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# Exploring ASCE Future World Vision Callouts: Engaging First-Year Construction Management Students in Futuristic Built Environments

**Dr. Rodolfo Valdes-Vasquez, Colorado State University**

Dr. Rodolfo Valdes-Vasquez is an Associate Professor in the Department of Construction Management at Colorado State University. His research, teaching, and engagement align with sustainable design and construction topics. He has received grant funding from federal and state agencies and private organizations. Rodolfo has taught multiple courses at the undergraduate and graduate levels, and he is well-versed in the scholarship of teaching. His efforts in leading the Sustainable Buildings program were recognized with the 2019 Award for Excellence in Education Abroad Curriculum Design. He has also worked as a construction project engineer, consultant, and safety inspector. He believes that educating the next generation of professionals will play a pivotal role in sustainability standard practices.

In terms of engagement, Dr. Valdes-Vasquez has served as the USGBC student club's adviser and the ASC Sustainability Team's faculty coach since 2013. He is currently serving as a CSU President's Sustainability Commission member, among multiple other committees. In addition, he is involved with various professional organizations at the national level, including the American Society for Engineering Education (ASEE), the Associated School of Constructions (ASC), the Construction Research Congress (CRC), and the Center for Infrastructure Transformation and Education (CIT-E). At the international level, he serves as the Associate Editor for the ASC International Journal of Construction Education and Research. He collaborates with faculty members in Brazil, Costa Rica, Ecuador, Panama, and Spain.

**Dr. Mehmet Egemen Ozbek**

Dr. Mehmet E. Ozbek is an associate professor and the graduate program coordinator in the Department of Construction Management at Colorado State University. He holds a Ph.D. in Civil Engineering with a focus on Construction Engineering and Management. Si

**Papa Ansah Okohene, Colorado State University**
**Zachary Lopez**

# Exploring ASCE Future World Vision Callouts: Engaging First-Year Construction Management Students in Futuristic Built Environments

**Abstract:**

The construction industry is evolving rapidly, driven by sustainability imperatives, technological advancements, and the need for adaptive urban planning. This work-in-progress paper explores how first-year Construction Management students engage with the American Society of Civil Engineers (ASCE) Future World Vision (FWV) Mega City 2070 platform—a virtual environment depicting a futuristic urban landscape. The study examines how students interact with "callouts" within the platform, representing innovative ideas about the built environment.

The pilot study focuses on the features and callouts within the platform that captured students' attention and how these interactions help students develop competencies vital to the evolving construction industry. A secondary objective of the paper is to present a structured assignment and its assessment rubric that guides student engagement with the FWV platform. The assignment is designed to enhance student learning outcomes by encouraging the exploration of innovative, technology-driven concepts early in their academic journey. By immersing students in a virtual environment, this assignment bridges theoretical knowledge with practical, forward-thinking applications, helping students develop a deeper understanding of how environmental, technical, and socioeconomic systems interact in the future of construction and the built environment. The assignment aims to help students identify and reflect on specific callouts' feasibility, relevance, and implications. Their submissions are analyzed through qualitative content analysis.

Preliminary results from this ongoing study suggest that the FWV assignment has successfully inspired students to explore a range of futuristic construction topics. Findings reveal that students prioritized 117 callouts of the 446 included in the platform, emphasizing automation, sustainability, and urban resilience, such as programmable construction sites, green infrastructure, and adaptive transportation corridors. Key themes include integrating renewable energy, modular construction, and advanced safety systems, alongside criticisms of implementation challenges, such as feasibility and cost. It is important to note that many students also raised concerns about job displacement due to automation, expressing a preference for more traditional, low-tech construction methods. This highlights the need for a balanced approach in preparing students for the future of the construction industry. These reflections highlight students' critical thinking, creativity, and awareness of emerging trends in the construction industry.

This study contributes to construction education by demonstrating how virtual tools like Mega City 2070 can foster engagement with complex, forward-thinking concepts, preparing students for the future of the built environment. Recommendations for enhancing assignment design and expanding the scope of student interactions are also discussed.

## Introduction

The construction industry is undergoing rapid transformation, driven by the increasing emphasis on sustainability, technological innovation, and adaptive thinking in designing and managing future built environments. To prepare students for these shifts, construction engineering and management educators must integrate tools and assignments that cultivate critical skills such as digital literacy, problem-solving, and creative thinking [1]. This work-in-progress paper examines how first-year Construction Management (CM) students engage with the American Society of Civil Engineers (ASCE) Future World Vision (FWV) Mega City 2070 platform [2].

The Mega City 2070 platform is one of the products of a major initiative undertaken by ASCE. This initiative, entitled FWV, began on the premise that the roles and responsibilities of civil engineers will drastically change in the future because of climate change, increasing population, and the adoption of new technologies [2]. The initiative involved performing deep research to identify the major trends that will impact on the infrastructure in the future (with a 50-year horizon) and, through scenario planning, to examine a variety of plausible scenarios for the built environment. The overarching goal of developing these future world scenarios was to help the broader infrastructure community (such as the owners, developers, designers, academicians, and contractors to be proactive in their current decisions that will impact the built environment in the future [3]. It is important to note that many subject matter experts from numerous disciplines, both within and outside of ASCE, and relevant industries were involved in developing this project, highlighting the need for broad input when the future of the infrastructure is concerned [3].

The Mega City 2070 platform is one of the products of the FWV initiative. It is an immersive virtual platform depicting a city with 50 million inhabitants as it exists in the year 2070. It allows the end-user to navigate in this virtual city both at the macro view (overview map of the city) and micro-scale (at the street level or even inside a building). Specifically, at the microscale, the end-user can click on the ideas/concepts (referred to as callouts in the platform) to learn more about them. There are 446 callouts in Mega City 2070, presenting unique and futuristic ideas about the built environment. Many of these callouts are quite thought-provoking and include examples such as “Buildings that Build Themselves,” “Programmable Construction Sites,” and “Automated Road Maintenance.” These callouts are central to the platform and are intended to make the end-user think about the future of the built environment. Each callout has a tab with general information, followed by more detailed information, and another tab highlighting the research that led to developing that idea/concept. This tab lists the papers relevant to that idea and includes interviews with subject matter experts. Finally, there is a tab allowing the end-users to comment on the idea/concept and share their opinions, agreements, disagreements, concerns, etc. related to it. This tab is central to the platform, as the goal of Mega City 2070 is to provoke the end-users to think about various aspects of the future cities and comment on those to promote healthy discussion among various professionals and disciplines. A screenshot of the callout called “Programmable Construction Sites” is shown in Figure 1.

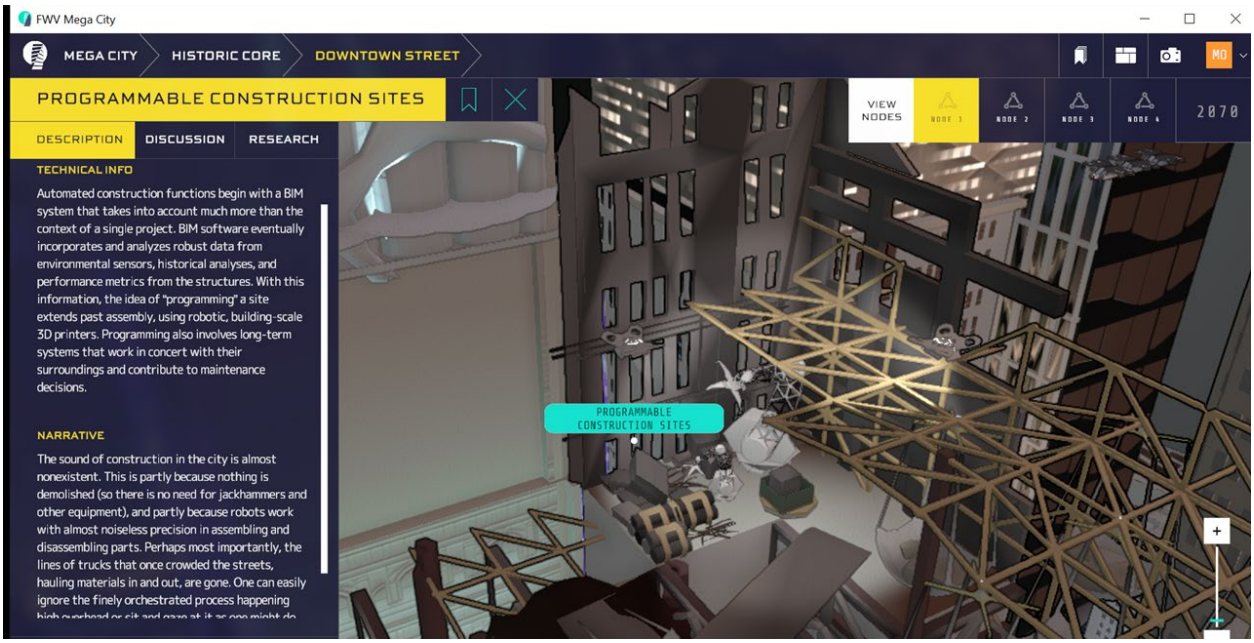


**Figure 1.** Screenshot of the Programmable Construction Sites Callout

This study originates from the callouts mentioned above in an effort to assess the students' engagement with the platform. Specifically, this pilot study identifies the callouts that capture students' attention the most (as evidenced by their interactions in the platform) and provides a reflection on how these interactions help students develop competencies vital to the evolving construction industry. A secondary objective of the paper is to present the assignment structure and its assessment rubric that guides student engagement with the Mega City 2070 platform.

## Background

Over the past two years, a considerable amount of research has been conducted into novel approaches to educate and inspire first-year civil and construction management students regarding the potential future of the built environment. In this educational context, the American Society of Civil Engineers' (ASCE) Future World Vision (FWV) project has become a key instrument, using immersive, vision-driven scenarios such as Mega City 2070 to inspire and educate students. This section focuses on research and instructional methods for utilizing FWV effectively and discusses the related outcomes of challenges and future directions.

The study by Bielefeldt [4] is regarded as one of the foundational studies related to integrating FWV into a first-year civil engineering course. This research showed that FWV could be effortlessly included in existing course frameworks through assignment and discussion platforms. For example, students learned about the FWV on day one of class in a video that sets the stage for an exploratory semester of learning. The findings showed that 59% chose FWV-related resources over the traditional readings, which is an extremely high level of engagement. In-class assignments regarding FWV scenarios, like the Floating City, created a real atmosphere of creativity and investigation.

Bielefeldt [4] also pointed out the motivational theories of the course design. Using the Expectancy Value Theory, a mix of self-efficacy, intrinsic interest, and utility values promoted student motivation. The choice was a valued factor to be used for increasing engagement. Students could choose contexts or themes that meant something to them, which gave a degree of autonomy- a determinant that is commonly very strong. Attention should also be paid to demographic differences, as diverse students will differ in motivation and interest. This would also enhance inclusion and create a more engaging learning environment to attract a broader diversity of individuals into civil engineering or similar programs.

Another significant study in this domain was conducted by van de Lindt [5], who investigated the educational prospects of FWV's Mega City 2070 and showed the importance of using a forward-looking approach to encourage students to look for solutions beyond conventional engineering solutions. His research underlined that working with a vision of the future helps students understand how civil engineering might be shaped to answer societal needs. The scenario-based approach provides the students with complex, realistic challenges for imagining solutions, such as adaptable infrastructure responding to climate change [5]. The study also identified that Mega City 2070 provided a good brainstorming tool, taking students from the conceptual box and pushing them toward interdisciplinary collaborations. This technique would help later in these students' lives and professional work when thinking creatively and out of the box is expected [5].

Mega City 2070 has more significance than engaging students alone. It is also a method for instructors to introduce engaging vocabulary and phrases about urban planning, sustainability initiatives, and resiliency efforts. The visual and interactive aspects of the FWV project enable the very abstract and often overwhelming principles of the Architecture, Engineering, and Construction (AEC) industry to be represented in a more concrete and accessible way, especially for first-year students with limited technical training. In particular, van de Lindt [5] suggests that increased inclusion of FWV features in civil engineering curricula would, in turn, provide a future generation of professional engineers who can be more creative and adaptable.

Oswald Beiler [6] furthers this discussion by investigating the integration of public policy in the curricula and highlighting the need for civil engineers to understand public policy because, often, infrastructure projects come with regulatory and societal constraints. The study recognized that though public policy is typically taught at the post-graduate level, its incorporation at the undergraduate level has much to gain [6]. Oswald Beiler's approach was integrating public policy discussions into a required, upper-level civil engineering course [6]. The course addressed the fundamental concepts of leadership, ethics, and sustainability introduced during earlier years. It elaborated further with the students on how to apply those concepts to more complex policy applications. For example, students worked on case studies on climate change mitigation and infrastructure resilience, applying real examples to understand how engineering and policy come together. In addition to advancing their technical knowledge, such learning gave them the skills to tackle the interdisciplinary problems they would face in practice. This study also identified that engineering education should be related to contemporary societal issues. Such training in public policy helps engineering students learn to think about the broader social and environmental implications of their engineering decisions. Beiler's research indicated that this could develop an interest in civil engineering for students driven by societal impact and

sustainability [6]. This is further supported by case studies dealing with public policy, which incorporate how such students will handle challenges likely experienced during their career development regarding compliance issues and stakeholder buy-in.

Integrating FWV into construction education aligns with the broader efforts to modernize civil engineering and related curricula such as construction engineering and construction management. FWV scenarios have already been shown in other research to successfully engage students through creativity and cross-disciplinary thinking and highlight the need to infusion public policy in engineering education. These collective efforts underscore the need to reform construction education to address modern challenges and opportunities. However, despite the previous attempts to integrate FWV into the curriculum, a significant gap remains in evaluating its long-term impact on students' motivation, retention, and preparation for practical problems encountered in real-world scenarios. Building on previous research, this study looks at how adding an FWV assignment to a first-year construction management course allows students to interact with "callouts" within the platform and supports them in developing competencies vital to the evolving AEC industry.

**Research Approach**

The research for this study focuses on qualitative content analysis methodology [7]. The study is also grounded in the learning objectives of a first-year course focusing on Construction Management, which is designed to introduce students to the construction industry's diverse practices, trends, and challenges [8]. By the sixth week of the semester, students had developed foundational knowledge of the industry's segments, project management principles, and sustainable construction practices. With this base, the course introduced a specialized module to integrate critical thinking and innovation into the students' understanding of construction management.

In particular, the module's learning objectives were designed to guide the students in achieving the following:

- Explore innovative construction practices by engaging with the Mega City 2070 platform to uncover groundbreaking ideas in construction management and the built environment.
- Apply critical thinking in construction: by evaluating the platform's callouts, focusing on their implications for project efficiency, sustainability, and management.
- Develop innovative solutions to construction challenges, drawing on advanced technologies, sustainable practices, and efficient project delivery methods highlighted in Mega City 2070.
- Formulate clear and well-structured comments on the platform's concepts, providing logical reasoning and real-world considerations to support their analyses.

To align with these objectives, the first major step in this study was to develop the assignment that would require the students to navigate the Mega City 2070 platform, identify the callouts (that would interest them), and provide their comments about those. Before the assignment was developed and shared with the students, the instructors, through a formal and detailed presentation, provided an overview of the FWV project as well as the Mega City 2070 platform in the class, discussing the genesis of the project and also showing the students how to navigate

in the platform as well as how to identify the callouts and the tabs within the callouts. Then the assignment was developed and provided to the students. Specifically, the assignment prompt read as follows:

"*For this assignment, you will need to navigate in the Mega City 2070 virtual platform that* was *shown to you in class (download and install for free at https://www.futureworldvision.org/download-desktop-app) and provide a comment that is at least a couple of paragraphs long with your detailed reasoning in* one or more *of the callouts in that virtual environment.*"

The virtual platform was also made available in one of the computer labs, and the students could access it even if their computers did not meet the system requirements. The rubric for this assignment was also developed and shown in Table 1 below.

**Table 1.** Developed Rubric used as an Assessment Tool of the FWV Assignment

| Criteria | Below Average | Average | Good | Excellent |
|---|---|---|---|---|
| Critical Thinking and Analysis (20 points) | Reflection is not relevant to the material.<br><br>Misunderstands key concepts. | Makes some connections between course material.<br><br>Understands key concepts. | Makes adequate connections to course material.<br><br>Understands key concepts and draw valid inferences. | Articulately reflects ideas, opinions, and experiences.<br><br>Understand the subject matter and related concepts. |
| Idea Development (20 points) | Ideas not clearly stated or developed. | Incomplete development of ideas; details and examples are not always evident. | Good reliance upon examples and details to illustrate and develop ideas and opinions. | Excellent use of examples and details to explore and develop ideas and opinions. |
| Mechanics and references(10 points) | There are many instances of incorrect spelling and punctuation.<br><br>Missing references or not obvious. | Several spelling and punctuation errors.<br><br>References are included in the text but need to be fully listed or they are based on the platform. | There are few or no spelling errors and some minor punctuation mistakes.<br><br>Some relevant references are included to back-up arguments, and they are also listed at the end. | Flawless spelling and punctuation.<br><br>Relevant references are included in the text to back up arguments, and the reference list is included. |

The second major step includes employing a qualitative content analysis methodology [7] to evaluate students' written reflections based on their interactions with the FWV Megacity 2070 virtual platform. The primary goal of this analysis was to examine how students identified specific "callouts" within the platform's scenarios. To ensure consistency and depth in analysis, three coders independently reviewed and categorized student submissions, leveraging both structured and interpretive techniques.

Approximately 200 students in three class sections were tasked with engaging with the FWV platform, selecting at least one callout, summarizing these callouts, and providing their opinions on their feasibility and relevance. For this study, the sampling frame is represented by the submitted assignments, and the unit of the analysis is the callouts [7]. Specifically, these assignments were submitted via the Canvas learning management system, utilizing the SpeedGrader tool to streamline review processes. Each submission was analyzed for explicit and implicit identification of callouts, alongside students' interpretations and evaluative commentary. Sometimes, the student did not mention the callout, but their discussion referred to it. A total of 142 assignments were included in the sampling frame.

The coding process followed a systematic approach grounded in the 446 callouts that are part of the virtual platform. As a part of this process, the coders began by thoroughly reading each submission to identify explicitly stated callouts, which involved scanning for direct mentions and annotating any discrepancies or misalignments between stated and described callouts. If ambiguities or a lack of specifying explicit callouts were observed, they were resolved by interpreting the student's context and recording brief notes in a shared Excel file, which included all the 446 callouts by a code number and sheets for each section to enter their data. This standardized Excel file served as the central repository for all coding outputs. Each assignment's callouts, associated descriptions, and additional observations were systematically logged. This structured format enabled cross-comparison of data, helping to identify patterns across the dataset. The overall data captured were the callouts included in each assignment and any observations related to these callouts.

The three coders were familiar with the virtual platform and thus leveraged prior familiarity with the assignment. The coders practiced grading three random assignments together to understand the process and clarify any questions about the process. They were encouraged to adopt an iterative review process. This process included re-reading submissions and systematically logging callouts and related observations in the shared Excel file. Their familiarity with the initial grading process facilitated efficient identification and interpretation, although some essays required deeper analysis to deduce unstated callouts. Observations were categorized into "Additional Observations" sections within the coding framework, capturing nuanced opinions and trends. Then, the coders examined broader trends in students' analyses. This entailed identifying major themes, recurring ideas, and students' overall critique patterns regarding futuristic urban concepts. Particular attention was given to how students reflected on the feasibility and implications of their chosen callouts.

Finally, the data was analyzed using frequencies, and the coders reflected on the highlights during the review of the assignments. The research approach balanced structured coding and

interpretive analysis, ensuring a comprehensive understanding of student engagement with the FWV platform.

**Results & Analysis**

Overall, 142 assignments were analyzed in fall 2024. The results reveal key insights into the frequency of topics represented by specific callouts. On average, 1.7 callouts were listed in each assignment. Figure 2 shows the distribution of the number of callouts by assignment. There were eight assignments in which it was difficult to identify the callout or not mentioned. So, these were not included in the analysis. Also, 15 assignments included three callouts, which might represent the excitement of students to learn more about the virtual platform. Specifically, 117 callouts from the 446 original list were mentioned at least once, representing 26% of the total number of callouts available on the platform.

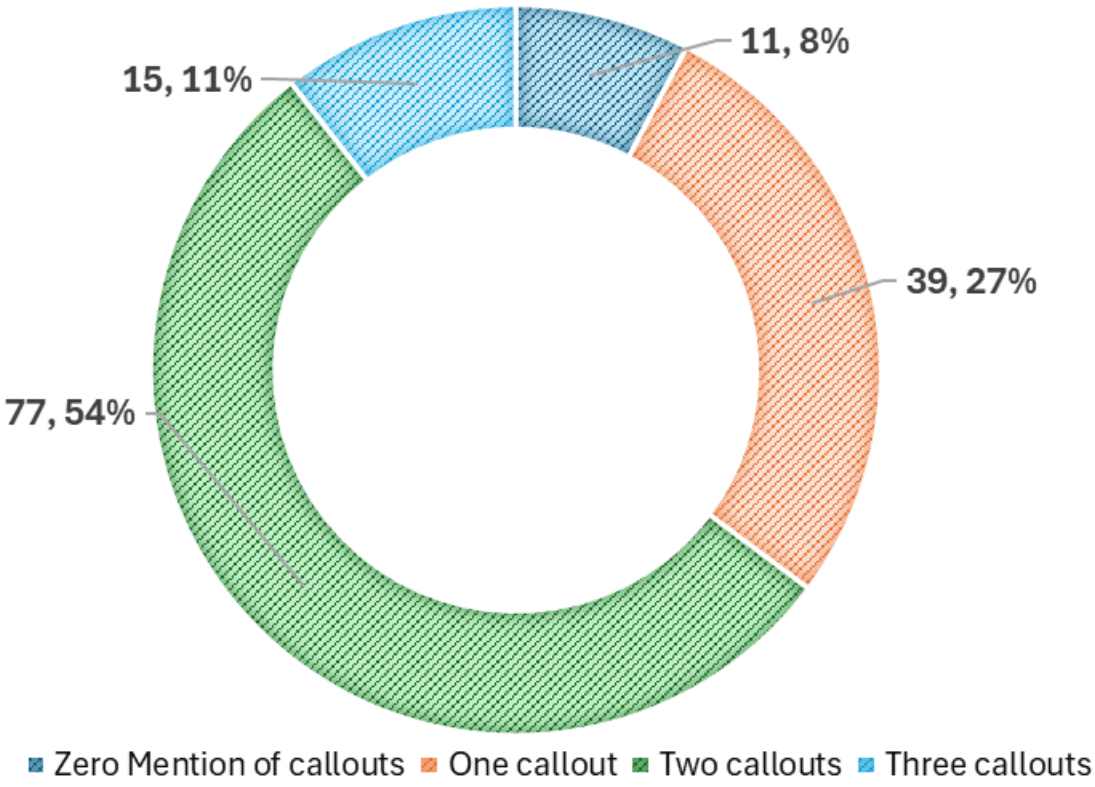


**Figure 2.** Distribution of the number of callouts by assignment

The frequent mention of the callouts shown in Table 2 suggests overarching priorities in urban planning, sustainability, safety, and technological integration. They reflect a future-focused approach where adaptability, resilience, and environmental considerations are at the forefront of the student's minds. From programmable infrastructure to green and adaptive urban systems, the emphasis aligns with a vision of smart but also sustainable and inclusive cities. The top 25 callouts with the highest frequency are shown in Table 2.

**Table 2.** Top 25 Callouts Mentioned in the Assignment by CM Students

| Callout Name | Callout Code | Frequency |
|---|---|---|
| Programmable Construction Sites | 279 | 14 |
| Green Infrastructure Overview | 158 | 9 |
| Delivery Drones Drop-off Space | 94 | 6 |
| Elevated Walkways | 119 | 6 |
| Urban Fire Suppression | 404 | 6 |
| Building on Top of Historic Structures | 50 | 5 |
| Noise Control Systems | 258 | 5 |
| Transportation in Adaptive Corridor | 395 | 5 |
| Adaptive Corridor | 7 | 4 |
| Integrated infrastructure | 189 | 4 |
| Multi-use Building Green Spaces | 250 | 4 |
| On-site Rainwater Harvesting | 259 | 4 |
| Temporary Housing | 381 | 4 |
| Urban Agriculture | 403 | 4 |
| Adaptive Corridor Core Sample | 10 | 3 |
| Anaerobic Digester | 29 | 3 |
| Automated Road maintenance | 36 | 3 |
| Biomimetic shade structures | 46 | 3 |
| Commerce and Services Happen in all Languages | 67 | 3 |
| Energy + Ag Sector Overview | 122 | 3 |
| Green Space in Adaptive Corridor | 159 | 3 |
| Historic Core Summary Overview | 171 | 3 |
| Home recycling 3D printers | 175 | 3 |
| Mixed-use High Rise | 231 | 3 |
| Riverwater Filtration | 332 | 3 |

Among these, the top occurrences include:

- Programmable Construction Sites (Code 279): This callout emerged as the most frequently mentioned topic with 14 occurrences. It significantly focuses on dynamic, adaptable, and automated construction methodologies where technological advancements drive efficiency and scalability.
- Green Infrastructure Overview (Code 158): Mentioned nine times, this callout reflects a major emphasis on integrating sustainable, environmentally friendly practices into infrastructure planning and development.
- Delivery Drones Drop-off Space (Code 94): With six appearances, this callout highlights designated zones or platforms for drone deliveries, ensuring streamlined and efficient last-mile logistics while minimizing disruptions in urban areas.
- Elevated Walkways (Code 119): Listed six times, this concept of elevated pedestrian pathways designed to enhance connectivity, reduce ground-level congestion, and provide safe, accessible routes in urban settings.

- Urban Fire Suppression (Code 404): With six occurrences, this topic highlights the critical importance of safety measures and infrastructure resilience against urban fire risks. Advanced fire prevention and control systems tailored for high-density urban environments. These systems include early warning sensors, automated extinguishers, and infrastructure to protect historical or vulnerable areas.
- Building on Top of Historic Structures (Code 50): Mentioned five times, this callout focuses on the practice of preserving historic buildings by constructing modern extensions above them, ensuring both conservation and the optimized use of urban space.
- Transportation in Adaptive Corridor (Code 395): Mentioned five times, this key concept focuses on integrating diverse modes of transportation, such as autonomous vehicles, public transit, and pedestrian pathways, into multifunctional corridors. It suggests a concentrated interest in mobility solutions tailored to urban areas.
- Noise Control Systems (Code 258): Also appearing five times, this callout highlights innovative technologies and materials designed to reduce urban noise pollution, such as sound-absorbing facades, smart barriers, and zoning strategies. It underscores the importance of creating quieter, more livable environments, emphasizing advancements in sound management technologies.

In addition to the callouts listed in Table 2, 32 additional callouts were listed twice, and the remainder of the 60 were mentioned once. Based on these 117 distinctive callouts and the observations of the points included in each, the general themes identified are shown in Table 3.

**Table 3.** Themes Identified

| Theme | Sub-theme | Observation |
|---|---|---|
| Technology and Automation | Drones | Multiple observations focus on the use of drones in various sectors, from fire suppression systems (students identify drones as a fire suppression method) to safety checks for structures (drones for bridge/skyscraper checks). These insights highlight drones as versatile tools for improving safety and efficiency in urban environments. |
| | Robotics and Labor | The potential for automation and robots to replace human labor is a recurring theme. Students express concerns about job displacement (e.g., threat to future jobs due to robots), while others point to the positive side, such as robots reducing labor costs in construction (modular housing and 3D printed structures). |
| | AI and Data Collection | The integration of AI into urban infrastructure is explored, especially in air quality monitoring systems (e.g., data collection for pollution) and the use of hybrid air quality systems. AI is also mentioned in integrating technology into a mega-city to improve efficiency (e.g., automated transportation systems). |

**Table 3**. Themes Identified (continued)

| Theme | Sub-theme | Observation |
|---|---|---|
| Sustainability and Environmental Impact | Energy Solutions | Several students discuss renewable energy sources like wind, solar, and nuclear. For example, nuclear energy is identified as a zero-emission solution to carbon emissions, while other students speak about the need for a sustainable energy system in urban environments, particularly waste-to-energy mobility and solar energy in skyscrapers. |
| | Green Infrastructure and Nature | Many students emphasize integrating natural plant systems and green spaces into urban designs. For example, biomimetic shades and green infrastructure are identified as ways to improve air quality and energy production (e.g., photosynthesis-like systems). |
| | Water Systems | There is a focus on the importance of sustainable water management, including river water filtration systems for mega-cities, decentralized water harvesting, and the reuse-recycle method (e.g., a farm expo using farm water for filtration). However, some students raise concerns about feasibility, especially with 3D-printed buildings and water systems. |
| Urban Planning and Mobility | Elevated and Automated Transportation | Multiple references mention eVTOLs (electric Vertical Take-Off and Landing vehicles) as crucial for future mobility in urban areas (e.g., the benefits of modular eVTOL systems), though some students express skepticism about their feasibility due to emissions or city population size. Additionally, students talk about dedicated walkways and elevated pathways that would improve safety and pedestrian access in megacities, ensuring smoother integration of larger transportation systems. |
| | Modular and Adaptive Infrastructure | Many students discuss the concept of modular living spaces that can adapt to various needs (e.g., lumbar support beds). This modularity also extends to construction, where lean construction methods help reduce waste and carbon emissions while expanding urban areas. |
| | Historic Preservation and Cultural Identity | Several students emphasize the importance of preserving historical buildings and cultural heritage in urban development. For example, supporting historic buildings in Paris and adaptive reuse are discussed as strategies to link the past with future urbanization. Students also highlight the costs of preserving these buildings, such as carbon fiber materials. |
| | Historical Core | The historical core of cities is seen as essential to maintaining cultural identity in the face of modernization (e.g., the historical core links our past to the future). |
| | Traffic and Pedestrian Safety | A common theme is the need for improved pedestrian safety in high-density urban environments. Elevated walkways are identified as essential to reducing pedestrian congestion on roadways and improving overall traffic flow. Students also discuss issues with robots freezing or overheating during construction, emphasizing the need for a robust infrastructure to support automation. |

**Table 3.** Themes Identified (continued)

| Theme | Sub-theme | Observation |
|---|---|---|
| Social Implications and Equity | Education | Students discuss modular education systems and equity in learning, emphasizing how personalized education can enhance students' learning experiences. They also suggest integrating multi-grade education within a single building to maximize space in mega-cities. |
| | Mental Health | Green spaces' mental health benefits are widely acknowledged (e.g., green spaces improve mental health in adaptive corridors), and noise control systems are noted as essential for reducing stress and improving overall well-being in urban environments. |
| | Language and Inclusivity | Several students highlighted the need for a universal translation system to bridge language barriers in a multicultural society. This would ensure interconnectedness in a world where migration and population growth will make such systems increasingly necessary. |
| Feasibility and Challenges | Challenges in Implementation | Many students raise questions about the practicality and feasibility of futuristic technologies. For example, 3D-printed skyscrapers are questioned due to their cost and limited use for the upper class, while aerial transport systems face skepticism regarding population density and infrastructure compatibility. |
| | Economic and Environmental Concerns | There are also concerns regarding the costs of implementing advanced technologies, particularly robotic labor in construction, modular housing, and sustainable energy solutions. Students note that while the potential for reduced labor costs exists, the initial investment and long-term maintenance could be prohibitive. |

The results emphasized construction management students' ability to critically evaluate futuristic concepts, balancing innovation with practicality and societal implications. In addition, our preliminary findings indicate that the FWV-based assignment inspired students to explore various futuristic construction topics, with a focus on technological advancements, sustainability, and innovative infrastructure. These results align with Bielefeldt's [4] observations, where students expressed increased interest in civil engineering after engaging with FWV scenarios. However, our study also revealed concerns among some students regarding job security and the complexity of future technologies, with a preference for low-tech construction methods. This contrasts with Tang's [9] observations, where graduate students were more inclined toward embracing advanced technologies. The discrepancy may be attributed to differences in academic levels and exposure to technological concepts. Moreover, the reflections of the coders underscore the importance of iterative review, methodological flexibility, and attention to detail in qualitative content analysis [7].

## Conclusion and Future Work

This paper makes a distinctive contribution to using digital tools and virtual reality models to engage students in complex, forward-thinking scenarios. The focus on student interaction with specific FWV callouts provides valuable insights into how virtual environments can enhance

engagement and learning outcomes, particularly in introductory courses. This paper's main contribution is its focus on how students from Architecture Engineering and Construction (AEC)-related fields engage with futuristic built environments. The fresh perspective from Construction Management students adds a new dimension to the educational discourse, offering a unique viewpoint on the future of the AEC industry. Furthermore, the analysis revealed key themes and insights:

- Students frequently emphasized sustainable and automated construction efforts. These callouts resonated with the vision of simplifying complex projects while enhancing safety. Automated traffic systems and construction processes stood out as pivotal themes, reflecting students' awareness of the benefits (e.g., reduced jobsite accidents) and challenges (e.g., potential job displacement).
- Students' enthusiasm for modular housing, automated transportation, and green infrastructure was present in their assignments. Their reflections balanced optimism for these innovations with criticisms of their feasibility, cost, and societal impacts, particularly concerning equity and accessibility. This demonstrated a nuanced understanding of the interplay between innovation and real-world constraints.
- Sustainability emerged as a unifying concern. Students recognized the importance of addressing climate change through renewable energy, green infrastructure, and self-sustaining buildings. Their responses underscored a collective prioritization of environmentally conscious urban planning.

It is important to note some limitations, such as students predominantly selecting similar callouts that are potentially influenced by the initial starting points in the virtual platform. This repetition suggested a need for greater variability in assignment structure to capture a broader range of insights. Despite this, students demonstrated a strong grasp of the callouts, leveraging their academic and professional backgrounds to provide thoughtful critiques and contextually relevant observations. Another limitation of our study is its focus on a single cohort of first-year students, which may not capture the full spectrum of perspectives across different educational stages.

Future research should consider longitudinal studies to assess how students' perceptions evolve throughout their academic careers. Future research could also be conducted to determine the lasting impacts these educational innovations have on student retention and choices of career. Additionally, seeing how integrating FWV works in different education settings and with different types of students could be greatly enlightening to their application. Through these instructional innovations, creativity, interdisciplinary thinking, and sensitivity to societal influences, civil and construction engineering, and management education may be positioned to take on an entirely new dimension, preparing the minds of a new generation of engineers.

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