BRICK & MORTAR VS. TRADITIONAL ADOBE HOUSING IN SOUTHWEST

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Introduction

Buildings have been used for centuries as forms of shelter, gathering places, and even places of storage. Currently, buildings account for 30% of energy consumption and nearly 55% of global electricity requisition (IEA, 2018). Both current buildings, as well as the construction of newly developed buildings, total 36% of global final energy consumption, and approximately 40% of total and indirect CO2 emissions (IEA, 2018). In the past two decades, green and sustainable building has evolved greatly from a fringe movement to achieving much mainstream status (Jones, K 2018). A study by Booz Allen Hamilton in 2016 for the USGBC expected to have an even larger increase in the following years. The average spending in 2015 was $150.6 billion, and by the present time 2018, it was expected to reach $224.4 billion (Jones, 2018). The same study expected green buildings to generate $303.4 billion in the gross domestic product (GDP). This revenue would support 3.9 million employment opportunities and provide $268.4 billion in labor earnings (Jones, K 2018). Here in the Southwest, we have traditional construction techniques, such as adobe, to compare against modern sustainable construction methods. Modern sustainable design and building can span a variety of materials such as wood frame, brick and mortar, and other techniques.

In addition to sustainable designs, this study will use adobe homes as a comparison. Adobe is a “timeless material for southwest homes” (Adobe: A Timeless Material for Southwest Homes). This style of building has been around since ancient Mesopotamians to Pueblo natives of the American Southwest. Today, adobe homes can fluctuate in pricing from a basic house to expansive high-end homes (Adobe: A Timeless Material for Southwest Homes). The materials used for these adobe homes are indigenous materials, meaning they are made from earth found within a few hours of the building site (Adobe: A Timeless Material for Southwest Homes).

The comparison between both building methods are not the only building styles used, but they are some of the most influential styles of design in this era and from the beginning of time as far as design goes. This case study will thoroughly illustrate how the sustainable building design built out of brick and mortar is potentially the new era of building that designers are gearing towards. The study will also include an analysis of traditional adobe construction, which may be a superior option for home construction in the Southwest. The two styles of buildings will be tested through a program known as Energy-10 which allows testing energy modeling throughout either building. Both methods of design will be based in a southwest setting; each idea will be thoroughly examined and discussed in order to see which one thrives to become the most successful in this setting. Once the results are analyzed, we will, at last, understand which method of building the Southwest should continue building to become more sustainable as a community.

Most sustainable building is referred to as smart housing, which is broken into three different styles; the styles consist of social sustainability, environmental sustainability, and economic sustainability. Social sustainability includes safety, security and universal design. Environmental sustainability includes water efficiency, waste efficiency, and energy efficiency. Economic sustainability includes construction costs, ongoing running costs, living costs, long-term maintenance costs, future modification costs, resale value, peace of mind and cost efficiency for our community. Concerning long-term maintenance costs, cheaper does not always mean better, and often the ongoing and long-term savings will outweigh any initial cost. As stated earlier, sustainable housing construction can be done with

Literature Review

Sustainability Background

Sustainability can be defined in different ways throughout the world, but one thing can be universally agreed upon: sustainability is ultimately always linked to all things on earth. The three pillars can be useful to explain the importance of sustainability; such pillars are known as the economic, social, and environmental pillars. If any of these three pillars are weak, the system as a whole is unsustainable (The Three Pillars of Sustainability, 2014).

Climate Change in Southwest

Global warming is occurring, and the impacts can be seen in hotter summers, increased flooding, and more wildfires. Each part of the world is affected differently, and it is true that much of the earth is being affected much more negatively than positively. Most scientists have agreed the Southwest is a climate change hotspot location, which could ultimately represent a vulnerable climate and a potential increase in greenhouse gases introduced to our atmosphere (Climate Change in the Southwest, 2018). The US Global Change Research Program illustrates how the currently average temperature in the Southwest may be subjected to increase by 4 to 10 degrees Fahrenheit, as compared to temperatures in early years around 1960 and 1979 (Climate Change in the Southwest, 2018). The Southwest will continue to experience consistent heat waves; mainly because of mid-level high-pressure systems developing over the area (Kirkpatrick, N, 2018). During the winter, anthropogenic climate change will also have impacts. Throughout the last 50 years, natural climate variability could potentially account for 40% of the changes observed in the snowpack, winter air temperatures, and spring streams in the west.

The continued release of greenhouse gasses will force the future climate to continue to remain outside of the normal range of variability. Seasons will change outside of their ordinary

time frames, and this will be due to greenhouse gas emissions on climate. This affects more than one season because if a dry spring season comes around earlier than originally expected, this will entail winter arriving late which could weaken and shift northward (Climate Impacts in the Southwest, 2018). This could cause severe droughts all around. Every year moving forward could become shorter for certain seasons but increase the length of time for others. Most impacts will affect humankind as we know it, beginning with water sources. Clean water is already one of the hardest elements to collect throughout the world; climate change only creates a higher water demand, and reduced water supplies will sequentially add new stresses to already strained water sources (Climate Impacts in the Southwest, 2018).

Native Americans are particularly impacted by climate change; their communities generally face high poverty rates and often lack adequate food, infrastructure, transportation and access to health and community services. Other affected areas are losses of crops and livestock. Additionally, medicinal and cultural plans and animals are also affected. If climate change is not geared towards a positive direction, Native Americans will be, without a doubt, limited in their ability to respond to increasing hardships, thus leaving them vulnerable to the elements (Climate Impacts in the Southwest, 2018).

Human health should be concerning for everyone, as heatwaves can be the cause of deaths in the Southwest. This concern is mainly due to the alarming temperatures we can reach in different cities; microclimates can be both positive for these situations but also negative. Areas such as pavements and buildings will retain heat and will then proceed to release it back at night-increasing the urban temperature during periods when it should be cooler (Climate Impacts in the Southwest, 2018). The highest percentage affected by these heat waves will always be lower class and elderly folks. The lower class may not have access to air conditioning, and the elder

may be too old to withstand what is now known as “ordinary” heatwaves due to potential health risks. The use of more electricity may add fuel to the fire and create an even hotter climate and create a strain on the electric grid and potentially result in brownout or power outages (Climate Impacts in the Southwest, 2018).

Forests may also be at risk also for climate change in the Southwest. Such heatwaves can create brush fires, as well as changes in geographic ranges of species. This increase in fire risk will change the entire ecosystems in the forest’s themselves. The alarming temperatures are threatening forests in the vicinity of the Southwest, forcing them to become vulnerable to other stresses, including pests. Warmer conditions, as well as dead trees, have been a large reason why wildfires have more than doubled in recent decades, resulting in deaths as well as unrepairable damage. Fires have been native to the Southwest, but recently those fires have destroyed homes, changed ecosystems, threatened public health, and damaged the economy. Plants have been extinct as well with the outcome of the wildlife fires (Climate Impacts in the Southwest, 2018).

Water availability has been a problem for the growing of crops as well as rising temperatures. This decrease in production causes local economic challenges as well as average food prices across the nation. Crops need irrigation systems, and it has been a struggle to maintain proper systems to keep sustaining our demand for crops. As we notice the region to become warmer and drier as the population grows, more freshwater will be demanded and will need to be diverted from irrigation to urban area use. The climate changes can affect the growth of crops- causing them not to ripen and mature early, reducing even more crop fields (Climate Impacts in the Southwest, 2018). Livestock will also be affected in the mix because of fewer crops to feed animals and the water availability as a whole.

Sustainable Building

One place to start to make a positive impact on mitigating energy use and emissions is in our buildings. Buildings account for about 30% of final energy consumption on earth and more than 55% globally for electricity demand (IEA, 2018). The building, as well as construction sectors combined, are responsible for 36% of global final energy consumption and nearly 40% of total direct and indirect CO2 emissions (IEA, 2018). Energy demand for buildings rises annually instead of decreasing; this is due to greater HVAC usage throughout the homes and or buildings. There are many forms of building a sustainable home, and not one way will always be the only correct way. It is thought as the least negative impactful way of building for the environment. These homes are built with several purposes, such as to promote better life quality, to reduce waste, more reliability, lower life-cycle environmental impacts, as well as less maintenance and more re-use.

Sustainable housing is broken into three parts known as "Elements of smart and sustainable housing" by the Queensland Government-Department of Housing and Public Works. The three parts include social sustainability, environmental sustainability, and economic sustainability. The first part of Sustainable housing includes social sustainability, which includes safety; it states that "A safe and secure home reduces the likelihood of injuries in and around the home" (Elements of Smart and Sustainable Housing). As far as security goes, "A secure home uses design and fittings to reduce crime (Elements of Smart and Sustainable Housing). Universal design "A home that is universally designed is flexible and comfortable for people with varying abilities at different stage of their lives" (Elements of Smart and Sustainable Housing). Many standards, as well as rating systems, exist when rating a sustainable home, LEED is at the top as well as, WELL (a building standard to focus exclusively on the health and wellness of people in building's), SITES (Comprehensive system for developing sustainable land), ILFI (The

International Living Future Institute), and more. Stuart Kaplow, from Green Building Law, explains how, “2018 will be a watershed year in the course of green building standards, codes and rating systems” (18 Trends for Sustainable Homes in 2018).

The second part is “Environmental Sustainability,” and it begins with how water efficiency options not only reduces our consumption of water treatment consumption of use but also helps slash water bills. Waste efficiency is a major factor; this will not only limit waste during the development of the building but will help establish certain solutions such as compounding to recycle waste. Energy efficiency follows; most sustainable housing allows to reduce energy consumption, which shrinks electric bills. The option for renewable energy has dropped in pricing in different areas, thus allowing more people to gain access to the alternative energies, plus numerous PR (Public relations) campaigns have educated us on all of the benefits. (18 Trends for Sustainable Homes in 2018).

The third part of “Elements of smart and sustainable housing,” include smart and sustainable housing referred to as Economic Sustainability. Construction costs lurk in the mix of sustainable housing. Savings can be immediate by using cost-efficient building materials, economic planning, and “smart” ideas (Elements of Smart and Sustainable Housing). As price continues to vary across the board, from renewable energy options to prefab building techniques to eco-friendly building materials, owning a sustainable home is the most affordable from all time (18 Trends for Sustainable Homes in 2018). Ongoing running costs will be present no matter what style of home it may be; pre-planning for the future is a must. Living costs are simple to upkeep things that must be done before they break or deteriorate and fixing ahead will always save money in the long run. Additionally, sustainable housing may include many different new alternatives to powering the home. Some have been fully tested using these

alternative power sources through different aspects of buildings, while others may be fairly new to homes.

As far as future modification costs are concerned, homeowner's desires change over time and between ownership. A few years after purchasing a home, the owner may decide to make certain alterations. Creating a sustainable home should not be something to cause anxiety or stress. Instead, sustainable homes may be created from already built homes and may sometimes be easier to build than brand new built homes, depending on the structure of course. This is mainly because some style of construction goes hand and hand with the renovations. Some improvements may be immediate and less expensive, and others may be time-consuming and be greater in cost (30 Innovative `Ways to Build a Sustainable House. 2018, May 23). Concerning resale value, sustainable housing can be attracting to home seekers. The greater the demand, the higher the resale value will be (Elements of Smart and Sustainable Housing). Concerning peace of mind, this allows owners to be content and assured of their large purchase. Lastly, cost efficiency is another important aspect of our community. This can be how much the specific home was able to save the community in not only funds but also in unnecessary materials. This style of construction is one that is aimed to achieve in many future home constructions but is not necessarily the best method.

Adobe Construction

We will start first looking at a construction method particularly well suited for the dry, arid climate of the southwest: adobe. Adobe has been around for centuries, all ranging from different parts of the world (Building an adobe house, 2018). Adobe bricks have a way of being found near the muddy river areas of those places such as Egypt as well as the ancient architecture of the Middle East. Mesopotamians, as well as American southwest residents, have used readily

available mud and straw to build homes, “adobe.” Adobe can be created from dried mud brick, combining the natural elements of earth, water, and sun (Craven, J. 2018).

As the west began to blossom, so did adobe homes in the early California days. A few then followed such as Arizona, New Mexico, and Texas. Tucson itself contains approximately 10,000 adobe homes itself (Adobe: A times less material for Southwest Homes, 2018). Adobe home styles may vary in price and size range from basic habitat homes to expansive high-end homes. Adobe building can be worded differently, such as “adobe architecture,” or be explained as a building material as well (Craven, J. 2018).

Despite the material itself being naturally unstable, an adobe wall can be load bearing, self-sustaining, and natural energy efficient (Craven, J. 2018). Constant monitoring of deterioration sources may include the breakdown of mechanical systems such as leaky plumbing; it is always a key factor for proper maintenance of adobe building. It can be for both commercial use and residential use. The term “adobe” has become a very popular style of architecture in desert climates, specifically in the southwest.

Why Adobe is used

Science has proven time after time the low thermal conductivity and high heat capacity enabling earthen building thermal stability compared with concrete construction. Adobe is widely distributed in arid and semi-arid lands where construction materials may be scarce. The local Climate is best suited to thermal mass construction. Earth has had different styles of building, but adobe continues being on top as a more popular style of building repeatedly.

A few methods are known as “Heat transfer mechanisms,” which are forms of how thermal energy can be transferred amongst objects, all rely on the basic principle that kinetic energy or heat needs to be at equilibrium (Hanania, J. 2017). Conduction is one of three

methods; it allows the flow of heat through a material by direct molecular contact. The contact generally occurs within a material or through two materials in range (Straube, J. 2011). The molecules tend to give their energy to adjacent molecules up until the equilibrium (Hanania, J. 2017). Convection is another method. Similar to conduction, convection transfers heat by the movement or flow of molecules with a change in their heat content (Straube, J. 2011). Typically, this method occurs as a result of differences in density (Hanania, J. 2017). Lastly, Radiation is explained as the transfer of heat by electromagnetic waves through a gas or a vacuum (Straube, J. 2011).

Thermal mass is by far one of adobe's most subtle characteristics, thus creating a resistance to temperature fluctuation (Adobe: A Timeless Material for Southwest Homes). This generally gives the option for cooler homes, thus lower electric bills. They include thick walls which automatically create natural insulation from the environmental heat that creates and sustains the same material (Craven, J. 2018). Some Modern Adobe blocks are still accessible today. A big design component with adobe may be that a single sun-dried block can provide not only the exterior of the building but also the interior. Adobe bricks may weigh up to thirty to thirty-five pounds each, and the weight provides the thermal mass (Tools for Organization, 2018). Adobe is known as the longest style of "green building" known to exist. "The green benefits of clay plaster are significant; it is a 100 percent natural, VOC-free, mold- resistant, odor and vapor neutralizing product that finishes to a velvety texture" (Adobe: A Timeless Material for Southwest Homes). Adobe may be for different reasons such as a method to meet economic, social and cultural needs, never exhausting all of our resources for succeeding generations but being cautious of the proper use of materials (J.D. Revuelta- Acosta, A. 2010).

Thermal mass can be restrained through climatic conditions dependent on the area. As far as the Southwest Region is concerned, most summer days may be very hot and dry, while the nights may be cool or even cold. Most winter days tend to be sunny with clear skies, as opposed to nights which are cold with temperatures nearing or below zero degrees Fahrenheit. These climatic conditions force homeowners in making the storage of energy an immense method of controlling and ameliorating the building microclimate and lowering the energy demand within the infrastructure (Meir, I. 2018). “High thermal capacity in a shaded insulated building can help lower maxima by 35-45% of the outdoor ones when the building is unventilated” (Giovoni, 1994). Shading can be an important matter when thermal capacity is in play; it can either reduce the thermal need or increase the need for thermal use as well (Meir, I. 2018).

Modern Construction

Sustainable homes contain three key elements: environmental sustainability, social sustainability or universal design, and economic sustainability. Homes are designed to reduce greenhouse gas emissions and may be constructed out of a variety of material and not simply the locally available ones, as seen in adobe construction. Most homes are designed to prevent injury through built-in safety features. Sustainable homes are designed to save money during construction and over the lifetime of the house. Sustainable home design trends in 2018 include resiliency, which allows durable materials and designs to become a part of building homes. This includes non-toxic materials for building purposes. Energy efficiency appliances come into place when creating a sustainable home, and this is because buildings account for 70% of energy and use approximately 40% of CO2 emissions throughout the US (18 trends for sustainable homes in 2018, 201). Water filtration to homes can help keep health concerns to a positive note. It is clear that 2018 has had high expectations from all sustainable communities worldwide, and it should

allow us to create a democratization of green building, in the U.S. and abroad. Sustainable building is forced to create thermal mass with different materials other than adobe, receiving the benefit of thermal mass without the cost of adobe.

As with adobe, thermal mass is a large piece of sustainable housing. The way thermal mass works is as a battery (Reardon, C, 2018). During the summertime, it absorbs all the heat during the day and then releases it by night to cool the home with the help of the breeze or the clear night skies, keeping the home at a comfortable temperature at all times (Reardon, C, 2018). Thermal mass has been known as an alternative to insulation. Proper use of thermal mass throughout a home can make an immense difference in not only heating and cooling but especially on electric bills.

Every building should establish an appropriate thermal capacity for the specific building, be considered vis-à-vis the style of building, plan, details, location and climatic conditions, as well as use patterns for every project. (Meir, I. 2018)

Construction Requirements

Most high-performance building requirements for sustainability provide a mandatory language for increased resistance towards disasters, as well as a reduction in the cost of repair, and a great amount of actual homes needing repairs post disasters (High-Performance Building Requirements for Sustainability, 2018). As far as large-scale housing is concerned, mixed-use and civil projects report on relevant factors in both regional and local economic strategy as well as how the development will promote viability (Sustainable Construction Checklist, 2015). A recruitment process, which includes retention and skills crisis of the industry has a serious economic impact on the construction process (Sustainable Construction Checklist, 2015). Having trained staff can be difficult, as well as retaining the same staff; this can reduce production time

and increase costs. Most companies are overcoming these objections by using innovative construction techniques, procurement processes, and training programs to maximize the future of their respective company as well as the industry (Sustainable Construction Checklist, 2015). For a successful building process, companies must partner with popular innovation within the demonstration program. Allowing partnerships creates a culture that is based on trust and cooperation, something clients want when relying on a crew to build their home (Sustainable Construction Checklist, 2015).

Homeowner Options

Both market and client demand have been major forces in driving green construction. Little by little states and local government have adopted regulations for building. Most requirements are geared towards green sustainable buildings. The reduction of energy usage and water usage are at the tops of environmental issues, thus driving green construction. Renewable energy, primarily solar, wind, and geothermal, continue to gain much popularity as sustainable alternatives to power the built environment repeatedly. Retrofitting an already existing building can sometimes be more cost effective than building a brand-new facility. The goal should always be to design a high-performance building by applying the integrated, whole-building design process, to the project during the planning or charrette phase that ensures all key design objectives are met. Designing major renovations and retrofits for existing buildings to include sustainability options will ultimately reduce operating costs and environmental impacts.

Methodology

Christel Vaenerberg (2009) stated sustainability consists of, “solutions which meet the needs of today without compromising the ability of future generations to fulfill their own needs.”

Creating a living condition which will allow a diverse variety of people through the years, even potentially after selling the home to a new family. This capstone will be an analysis of someone's future home, based on the comparison of both sustainable housing, defined as using modern construction techniques and materials, versus Traditional Adobe homes in the Southwest. The study will use two different quantitative methods meshed to create one outcome that will create results of which style of housing is preferable over the other. As explained in the reading, "Quantitative research is explaining phenomena by collecting numerical data that are analyzed using mathematically based method" (Introduction to quantitative research, 2010). The information gathered will not only be visible as a physical model through a computer-based program but will show the difference in cost through the different funding needed for construction on either. The first portion of this study is creating two different models and testing them through Energy-10 a simulation, which will help to view both outputs. This is a great method of showing the audience the main differences amongst both styles of building.

The second portion is a cost-benefit analysis. This again allows the readers who want to see the facts from start to finish of the bits and pieces it takes to construct such a home to do just that. It helps one to understand the root of the building because every cost will be explained on the same analysis breaking down the background of why the material may be needed for the building to succeed in its style of design. Some costs will be greater, but the longer outcome may be more rewarding than the upfront cost. After all, if something is meant to benefit in the long run, it may be costlier or time-consuming to build at first. Once these steps are completed, one should be able to gather a more in-depth understanding of which style of building will thrive in the southwest as the most successful style of building. Previous work done by Janice Eda and Rachel LaMantia have been conducted similarly- through visible results as well as a comparison

report to sum the main possible savings through each style of architecture. By completing these two quantitative methods, I will be able to represent the best solutions for each style of architecture and demonstrate it to the audience in order to promote more sustainable housing no matter the capital needed for building. The more sustainable building will then be promoted more in our community which will allow Tucson to grow into a Sustainable Community.

Results

Overall, it appears that the sustainable housing style built out of brick and mortar would be the better choice- as long as construction costs continue to be less inexpensive. The results are directly from an Energy-10 simulation which compared a building with sustainable features made out of brick and mortar, while the second building was constructed as a traditional Adobe home would regularly be built. Although there are other styles of the building which compete head on to sustainable housing through the ratings, sustainable housing has had an increase of interest and has made itself as if not the top candidate for the type of building style but also a comprehensive analysis lets one reset expectations from the two style of homes. The building material style may also be a factor when inputting raw data in an energy simulation system. This is mainly due to different materials meshing better with specific building styles and requires us to comprehend the numerous amounts of building styles and how energy efficient they can become through an analysis. The overall construction costs were much higher in the Traditional Adobe Housing due to sq. footage costing an average of $125 per sq. ft. (Vikingmudman,2017), as opposed to brick at max may cost $10-15 per sq. ft. (Cost to install brick or stone siding, 2019). This is a significant price difference which proved in the construction costs differentiating by $62,444. The energy model comparison included the brick and mortar home built with

electric usage for all amenities; this is why the total electric usage concluded to be 22,721 kWh as opposed to the traditional Adobe home that used a total of 18,401 kWh.

The average usage from each style of building is 1,533 kWh monthly for the Traditional Adobe method, as opposed to the Brick and Mortar home used an average of 1,893 kWh. Locally TEP charges a tiered rate of .066 for the first 500, .081 for the next 500 and .086 for the rest. Additionally, another .036 for the summer month and .033 for the winter.

Average Annual kWh:

Summer	Sustainable (1893)	Adobe (1533)
500 (.102)	51	51
501-1000 (.117)	58	58
1000+ (.122)	108	65
Per month	217	174
For 6 months	1,302	1,044

Winter	Sustainable (1893)	Adobe (1533)
500 (.099)	49.5	49.5
501-1000 (.114)	57	57
1000+ (.119)	106	63
Per month	212.5	169.5
For 6 months	1275	1,017
1 year	2,577	2061
Difference		-516

Energy-10 Results:

	Sustainable Housing (Brick & Mortar)	Traditional Adobe Housing
Floor area	2,000 sq. ft	2,000 sq. ft
Floor Type Insulation	Reff= 12.2	Reff= 27.4
Heat/ Cool performance	COP= 2.9, EER= 8.9	COP= 4.3, EER-= 13.0
Peak Electric	10.20	5.57
Daylighting	No	Continuous Diming
Total Electric	22,721.66 kWh	18,401.39 kWh
Construction Costs	$318,727	$381,171

These results are only an average for a year; they could potentially be higher during summer time vs. winter. The Traditional style of building would eventually become most efficient in approximately 100 years; this could most definitely be useful regarding the long-term existence of traditional adobe structures vs. another style of building.

Conclusion

The results of the study indicate that the sustainable housing method will result in greater savings when comparing the entire life-cycle costs between both styles of building in the Southwest. In the study, the two building styles resulted in a 0.318 (Net Present Value) for the life-cycle cost-benefit ratio. Although the Adobe style of the building came close to surpassing the brick and mortar methods in a few categories, such as paying less property tax and having a smaller mortgage, the sustainable housing method outperformed through longevity. Either building method will need a thermal mass technique; this allows adobe to have great automatic success. A potential home buyer or a client who is looking to build a home from the ground up

should weigh the monetary savings against other constraints. It will be up to the client which route they chose for a home, but the savings can be presented with hard numbers.

However, it is important to note that energy modeling software results may vary depending on the similar inputs and close range of results. Different styles of energy modeling software can alter results to reflect other inefficiencies that buildings may produce based on construction style. Energy policies will play a major role in the results. This is because they allow energy modeling efficiency to become more accurate. Various climatic conditions may also cause the results to become more complex when analyzing them through the exact energy modeling software. All of this is to say that the choice of software, as well as the inputs used, can have an impact on the results. Future studies should consider running analysis across multiple software platforms to compare results. Additional styles of housing can be compared and contrasted in the future of the analysis in order to continue gathering a potential survey of the supreme housing method.

Finally, capital costs will always be a considerable component to the direction of a design process in order to meet within the budget that may be preset. While the sustainable home may win out in cost savings, an owner may not be able to afford the home. In the same vein, creating a safe residential environment can consist of many different methods as discussed previously dependent on the materials composed to design a home. Knowledge regarding the numerous styles of buildings may also present itself when designing for a potential buyer who may not have personal background or knowledge in the design process. This is where the designer will come in to allow the interpretation of the designer's "terms" to the buyer's terminology. Facilitating the constant communication amongst the designer and buyer will allow the course of the building to become effortless, thus avoiding any mishaps from occurring.

Limitations

One may consider the costs of creating a more sustainable living condition to be too costly and time-consuming, and this forces the homeowner to stick to the basics of what a contractor may comprehend about sustainable housing. It is up to the homeowner to become educated on the available options to integrate into their home as well. This will assist with understanding the costs behind the building before committing to something that they cannot afford. Doing their research behind a concept will allow them to select the best concept dependent on potential house building style or climatic conditions. This will lead them to a path they may create themselves and know what to ask for from a contractor. If the specific contractor working on the home is not familiar with a concept, it will be their duty to find a different contractor who will be familiar with the idea or ideas. Once they have done so, the homeowner/buyer will be able to have the correct conversations to create their vision of sustainability. While education of the profession is important, creating material that is easy for homeowners to find and understand is equally so.

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