioned in their studies that the Mehr

housing projects which are located in suburbs, the tenants suffer for transportation issue.



Figure 2: Semnan Mehr housing inside the city (URL 2)

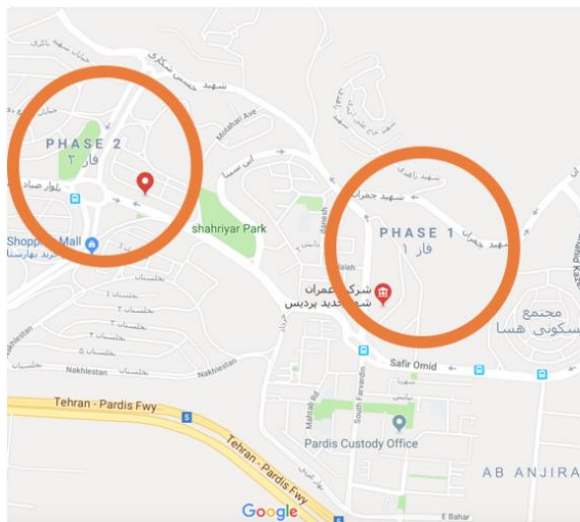


Figure 3: Pardis Mehr housing outside of the city (URL 2)

4.2. Locational Features

Mehr housing projects that are located in the cities have access to different facilities such as educational, entertainment, bazars, sport and health facilities. They have also access to gas, electricity, water, telephone and sewage system. However, the projects which are located in the suburbs suffers from lack of access to entertainment, health, educational, bazars, and sport facilities. Some of the projects have lack in access of gas, water, electricity and telephone. Also, Rafieeyan (2014), Droudi (2014), Ghanbari (2013) and Pour Mohammadi (2014) in different studies on Mehr housing projects out of the city in suburbs was mentioned that the citizens have problem with the lack of facilities in suburban areas. It is better to locate these projects near the big cities to reduce the price that should pay for infrastructure for Mehr housing projects in suburbs. Citizens for satisfying their need they

should use urban trips which bring wasting time and money for low-income people. It should be more attention in the selecting of the land. Because in these projects the lands are outside of the city and suddenly the city extended without any programmed plan.

4.3. Safety and Security

All of the Mehr housing Projects have governmental insurance. One of the most important factor that should be considered in design is, obey all the rules and regulation to construct a building which is protected from earthquake. Mostly, these houses are not constructed and located based on environmental factors and natural environment. If in theses projects natural disasters happened, they do not have any facilities to support the people who are living in these complexes. Ghanbari (2013) also stated in his study, the projects in these three cities such as Tabriz, Hadishahr and Marand, were not designed by considering the environment factors. None of the mentioned projects are located due to protecting from earthquake. For example in Neyshaboor earthquake in 2017 all of the housing units were destroyed (Fig. 4). These apartments are not constructed based on earthquake rules and regulations.



Figure 4: Mehr Housing in Neyshaboor (URL 3).

From other point of view there are too many families with different cultures that caused raise of crime so easily. The projects which are located in suburbs, have more percentage of crime compare to the ones that are locating in cities. Besides, Mehr housing projects have no any security person and also there is no any security camera.

4.4. Public Open Spaces and Recreational Activities

The other factor that is very important in Mehr housing project is, having public spaces and recreational activities around these projects. The projects that are locating in the city have access to park and green areas. Under the influence of the Islamic religion, the way of life

is more introverted. Thus recreational areas such as park, open spaces, semi open spaces in these projects provide social communication. This situation cause increasing rate of marriage and decrease the rate of divorce as Pour Mohammadi mentioned in his study in (2014). However, in projects that are locating in suburb areas, they have lack in public open spaces such as gardens, parks and playground for children. Rafieeyan (2014) mentioned in his study, the quality of the houses can be improved by the green spaces. However, in parallel to this issue, the gathering from different cultures in these public areas could raise the crime, specifically among teenage and children. This situation forces the children to spend much more time together and raise the crime among them. From the other view suburb areas have much more potential for existing the crime than the projects that located inside the city. Karimzadeh (2015) by study Sarvestan and Abadeh Mehr houses project and Droudi (2014) by study Pardis Mehr house project also mentioned that the projects they analysed they have cultural problems.



Figure 5: Pardis Mehr housing in suburbs area (URL 4).

4.5. Plan Layout and Functions

There are different plan types in Mehr housing project. These apartments are categorized as high rise and medium rise buildings. The plans of Mehr housing projects should be suitable for the population density and also culture of the city. They should be designed by considering the climatic factors of different cities and sun orientation. As Soltani (2014) stated in his study, the citizens are not satisfied with design of their units due to the climatic factors. By constructing these types of houses the number of the detached and semi-detached houses are reduced. That also extends the cities without any program. These type of apartment buildings could be beneficial for the use of different number of families that have specific square meter in the same time by constructing in the same land. Also, Pour Mohammadi (2013) stated in his study about this situation in

Zanjan city. One of the most important problem related to Mehr houses is that all of them are designed mostly look like each other. There is no any attention to the specific cultural and climatic factors in these houses.

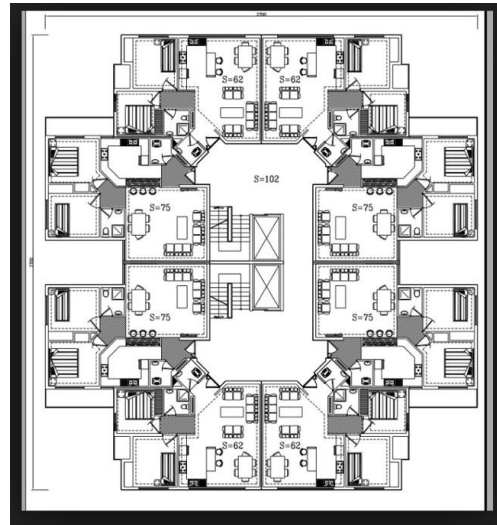


Figure 6: Type of plan for high rise Mehr housing project in Pardis city (URL 5).

In this plan there are two type of units. One of them is 75 square meter. The other one is 62 square meter. Both of them are two bedrooms and they have one toilet and one bathroom. The kitchen belong to these units is an open kitchen. Due to the Iranian culture, this type of kitchen is not suitable. Most of the Mehr housing projects have two bedrooms. Generally, plan schemes of the Mehr Housing projects are same in different cities. Generally, this type of houses (two-bedroom type) are suitable for the small sized families such as with one or two children. However, the families that they have more than two children they need bigger housing units to satisfy their needs and necessities.

4.6. Physical Features

These houses should be protected from the earthquake and the isolation system to make the structure gets more durable. The total cost of Mehr house projects are not high. They don't spend too much money in the appearance. Thus, it could be affordable for low-income people. So mostly contractors choosing to use low quality material. Most of them are look like each other and they have same material in different type of climate in Iran (Fig. 7, 8). Most of the doors and windows are same type. By this issue they reduce the satisfaction of the citizens. They should give attention to the sewage disposal system. Droudi (2014) also stated that the other important factor is to have good lighting and good view in Mehr housing projects. Generally, in Mehr housing projects there is a semi open balcony for each

flat. In parallel to the religion of this country, generally the families have more privacy and they are not using these semi open spaces as a socialising area. They are generally using for storing the staffs or organizing them as a small green area.



Figure 7: Mehr housing project in Alborz city (author)



Figure 8: Mehr housing project in Semnan city (author)

Table 2: General weaknesses and strengthens of Mehr houses.

Factors	Weakness	Strengthens
Accessibility	Lack of access to public transportation in suburb projects	Access to public transportation in city centre projects
Locational Features	Lack of access to educational, bazars, entertainment, health, sport, water, telephone, gas and electricity facilities in suburb projects	Access to educational, bazars, entertainment, health, sport, water, telephone, gas and electricity facilities in city centre projects
Safety and Security	Raise of crime in suburbs area projects, no any security person and security camera in both type of city centre and suburbs projects, they don't consider earthquake	All of the projects have governmental insurance
Public Open Spaces and Recreational Activities	Children gathering from different culture make raise the crime in public areas in suburbs project	Access to park and green areas in city centre projects
Plan Layout and Functions	Plans are not suitable for the population density and also the culture of the specific city and not respecting the climatic factors	They answer the average needs of the users
Physical Features	Poor sewage disposal system, low quality in choosing material, have same material in different type of climate	Industrialized construction system

5. Conclusion

Today having affordable house is an essential need for every type of families, which belong to low-income group. This study analyses the Mehr affordable housing projects in different province with different population. This policy with the aim of creates housing for low-income people by omitting the land price try to solve the housing problem in Iran. However, these projects have some strengthens and weaknesses based on different factors such as location and accessibility, safety and security, public open spaces and recreational activities, plan layout and functions and physical features. Lack of access to public transportation, entertainment, market, educational and health facilities and also raising crime in suburb type Mehr housing projects are some of the weaknesses. By this study on the selected cases, it is obvious that it is no matter how is the density of the population in different cities, they have common problems in general.

The architectural qualities of the Mehr housing projects can be developed by considering cultural aspects such as Iranian life style and appropriate functional spaces in proper sizes. Also, environmental factors need to be analysed during the design process. For the housing groups that are far from the cities, the necessary social, educational, health and recreational activities can be provided. Besides, the architectural identity of these housing groups needs to be considered during the design and construction processes.

Generally, this type of houses (Two-bedroom type) are suitable for the small sized families such as with one or two children. The use of the industrialized construction system which is providing more economical and easy production in a shorter time is one of the strengthen of these Mehr houses projects. Besides, the groups which are located in the cities have an access to the social, educational and entertainment activities.

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Evaluation of Çanakkale Kilitbahir Castle in the Context of Refunctioning

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ABSTRACT

The Dardanelles Strait functions as a bridge between Biga and Gelibolu peninsulas, connecting the Aegean Sea and Marmara Sea. Many defenses have been built on the Dardanelles Strait, which have hosted many civilizations from the past to the present day, in line with the needs of the time. Kilitbahir Castle, which has a three-leaf clover plan and is located on a slope rising on the Gallipoli peninsula in the narrowest part of the Bosphorus after the conquest of Istanbul by Mehmet the Conqueror; manifests itself as a pioneering structure of the military architecture of the era with the developing artillery technology. The castle consists of a heart-shaped seven-storey inner tower in the core, the inner tower in the form of a three-leaf clover and the outer walls surrounding it. The architectural assembly of the castle is among the most aesthetic and unique among the Ottoman Castles. In terms of protecting the physical environment, it is observed that the defensive buildings which survived up to today are not adequately protected, losing their historical and architectural values. In this context, the restoration of Kilitbahir Castle dating back to Ottoman Period defense structures on the Dardanelles Strait was evaluated. Its phases throughout the process along with the current location and architecture were evaluated by using written and visual resources. European Archives, BNF Archives, Topkapı Palace Archives and İstanbul University Archives were utilized for reaching the castle engravings. In accordance with the information obtained in the historical research process, the exhibition arrangement and environment planning project of the structure, which serves as a museum, were prepared.

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1. Introduction

One of the most important actions of human existence is the concept of protection and defense. These actions led to the emergence of defense structures. They needed to be protected in order to prevent any attack from the opposite side and created defenses that they could protect themselves with. Defense

structures from the past to the present day are one of the important elements forming the urban texture. The castle buildings were built

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along the periphery of the cities, on the islands near the straits or on the sea shore and near the shore. In this process, the strategic location of the city and topography also played an important role. In this context, the castles consist of circular, hexagonal or polygonal masses of bastions, or in a regular geometric form, bound together according to the topography of the city. When it comes to defense in the Turkish and Islamic cities, the buildings made up of sections such as Inner castle, Outer castle, Şehristan and Rabat come to mind. The inner castle is the main center of the defense of the area surrounded by the ramparts on the highest slope of the city, the area where the ruler or commander resides. It is the core point of the city. Outer castle surrounds the city. Şehristan is a region in the city with trade, religion, public and residential areas. Rabat is the area where there are trade functions and structures that develop around the fortress doors outside the fortifications.

Kilitbahir Castle, which was ordered to be built by Fatih Sultan Mehmed in the Ottoman Period with its own scheme, is located at the narrowest part of the Dardanelles Strait, directly opposite of the Castle Fortress to control the sea passage at Rumeli Side. Tursun Bey, one of the historians of the period, wrote that two castles facing each other were built in the narrowest part of the Bosphorus (called Eceovasi) after the conquest of Istanbul, that one of them was named Kilitdül-bahr and the other was named Sultaniye and these castles were equipped with artillery. (1)

2. Literature Review

2.1. Kilitbahir Castle Location and History

Kilitbahir Castle is located on the Dardanelles Strait, which connects the Marmara Sea and Aegean Sea, at the edge of Malaz Hill where two opposite shores get closest with each other.

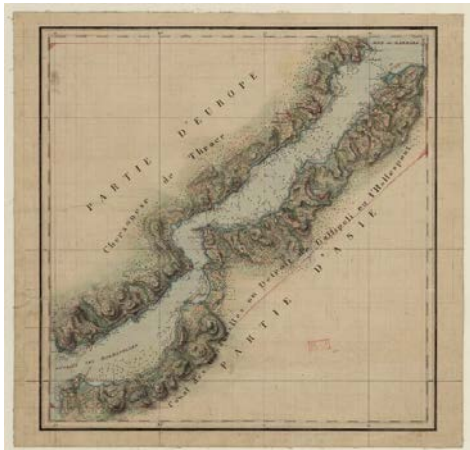


Figure 01: Map of 18th Century Dardanelles Strait, National Library of France, Map and Planning Department, GE C-4074.

It was built by Mehmet the Conqueror after the conquest of Istanbul in order to keep the Bosphorus under control between 1461-1462. Having a three-leaf clover plan and located on a slope rising on the Gallipoli peninsula in the narrowest part of the Bosphorus, Kilitbahir Castle manifests itself as a pioneering structure of the military architecture of the era, integrated with the developing artillery technology.

The castle consists of a heart-shaped seven-storey inner tower in the core, the inner tower in the form of a three-leaf clover and the outer walls surrounding it. The sea-side part of the arc-shaped outer walls did not survive. There are ten bastions on the outer walls. Two of the bastions are circular, four are triangular and four are square. There are three gates on the outer walls, two on the land and one on the sea side. The inner castle form of a clover plan formed by the joining of three circular shaped walls. The courtyards inside the walls are separated by a door. It was aimed to separate the courtyards from each other by closing the doors at the time of the attack. The inner castle has two gates, one at the sea and one at the land side. Inside the clover-shaped inner castle walls are seven-story inner towers reflecting the same geometry. The inner tower is connected to the inner castle walls with arches separating the courtyards.

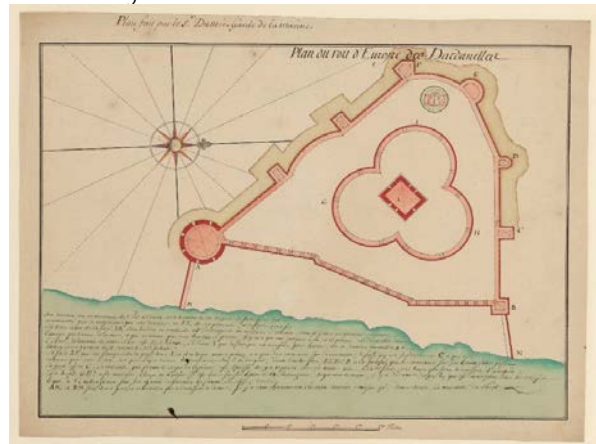
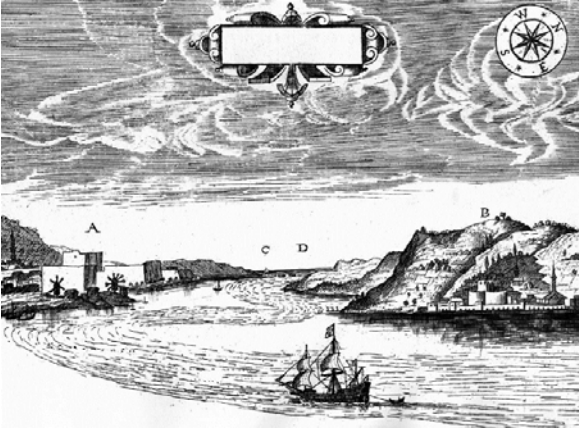


Figure 02: Gravure 01. Sr Berquin's Kilitbahir Castle Plan; National Library of France, Map and Planning Department, GE SH 18 PF 98 DIV 5 P 2

Evlia Çelebi talks about Kilitbahir Castle, which he saw in 1659, a neighborhood of tiled houses and a mosque that he named Hünkar Mosque. Furthermore, after saying that there are wheat warehouses and arsenals here, he states that there are no inns, baths and bazaars, and some artillery shells from Mora and other shells



belonging to the Kanuni era are placed on the shore.

Figure 03: Gravure 02: George Sandys' Gravure dated 1621 (Ministry of Culture and Tourism - Anatolian Gravure Album)

According to Evliya Çelebi, Suleiman the Magnificent extended the Kilitbahir Castle by repairing it with the spoils taken from the Conquest of Rhodes and adding walls with the Kanuni Tower (Yellow Tower). The Dardanelles Strait, Kilitbahir and Laimenlik Castles, where George Sandys visited and engraved during his Egypt trip in 1610, behind which appears Istanbul. In the travel book published by George Sandys in 1621, titled "A relation of a journey begun An: Dom: 1610. Fovre bookes. Containing a description of the Turkish Empire, of Egypt, of the Holy Land, of the remote parts of Italy, and ilands adioyning", the inner castle from the era of Mehmet the Conqueror and walls and Kanuni Tower built in the era of Suleiman the Magnificent can be observed in the Kilitbahir Castle, marked as "B".

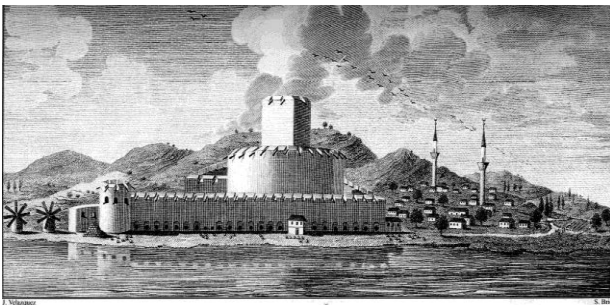


Figure 04: Gravure 03: Joseph Moreno's Gravure dated 1790 (Ministry of Culture and Tourism - Anatolian Gravure Album)

Kilitbahir gravures inside the tower, the inner castle and the Kanuni Tower (Yellow Tower) and the outer walls are found in the work "Viage á Constantinopla, en el año de 1784 (journey to Istanbul in 1784)" prepared by José María Moreno (Joseph Moreno).

The last architectural formation of Kilitbahir Castle reached to the day-time was

completed when the Namazgah Redoubt was rebuilt between 1893-1894. In the works carried out on this date, the door and the wall located on the sea shore in the east direction of the castle, the wall, the shrine, the headquarters building and the door were added to the south side of the bay, surrounding Namazgah Redoubt. The wall of the inner castle in the sea direction and the port gate were destroyed during this period. Namazgah Redoubt, walls and castle gates were added to the Kilitbahir Castle during the reign of Abdülhamit II, finalizing the shape of it.

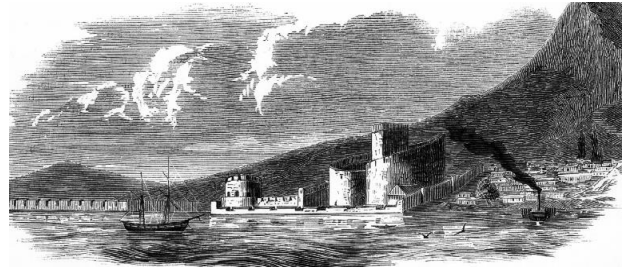


Figure 06: Gravure 04: Gravure of Kilitbahir Castle and Namazgah Redoubt dated 1853 titled "L'illustration: Journal universel".

Kilitbahir Castle was depicted close to its present appearance. The walls in front of the inner castle were not drawn first in this gravure. From the building traces reaching today around the inner castle, the building at the shore to the north are observed in this gravure.

3. Material and Method

Kilitbahir Castle has an important place among the defense structures in Çanakkale the period of its construction, its strategic location, and its architecture. The fact that location of the Historical Gallipoli Peninsula is within the trip route has caused the Castle to increase the number of tourists day by day. The castle has undergone many repairs until reaching today, but it has not been able to gain a function together with its architectural texture and its surroundings and that caused it to have a structure that only exhibits its own architecture. Due to these reasons, environmental planning and exhibition were needed.

European Archives, BNF Archives, Topkapı Palace Archives and Istanbul University Archives were utilized for the researches conducted to draw the project. In accordance with the information obtained in the historical research process, the exhibition arrangement and environment planning project of the structure, which serves as "Ottoman Castle Museum", were prepared.

3.1. Sampling Area

The castle is situated on a slope in the narrowest part of the Dardanelles Strait. It is located opposite the Çimenlik Castle on the strait, which was built during the same period.

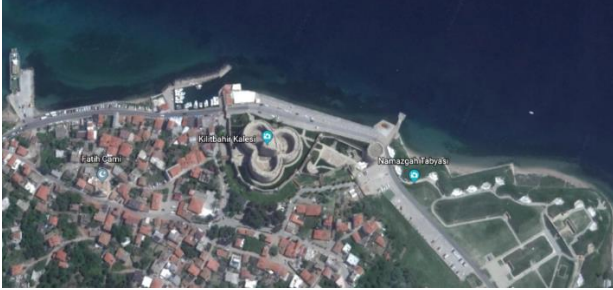
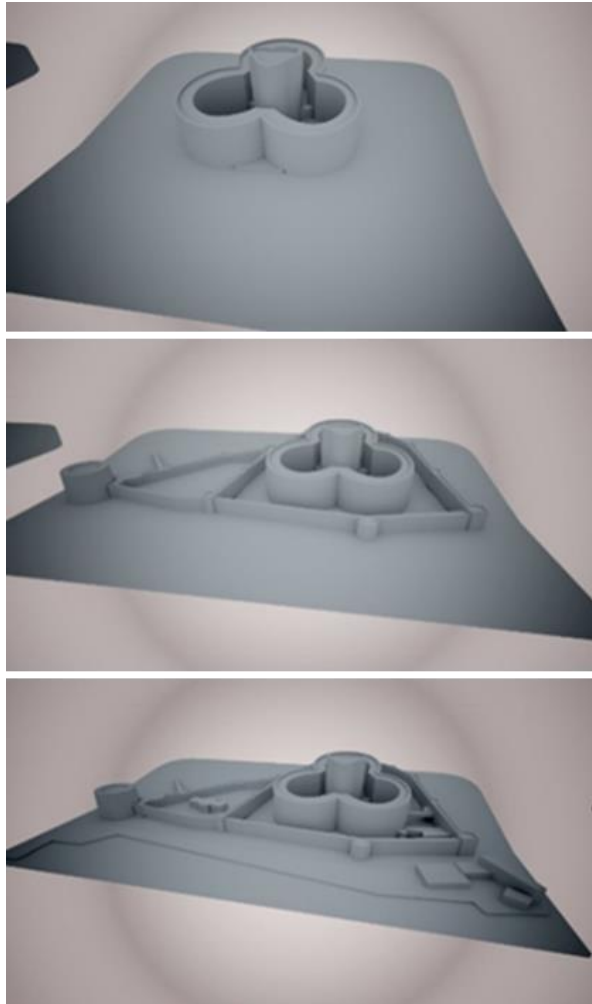


Figure 07: Kilitbahir Castle, 40.15 ° N, 26.38 ° E coordinates

The refunctioning of Kilitbahir Castle considered altogether with the inner tower built during the reign of Mehmed the Conqueror, the Yellow



Tower built by Suleiman the Magnificent, the Late Period Courtyard and the additions made in Abdülhamit Era.

Figure 08: Era of the Conqueror (Inner Tower) - Era of Suleiman the Magnificent (Yellow Tower, Late Period Courtyard) - Era of Abdülhamit (Military Factory, Shrine), K. Duyar.

3.2. Method

European Archives, BNF Archives, Topkapı Palace Archives and Istanbul University Archives were utilized for reaching the castle engravings in the historical researches conducted during the refunctioning process of Kilitbahir Castle. In accordance with the information obtained, it is envisaged that the castle museum function will be re-functioned together with a script describing Castle Life in the Era of Mehmet the Conqueror.

4. Refunctioning the Kilitbahir Castle

In the entrance to the castle, the circulation is planned as two separate tours, short and long.

Short Tour:

- o Yellow Tower / General Museum Presentation,
- o Demo Museum / Disabled, Old, Sick, Tired Visitors,
- o Amphitheater / Greeting and Museum Activity Area,

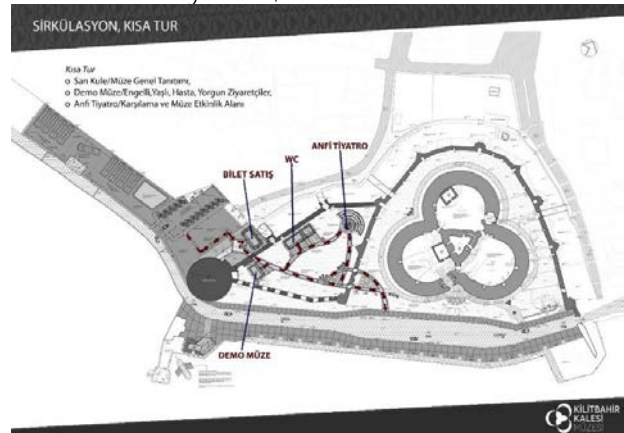


Figure 09: Kilitbahir Castle Site Plan-Short Tour Route, K. Duyar.

Long Tour:

- o Yellow Tower / General Museum Presentation,
- o Demo Museum / Disabled, Old, Sick, Tired Visitors,
- o Amphitheater / Greeting and Museum Activity Area,
- o Piri Reis Section,
- o Multivision Section,
- o Temporary Exhibition Section,
- o Tower Museum

2 separate tours as specified above were offered where visitors would be able to visit the outdoor and exhibition spaces without leaving the script, to easily participate in museum activities along the route, and to avoid unrestrained travels within the area.

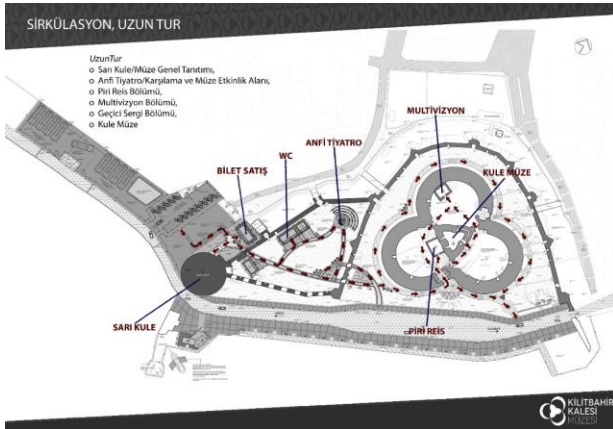


Photo 10: Kilitbahir Castle Site Plan-Long Tour Route, K. Duyar.

4.1. Entrance Area (Parking Lot, Museum Entrance, Ticket Sales)

By taking the visitor from a single point with "1C Entrance" close to the car park area and in line with the exhibition arrangement scenario; 2 separate tours, Long Tour and Short Tour, were offered where visitors would be able to visit the outdoor and exhibition spaces without leaving the script, to easily participate in museum activities along the route, and to avoid unrestrained travels within the area.

4.2. Yellow Tower

The Yellow Tower is the first place of the trip route. For this reason, the exhibition project is planned as the "General Presentation Area of the Ottoman Calendars", which is important for the visitor's perception of the museum concept and scenario in a complete and accurate way. In this place, a brief introduction of the visit is offered in a thematic order about the general presentation of Ottoman monuments, architectural structures, castle structure, castle equipment, organizational structure, commercial life effects and defense strategies.

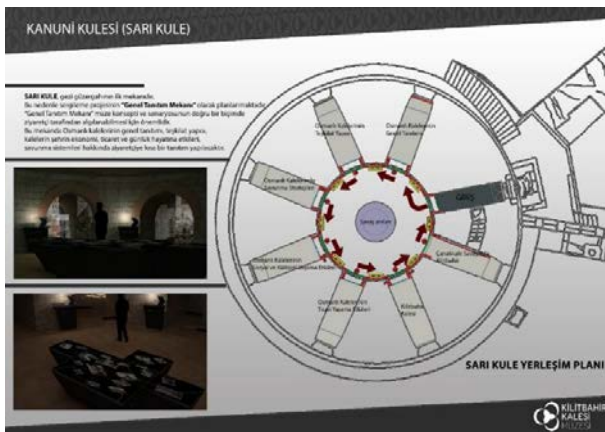


Photo 11: Yellow Tower Plan, K. Duyar.

In the Yellow Tower, in addition to interactive presentations within a thematic order about the general presentation of Ottoman monuments, architectural structures, castle structure, castle equipment, organizational structure, commercial life effects and defense strategies, the subject is depicted with niche transparent projection curtains and impersonations on the subject.

4.3. Demo Museum

The physical conditions and historical texture of the Tower Museum and the Yellow Tower, two of the most important places of the exhibition arrangement project, make it impossible for the handicapped, elderly, sick and young children to easily complete the sightseeing tour. Since it will not be possible to remove the negative consequences of the physical obstacles at all times in the registered structures, Demo Museum will be prepared in order to present the exhibited works and the scenario to the disabled visitors who cannot visit the museum. The demo museum features virtual tour, diorama and touchscreen table. One of the most important elements of the Demo Museum is the capability of the visitors whose health and physical condition do not allow them to tour the museum to see the museum and its surroundings in a virtual environment with virtual headings and in 360 degrees while sitting. The visitors will be informed with the embossed writings on the walls for the visually handicapped visitors and they will be able to touch and examine the identical replica of several works to be exhibited in the museum. Demo Museum is prepared to serve visitors who have to leave without seeing the building which is kept closed due to restoration and repair. Demo Museum is especially important as it is a first-time application that will be carried out for the museums that are compulsory kept closed.

4.4. Museum Management / Administration

When scrutinized in a museological perspective, it is vitally important to have a control over the museum area and to be accessible all the time for an effective museum management. Therefore, the "Museum Management / Administration" structure is positioned in front of the walls at the entrance of the area to ensure museum visitors and visitors coming for any business easily and conveniently reach the management unit and that the security of the area can be maintained quickly and efficiently in emergency or routine controls.

4.5. Piri Reis Section

Right next to the tower inside the castle is the exhibition of Piri Reis's life and its most important work, Kitab-ı Bahriye and world map, according to modern museology. In the section, the 3D silicon sculpture animation area, the video display area, the same edition of the original of the Kitab-ı Bahriye as well as the Turkish version, the exhibition of astrolabe, compass and divider reproductions and the map installation showing the similarities between the world map of Piri Reis and today's world map that utilizes the enhanced reality software.



Photo 12: Piri Reis Section Plan, K. Duyar.

4.6. Multivision (Bath Structure) and Temporary Exhibition Area

The "Multivision Section" located in the bath structure of the project has been used as a Temporary Exhibition Area on special days as well as the stated function. Our greatest goal should be to bring our renewed and developing museums to international museum standards with the understanding of contemporary museology. In this context, the exhibition arrangement project should not be considered independent of museum planning. All sections and functions, which should be included for an accurate, scientific and contemporary museum, must be included in the planning.

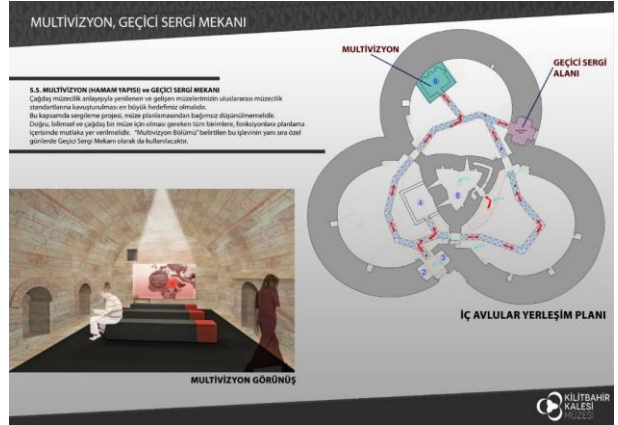


Figure 13: Multivision-Temporary Exhibition Area Plan, K. Duyar.

4.7. Tower Museum

In the scope of the exhibition arrangement project of the 6-storey tower structure which is functioning as a Tower Museum, life in Kilitbahir Castle is explained. In the ground floor, the space is divided to three different eras since the construction of the Castle, namely Era of Mehmet the Conqueror, Era of Suleiman the Magnificent and Era of Abdülhamit. Defense, catering, commerce and worship are depicted in Floors 1, 2, 3 and 4. On the 5th floor, it is stipulated to exhibit the works that were excavated during the excavation in the Castle.

5. Conclusion

Kilitbahir Castle is a very important place in terms of architecture and art history among the castles in the Era of Mehmed the Conqueror. Having a planned structure of a three-leafed clover, the castle consists of a seven-storey inner tower in the core, the inner tower in the form of a three-leaf clover and the outer walls surrounding it. The architectural assembly of the castle is among the most aesthetic and unique among the Ottoman Castles. The sea-side part of the arc-shaped outer walls did not survive. There are ten bastions on the outer walls. Two of the bastions are circular, four are triangular and four are square. There are three gates on the outer walls, two on the land and one on the sea side.

The Castle is one of the important defenses in terms of both its period and its strategic position. The Historical Gallipoli Peninsula is among the travel routes that increase the number of tourists every day. The structure, which is a center of attention with its history and culture, should be refunctioned and should survive. For this purpose, the structural equipment has been functioned without damaging the present structure of the castle, and support has been provided with the

demounting structures in areas where it is not sufficient. The original architectural texture of the castle and the areas that have been rendered functional by its surroundings will be taken for a longer period of preservation and transfer of the past to future generations.

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