The Integration of Virtual Reality in the Commercial Construction Industry

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Virtual reality has recently been spreading throughout the commercial construction industry rapidly. Some of its capabilities are safety training, helping spot Americans with Disabilities Act (ADA) issues, logistics planning, and virtual walkthroughs. Many construction companies were starting to utilize virtual reality's advantages until COVID-19 hit. The initial wave of COVID slowed down construction in general as well as the need or use of virtual reality. Now, some companies are worried about the health risks and implementation issues that virtual reality headsets might bring while other companies are optimistic about the future of virtual reality. This report will explore the different advantages and disadvantages of implementing virtual reality into a commercial construction company. Interviews and surveys have been conducted to further the research on this matter. Ultimately, it was determined that VR is case and company specific. Not all commercial construction companies need VR; however, some benefit from it.

Key Words: Virtual Reality, Commercial Construction, Management, Walkthrough, Design

Introduction

In construction today, technology plays a big role in helping workers with everyday tasks like communication, information sharing, assistance with scheduling and estimating, and more. The integration of technology in the workplace has allowed construction managers to manage a project more effectively but not all construction companies take advantage of the latest technology for their companies. Some would rather stick to traditional methods like viewing paper documents instead of pdf's or using a telephone instead of virtual meeting sites like Zoom in order to get a job done. Traditional methods will always be a viable option for construction; however, taking advantage of new technological advances can help a construction company succeed.

VR, or Virtual Reality, is a computer simulated environment in which users can interact with three-dimensional representations of a certain environment, building, or location. According to an article posted in Frontiers Media, a publisher for scientific journals, "the concept of VR was formulated in the 1960s and the first commercial VR tools appeared in the late 1980s" (Cipresso, et al. 2018). The

first VR headset came out around the 1960's and was used as another form of viewing films. Shortly after, the US military adopted the technology to use for training purposes. Around the late 1980's, virtual reality headsets became a new way to play video games and has blown up in popularity within the gaming industry. The use of VR has since made its way into the construction industry. With uses in safety training, ADA issues, virtual walkthroughs, and many more, virtual reality has proven to be a viable option for some commercial construction companies to consider using. Some companies that are not as technological adapt as other companies may not see as many advantages from the implementation of VR. The use of VR in a company is case specific, in which not all companies will find use from this tool; however, the companies that can implement it can benefit greatly. Interviews and surveys were conducted to see if this is the case for construction companies who have already implemented this technology. The companies interviewed include Clark Construction, Hathaway Dinwiddie, Bernards Construction, Shepley Bulfinch, and Pixo.

Purpose

The goal of this research is to identify if virtual reality will be a useful tool for a commercial construction company or not. This will be done by furthering the research on this topic as well as conducting surveys and interviews with companies that have either previously used VR or not. The results will be able to show where VR is useful in a construction project, who will benefit from it, and why some companies are not taking advantage of this tool.

Methodology

A quantitative survey was conducted with around 20 construction companies located in the Central Coast area of California, to either discuss the company's use of VR or why the company did not use VR. The survey was anonymous with the option to leave an email at the end if the company wished to be contacted to further the discussion of their use of VR. In total, there were eight questions that asked whether or not companies have used VR, if the respondents answered yes, the next question they were asked is what purpose they used VR for, if the respondents answered no, then they were asked why they have not used VR. The survey also asked if the use of VR end up helping the company, did the use of VR benefit a specific project, would your company ever decide to use VR in the future, and would you be willing to participate in a five to ten minute phone call about your VR experience? These survey questions best suit this topic because it allows for both companies that have used VR and those who have not to give feedback.

Interviews were also conducted with the companies that provided their emails in the survey along with companies found through independent research. The companies that were interviewed include companies from the commercial construction industry, an architectural firm, as well as a company that makes and sells the training software that is used in a virtual reality headset. The interviewed companies were asked:

1. When they first started using VR and for what purpose?
2. Do they still use VR today for that same purpose?
3. Were there any obstacles in implementing VR?
4. At what stage of a project was VR used?
5. Whether they thought VR helped or hurt their company more?
6. If they can give a specific example when VR has either helped or hurt their company?
7. Would the company think about implementing VR in the future for some other use?

8. How has COVID affected their use of VR?
9. Are any other new technologies that they plan to take advantage of in the future?

With this range of questions, each company was able to be analyzed to see how VR affected their company.

Survey Results

When conducting this survey, construction companies were asked if they have ever used virtual reality to assist in pre-construction activities, safety training, ADA issues, etc. Only 40% of respondents said that they have used VR before. Out of these 40% of companies, the most common use of VR was for either project startup/design, or for walkthroughs. There were no companies in the survey that said they used VR for safety training and only one company mentioned they have used VR for ADA issues in the "other" category. For those who responded they have not used VR in their company, they were also asked why. From this question, 66% of respondents said that they do not think it will be helpful for their company. 17% of respondents said they have not been introduced to VR in construction, and the remaining 17% of respondents said there has not been a need for VR yet within their company. It is also worth noting that no companies have reported that the use of VR would be too expensive for their company to use. For the companies that do use VR within their company, they were also asked if the use of VR ended up helping their company in terms of cost, design, safety, etc. What was found was that while 32% of companies responded yes, 58% of companies responded that their company does not use VR. Companies were also asked if VR helped benefit a specific project. Again, while 32% of respondents said yes, VR helped, 58% of respondents still said their company does not use VR. When asked if a company would ever decide to use VR in the future, 65% of respondents said yes while only 5% said no. For this question, respondents were also given an option to choose "other" in which they could fill out their own answer. What was recorded was that these companies were not against the idea of using VR; however, they have not come across a case where VR would benefit them as of yet. With this being said this does not mean that companies do not like the idea of virtual reality, they just have not found the right use yet. This information can be seen in its original survey format below.

1. Which industry does your company work in? (ex. residential, commercial, industrial, etc.)

More Details   💡 Insights

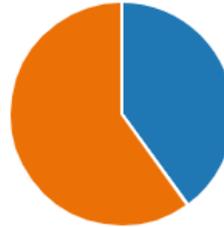**20**
Responses

Latest Responses
"Commercial "
"commercial"
"Commercial construction"

2. Has your company ever used virtual reality to assist in pre-construction activities, saftey training, ADA issues, etc.?

More Details

- Yes   8
- No   12

3. If yes for question 3, how did you use VR to help your company?

More Details

- Safety Training   0
- Pre-Construction Design   2
- ADA issues   0
- Other   6

4. If no for question 3, why has your company never used VR?

More Details   💡 Insights

- Too expensive   0
- Do not think it will be helpful f...   8
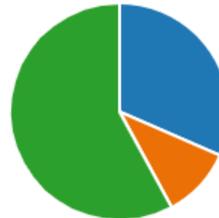- Have not been introduced to ...   2
- Other   2

5. Did the use of VR end up helping your company? (In terms of cost, design, safety, etc.)

More Details   💡 Insights

- Yes, VR was a help to our com...   6
- No, VR did not help out comp...   2
- Our company does not use VR   11
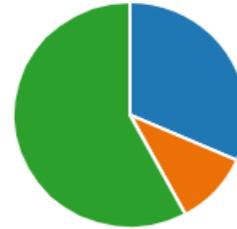
6. Did the use of VR benefit a specific project?

More Details 💡 Insights

● Yes, VR was helpful for a speci... 6
● No, VR was not helpful for a s... 2
● Our company does not use VR 11

7. Would your company ever decide to use VR in the future?

More Details

● Yes 12
● No 2
● Other 6

Interviews

The interviews conducted ranged from commercial construction companies to an architectural firm, and even a company that makes the software used in the VR headsets. It was found that there are many different types of VR systems for companies to use. Although different systems were used, the same functions can be used universally throughout the headsets. The main uses for VR in these companies were mostly for walkthroughs and pre-construction design and activities. There are other uses for VR like spotting ADA issues and training programs; however, these would also be implemented before construction starts. Businesses were also asked if they had any obstacles in implementing VR into their company. Each company that was interviewed gave a different response. Bernards Construction said their biggest challenge was, "having computers powerful enough to run the headset" (Roos, 2022) while Clark Construction said it was mostly getting use to being in the virtual environment. Pixo, a company that creates training programs for VR headsets, said the biggest challenge they saw was people overcoming the motion sickness from being in the headset for too long.

Another question these businesses were asked was if they thought their use of VR helped or hurt their company more, and to give a specific example. Both Bernards and Clark Construction commented that VR has helped their company while pushing innovation until COVID-19 slowed construction. Ever since then, the use of VR has been limited, with companies focusing more on finishing the job and getting paid. However companies like Bernards Construction, who previously had a lot more involvement in VR, saw advantages like, "helping those project team members that will be working on a project to build a memory of the building details through VR…for a newer person (with less experience in the field and less experience with 2D drawings) it takes a lot of time for them to flip from plan views to elevation views, to detail views to try and figure out what complex parts of the project look like in 3D and in full-scale" (Roos, 2022). Clark Construction shared that their biggest

advantage was to be able to show the owner/client a view of what they were building in order to solve any scheduling or rework problems that might have occurred otherwise. This was especially helpful for projects like hospitals and emergency rooms, where the client or doctor could give feedback about the layout of the rooms.

Companies were also asked if they thought they might use VR in the future for any use, whether it is for training programs, design aesthetics, ADA issues, or anything else. What was reported was although VR has been emerging in the industry as of lately, there seems to be a decline in the excitement around VR. This is much to do with COVID but generally, if a company has not already found a use for VR, it is harder to convince them until there is a case specific need for it. When asked if COVID played a role in the decline of VR, the answers were unanimously yes. Each company that was interviewed that had used VR in the past does not use it now in the same capacity. Sharing headsets can pose as potential health risks and with more people telecommuting recently, it would be difficult to implement VR into a company that has never used it before. Finally, companies were asked if they had any plans to implement any other type of new technology in the future. Without giving away too many company secrets, what was found is that most companies are always looking for the next great innovation. Whether it is VR or not, every company is looking for the best technology for their company in order to work as efficiently as possible.

Analysis

Cost-Effectiveness

After talking to different companies about virtual reality along with surveying companies that use and do not use VR, it was found that the cost to implement VR in a company does not seem to be an issue. However, not all companies want to start using a new piece of technology right away if they do not see the benefits from it. The problem with the little usage of VR in the construction industry is not because it is too expensive but not enough companies can find uses in their company. Whether or not the company has a Virtual Design Construction/Building Information Modeling (VDC/BIM) department can play a factor in deciding to spend the money on virtual reality technology. If a company already has some types of BIM implications, then that company will be more willing to try out the implications of VR. If a company does not have one of these BIM or VDC departments, it will be harder to show the advantages that VR can bring. In addition, VR headsets and programs are made to be cost efficient, so contractors can use their programs again and again. But like with most other things, COVID-19 has made the price for using a VR headset and the cost to keep it sanitary go up. Before 2020, companies could buy a single headset and the whole company could use it. Now, a company would have to either buy a headset for ever single employee or not let everyone use it. The cost for a single VR headset has stayed roughly around the same price, not taking inflation into account, which means once COVID ends, VR might gain more traction as being a cost efficient construction management tool.

Design Stage

It was found that the design stage is where companies use VR the most. The main usage found was for virtual walkthroughs during this design stage. With virtual walkthroughs, a contractor is able to communicate with the owner/client much more efficiently through a VR headset. They are able to show a first person experience into a virtual world that has not been built yet. From there the owner/client viewing the virtual environment can check for design issues, ADA issues, safety issues,

and overall aesthetic purposes. This is also a great use for doctors or firefighters where they need specific rooms for specific purposes. Paper construction plans can sometimes be hard to grasp the concept if you are not familiar with them. This is why virtual reality can provide a unique experience for the owner/client to view their building or room in a way that they can understand.

COVID-19

COVID-19 put a major halt in construction when lockdowns first started in March of 2020. Construction was able to start up again shortly after, but areas like VDC departments saw less uses of VR and other similar technology. COVID also made the sharing of items, like a virtual reality headset, harder because of sanitary reasons. Right as VR was gaining attention in the construction industry, companies had to stop since it was more important to finish the job and get paid. Once COVID ends, there will be more hope for virtual reality's future. As soon as people can start focusing on innovative technology again, like VR, instead of health risks, there will be more of a demand for virtual reality.

Implementation of VR

When implementing VR for the first time in a company, there might be some things people will have to adjust to. If it is the first time wearing a virtual headset, the user might experience motion sickness from being inside the headset for too long. Other than this, most programs created for VR headsets are user friendly in which technologically adapt persons can grasp the concept quickly. For those who are not as technologically adapt as others, clear and specific instructions are provided for most programs that are used in the VR headset. Since these headsets are fairly generic, this means that an owner/client who is not familiar with technology can still be able to virtually walk through their building while making comments. Figure 1 shows a 1:1 scale model of a building that was rendered into one of these virtual reality programs called Prospect. As seen in the figure, one can select different layers of the building, take pictures, measure elements, make notes, jump around from room to room, and even see where others are in a building that are using the same program. Programs like these can provide an owner/client with the ability to view their building from home before construction has even started. This way the owner/client can make any last minute decisions before the process starts.

Figure 1: Prospect's Virtual Reality Program (Brestel, 2018).

Conclusions and Future Implementation

Within the past 10 years, virtual reality has been growing in popularity within the construction industry. More and more companies started to utilize the advantages of VR until COVID-19 slowed down construction. Now, companies are more focused on completing a job rather than finding a place to incorporate VR. With this being said, it is not the cost that drives construction companies away rather than a specific need for it. What was found through surveys, interviews, and research is that VR is mostly used during the design stage of construction. Although it is mainly used for owner/client walkthroughs, there have also been uses for safety trainings, spotting ADA issues, as well as design purposes. Ultimately, it was decided that VR is case and company specific. Not all construction companies need or use VR within their company; however, those who can efficiently incorporate this technology into their everyday business life can greatly benefit from it.

If this project were to be further researched, different uses of VR would be analyzed. Clash detection, for example, was not a topic of this research; but further research into this topic can prove to see if it would be viable tool to use in virtual reality. Also, a wider search of companies that are not located in the Central Coast area of California might prove to show different results. Construction companies in the mid-west for example might have different uses for VR than those in California. Finally, augmented reality (AR) would be another area of research that might prove to be either better or worse than VR. AR is an interactive real-world experience while VR is a virtual experience. Further research of the uses of AR can possibly provide benefits to construction in addition to virtual reality.

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