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leading subject of the architectural designs. Hence, the efforts for combining
these days. Biomimicry is a concept that talks about the ideas inspired by n
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designs. This approach is also called “Top-down Approach” [6] and “Problem-Driven Biologically Inspired Design” [7].

Biology in engineering design

When designers have the knowledge of biological research and it influences human designs rather than first determining human design problems. This approach is also called “Bottom-Up Approach” [6] and “Solution-Driven Biologically Inspired Design” [7]. Biomimicry approaches illustrate these two approaches (Figure 1).

Biomimicry Levels

In addition to these two approaches, three levels of biomimicry that can be applied in design problems are form, process, and ecosystem [5]. For each level, there are five possible dimensions to imitate (Table 1).

Although these levels may have some overlap, they are necessary for completing biomimicry approaches.

Sustainability Turn

- Building structures, sanitary engineering systems, alternative ways of construction are to employ environment-friendly building materials and consider ecological construction theories.
- Environment-conscious ventilation, energy, material consumption must be observed in the functioning of the building as well [11].
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- Supertall buildings with the average height of 300 to 600 meters. is building type constitutes 10% of the total tall buildings.
- Megatall buildings with the average height of 50 to 300 meters. is building type constitutes 0.05% of the total tall buildings around the world [16].

Living in tall buildings has its own advantages. It can offer accommodation for a wide range of people close to their workplace that causes fewer work trips and less fuel consumption. The modern high-rises provide amenities such as shopping centers, pools, gyms, and public spaces for social interaction so that residents do not need to find other places for these activities. Residents of upper floors often

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in the early design stage (not just added) to have a major impact on architectural sustainability.

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energy, photovoltaic solar energy, geothermal energy, biomass, etc.) on the other hand (Table 2) [22-26].

Conclusion

Biomimicry is emulating nature's strategies to solve problems that humans face nowadays. One of the major problems of the modern world is to promoting sustainability in building sector because of growing number of high-rises and their high energy consumption and negative environmental impact. The study of three tall buildings shows how various approaches and levels of biomimicry (that are discussed in this paper) can be applied to tall building design. Buildings become more efficient and sustainable when the biomimicry principles are applied. However, the impacts depend on the level of biomimicry that is mimicked. Overall sustainability of the buildings increased when the organism behavior or process is imitated rather than a simple imitation of the shape. As we can see in DNA Towers the inspiration that is just at the organism level and shape imitation, slightly increased the level of sustainability. On contrary, MMA Office Building reached the satisfactory level of sustainability through using biomimicry; both organism and behavior level. In addition, Pearl River Tower employs an organism based biomimicry and behavior level that substantially enhanced the tower's sustainability. All studied buildings in this paper are based on design looking to biology (problem-based) approach; as most of the architectural designs that employed biomimicry. It can be inferred that solution based design needs in depth understanding of biology and close collaboration of architects, biologists, and ecologists.

Therefore, it is much less frequent in architecture. However, transferring biological principles into human design needs the knowledge of biology and biomimicry principles in order to boost the sustainability level of buildings. These principles should be incorporated into the design

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