



What Got Us Here, Won't Get Us There

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Looking beyond Human Centred Design approach for bettering lives of Construction Workers in India

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Abstract: It is anticipated that close to 7 billion people will call a city their permanent home by the year 2050, as stated in documented databases such as the Central Intelligence Agency (CIA), Our World in Data and the World Bank's World Development Report. We estimate that there will be around 7.95 billion people living in the world in the year 2022, with 4.54 billion residing in urban areas and 3.42 billion in rural areas. Over 51 million people are employed in the construction business across the United States, making it one of the major industries in terms of employment in recent years. The construction business in India is responsible for the employment of more people than any other single sector. Estimates provided by the most recent Periodic Labour Force Survey (PLFS) 2019–20 suggest that there are approximately 1.1 million people employed in the construction industry in Delhi, which is known as the capital of migrants and a city of opportunities. This is due to the fact that the percentage of the population that is employed in low-income countries is significantly larger than in high-income countries.

The pressure to find an immediate job in order to meet the financial requirements of a family of three or four has resulted in an increase in the number of people in India who are working in the construction industry. Despite the fast growth of the construction industry, neither the administrative apparatus of the government nor the employers on the job sites have kept pace with the steadily improving standard of living experienced by construction employees. Migrant construction workers are frequently put in perilous situations, suffer from illness, are subjected to a significant amount of harassment, and have a poor quality of life while working.

This qualitative and experimental study sheds light on the precarious circumstances in which construction employees find themselves and how technology might benefit their wellness and lifestyle on the job site. Specifically, the study focuses on how technology can assist construction workers in maintaining a healthy lifestyle while on the job. Because of advances in technology, human-centred design can now be carried out on a very global as well as a very tiny level, sparking empathy at every stage.

Keywords: Construction Industry, Construction Workers, Quality of Life, Unskilled Workers, Exploitation, Technological Aid, Design Thinking

1. Introduction

The construction labourers' issue in Delhi is a significant concern due to the booming construction industry and the influx of migrants from various backgrounds. These labourers, who predominantly come from low-income households and lack formal education and skills, face numerous challenges upon arrival in the city. The following analysis aims to explore the scope of the problem and shed light on the conditions faced by construction labourers in Delhi.

- **Exploitation and Vulnerability:** Construction workers in Delhi, especially those from migrant backgrounds, are often subjected to exploitation. Their lack of education and skills, coupled with their desperate need for employment, makes them susceptible to unfair wages, long working hours, and hazardous working conditions. Many workers are unaware of their rights and are unable to assert themselves due to their vulnerable status.
- **Living Conditions:** Migrant construction labourers typically live in makeshift housing provided by construction companies or in nearby locations. These accommodations are often substandard, lacking proper sanitation facilities and basic amenities. The living conditions further exacerbate the challenges faced by these workers and their families.
- **Lack of Social Security:** Due to their unorganised status, construction labourers in Delhi are deprived of social security benefits such as health insurance, pension schemes, and access to formal banking services. In the event of accidents, injuries, or health issues, they often struggle to receive adequate medical care and financial support.
- **Skill Development and Upward Mobility:** The lack of education and skills among construction workers limits their opportunities for upward mobility and career growth. Without access to training programs and skill development initiatives, they remain trapped in low-paying jobs with limited prospects for improvement.
- **Urbanisation and Rapid Growth:** Delhi's rapid urbanisation and booming construction industry have contributed to a large influx of construction labourers. The city's infrastructure development, including residential and commercial projects, requires a substantial workforce. However, the sheer magnitude of construction activities puts additional pressure on the existing labour force, leading to increased competition and potential exploitation.
- **Policy and Legal Framework:** While India has enacted laws and regulations to protect the rights of workers, the implementation and enforcement of these laws remain a challenge. Additionally, the lack of comprehensive policies specifically addressing the concerns of construction labourers in urban areas adds to their vulnerability.

Addressing the issues faced by construction labourers in Delhi requires a multi-faceted approach involving various stakeholders. Efforts should focus on providing formal education and skill development programs to enhance employability, ensuring fair wages and decent working conditions, and extending social security benefits to this marginalised workforce. Collaboration between government authorities, construction companies, NGOs, and labour unions can play a crucial role in improving the lives of construction labourers and creating a more equitable and inclusive construction industry in Delhi.

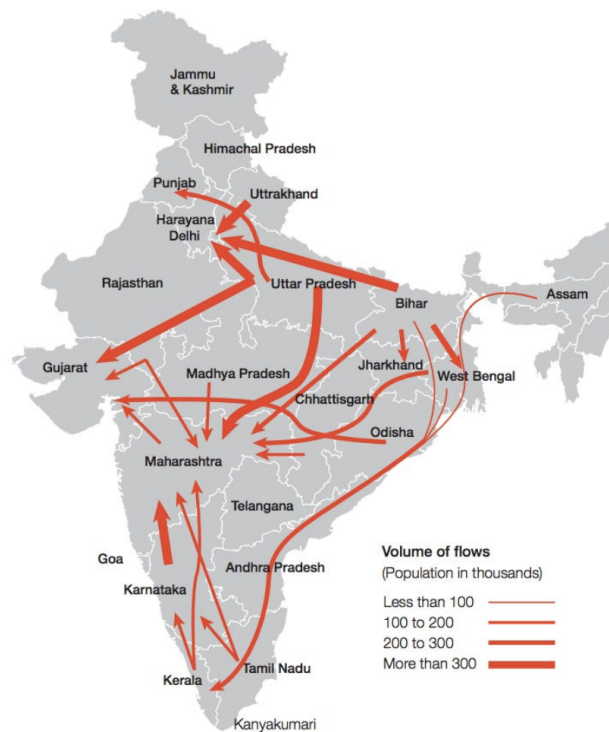


Fig 1. Map showing migratory patterns in India, Migration Policy Institute, 2014 & Kashyap, 2016

2. Literature review

As a result of this, migration within India from one state to another has become so common that its effects can now be seen in every sphere of life. Many people who are unskilled or just partially skilled are forced to migrate since it is difficult for them to obtain better work in their home country or neighbourhood. As a result, migration becomes a way of life for some people. These migratory labourers may be found in any region of the nation, no matter its breadth or length. The rapid urbanisation and industrialization of the regions has resulted in an increase in the number of job prospects as well as the construction of improved infrastructure. People go to these areas because they believe they provide better opportunities and living conditions. The population of India, as per the census taken in the year 2001, was estimated to be 1028 million. According to the Indian Labor Statistics 2011, there were 309 million people in the nation who were migrants in 2001. This is around 30 percent of the overall population of the country. The preliminary statistics from the 2011 census showed that the country's population reached 1210 million, and as a result, it is believed that the migratory population would be more than the number counted in 2001. (Census 2011). As for 2021, the census has not been carried out due to the COVID-19 pandemic in India and has been shifted to 2023.

The construction sector is the single biggest employer of migrant labourers in Indian cities. These workers are among the poorest of the poor (Karmayog, 2010). The only way for millions of unskilled porters, bricklayers, and other low-caste workers to escape the acute poverty of rural life and find work is to leave their home villages and go to larger cities. These migratory labourers may be found all across the nation and often bring their families with them when they move from one location of employment to another. They reside in temporary settlements for the length of the construction project, which are occasionally supplied by the construction firm, and then relocate to another location when the project is complete. They typically are members of the most impoverished segment of the population, and the vast majority of them are illiterate. Due to the fact that they are migrants, they are not registered, and as a result, they are denied fundamental governmental

amenities (Pratham 2009). Women and children have traditionally played a role as "associated" migrants in the construction industry migration pattern within India; nonetheless, the major choice to move is often made by the head of the family, who is typically male. Women who migrate as part of a family unit are more susceptible to exploitation since the region to which they relocate offers them fewer economic opportunities and less social support (Chandrima B.C., 2010).

Another brilliant example is DOME which celebrates a modular solution to help reduce homelessness. It provides bridge housing to the unsheltered. It provides a secure environment for homeless individuals while they try to find permanent housing. This LA based firm states that, "more than 500,000 Americans are homeless. Of that total, more than one-third of those homeless-35%- is unsheltered. And 47% of all unsheltered homes live in California, which is four times higher than the state's 12% share of the U.S. population". This particular prototype has been installed in LA Architecture & Design Art Museum, where interested parties can evaluate its design, construction and utility, and offer comments (Caulfield John, 2019).

As per the schemes by the Ministry of Housing and Urban Affairs, which promote and help with affordable rental housing complexes for the ease of living for urban migrants and the poor, they are still in a very nascent stage of execution. Many NGOs and Anganwadis are taking initiatives for big construction sites that go on for long durations, say over 5 years, where they take in children and teach and educate the mother about hygiene, sanitation, and the well-being of everyone. Harshdeep Singh Puri, Minister of Housing and Urban Affairs, expresses serious concerns over the pathetic living conditions of a large number of construction workers. He noted that the law provides for various facilities for them but is not being complied with by the builders.

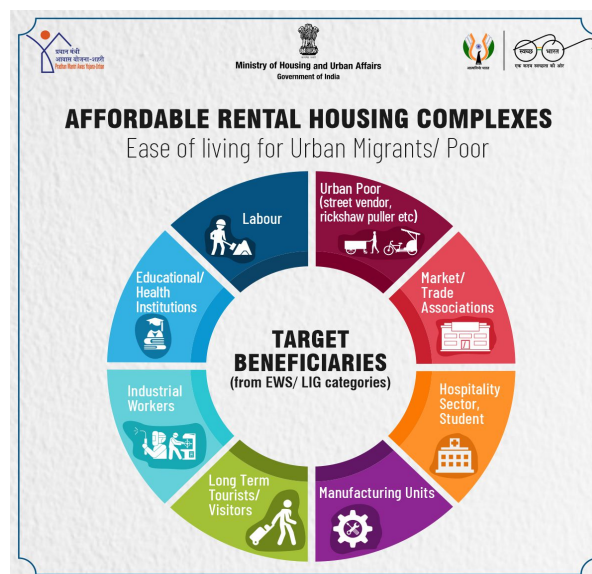


Fig 2. MOHUA Affordable Rental Housing Complexes, 2015

The implementation of technology, such as Augmented Reality (AR) and Virtual Reality (VR), has the potential to significantly improve the lives of construction workers on-site. These emerging technologies offer various applications that can enhance worker safety, efficiency, and overall well-being.

One of the primary benefits of AR and VR in construction is the ability to provide workers with enhanced training and education. Through immersive simulations and virtual environments, construction workers can receive hands-on training for complex tasks and hazardous scenarios, improving their skills and knowledge without exposing them to real-life risks. This not only enhances worker competency but also reduces the likelihood of accidents and injuries on construction sites.

AR can be utilised to overlay virtual information onto the real-world environment, providing workers with real-time guidance and instructions. For example, workers can wear AR-enabled headsets or use mobile devices to view digital overlays that indicate precise measurements, equipment operation procedures, or structural information. This aids in accurate construction execution, reduces errors, and minimises rework, ultimately improving worker productivity and project efficiency.

Additionally, AR and VR can facilitate remote collaboration and communication among construction teams. Workers can use AR tools to share their perspectives, markups, and annotations in real-time, enabling effective communication and coordination across different stakeholders involved in the construction process. This helps to reduce misunderstandings, delays, and conflicts, leading to smoother project execution.

Furthermore, the implementation of AR and VR can enhance worker safety by providing real-time hazard detection and visualisation. For instance, AR-enabled devices can highlight potential safety hazards, such as live wires or unstable structures, in the workers' field of view. VR can simulate dangerous scenarios, enabling workers to practise emergency protocols and evacuation procedures in a controlled environment.

Moreover, AR and VR technologies can contribute to improved worker well-being by reducing physical strain and fatigue. For instance, AR-powered exoskeletons can assist workers in lifting heavy objects, reducing the risk of musculoskeletal injuries. VR can also be used for relaxation and stress reduction during breaks, providing workers with virtual environments that promote relaxation and mental rejuvenation.

While the potential benefits of AR and VR for construction workers are substantial, it is important to address potential challenges, such as the cost of implementation, accessibility, and training requirements. Nonetheless, with proper planning, investment, and integration into construction processes, AR and VR have the capacity to revolutionise the construction industry, making work environments safer, more efficient, and ultimately enhancing the lives of construction workers on-site.

Here are some examples of how Augmented Reality (AR) and Virtual Reality (VR) are being used in the construction industry:

Virtual Design and Visualization: AR and VR technologies enable architects, engineers, and construction professionals to visualise building designs in a virtual environment. They can walk through virtual models, explore different design options, and make real-time modifications, enhancing the design process and reducing errors before construction begins.

Safety Training and Simulations: AR and VR provide immersive and interactive training experiences for construction workers, allowing them to practise safety procedures and simulate hazardous situations without real-world risks. This technology helps improve safety awareness, response times, and decision-making on construction sites.

On-site Assembly and Maintenance Assistance: AR systems can overlay virtual information onto physical structures, guiding construction workers during assembly and maintenance tasks. For example, workers can wear AR glasses that display step-by-step instructions, annotations, and warnings, improving accuracy and efficiency in complex construction processes.

Clash Detection and Coordination: AR and VR technologies facilitate clash detection by overlaying virtual models onto the physical construction site. This enables project teams to identify clashes or conflicts between building systems, such as electrical and plumbing, before construction begins, saving time and cost associated with rework.

Remote Collaboration and Communication: AR and VR enable real-time collaboration among stakeholders, regardless of their geographical location. Project teams can virtually meet, review designs, and make decisions together, enhancing communication and reducing delays in the construction process.

Client Presentations and Marketing: AR and VR provide immersive experiences for clients, allowing them to virtually explore and interact with proposed building designs before construction. This enhances client understanding and satisfaction, streamlines decision-making, and improves marketing efforts for construction companies.

Facility Management and Maintenance: AR and VR technologies can be used for facility management tasks, such as maintenance and repairs. By overlaying digital information onto physical assets, maintenance technicians can access equipment manuals, view repair history, and receive real-time guidance, increasing efficiency and reducing downtime.

These examples demonstrate the potential of AR and VR technologies to improve various aspects of the construction industry, from design and safety training to collaboration and maintenance. Continued advancements in AR/VR technology are likely to further enhance construction processes and the overall well-being of construction workers.

3. The International Construction Industry

Like the word "migrant," "construction industry" refers to a very broad field. It is mostly made up of craft, professional, and industrial services that have to do with building, tearing down, fixing up, and maintaining built environments. In many places, there are three main types of construction markets: civil construction, industrial construction, and residential and commercial construction (e.g., single-family dwellings, office buildings, condominium developments). In terms of jobs, the sector has a wide range of professional, managerial, technical, and manual jobs, such as architects, engineers, and project managers, as well as carpenters, electricians, steel fixers, and general labourers. The size, structure, and market reach of construction firms can also vary a lot. The biggest companies, like the French multinational Bouygues Construction, which employs 130,000 people in over 80 countries, can make billions of dollars every year. The smallest contractor firms, on the other hand, can focus on a small area and hire "as many men as will fit in a van," as one Toronto contractor put it. In fact, construction markets are often "bottom heavy," with a small number of very large firms and a large number of mid-size (>100 employees) and small (>20 employees) firms. The next section only talks about four things about the global construction industry: There is a lot of concentration at the top, subcontracting of services at the "bottom end," it can't be separated from informal economies, and the market tends to be unstable.

Construction is a big part of the world economy and one of the biggest employers in the world. On average, 5–10% of the formal sector workforce in most countries works in construction (Bosch and Philips 2003; Martin 2009). This is because productivity gains from mechanisation, automation, or prefabrication haven't been as big as they have been in industries like auto-manufacturing, which use a lot of people. Because of this, construction tends to be one of the largest industries in many economies, both in industrialised and developing countries.

3.1 Illustrating Technological Variations In Construction Work

- **The United Arab Emirates (UAE)**
The ever-increasing influence that technology has on the construction industry in Dubai. The building sector and other ambitious initiatives in Dubai have earned it a reputation as a global construction hub. Because of the implementation of cutting-edge technologies, the city's construction industry has experienced phenomenal expansion over the course of the past several years. Because of advancements in technology, Dubai has been able to preserve its status as one of the most cutting-edge cities in the world.

The building industry in Dubai is able to develop at a rate that is both faster and more efficient than it has ever been before because of the assistance of cutting-edge technologies such as 3D printing, robots, and artificial intelligence. While guaranteeing that all projects are finished with precision and quality, Dubai is able to maintain its amazing expansion in this industry thanks to the use of these technologies. The Dubai Government has made significant progress towards implementing cutting-edge and forward-thinking technology in the region's construction sector. With the assistance of emerging technologies, the government of the UAE has set a goal to transform the building sector into one that is entirely sustainable by the year 2030. With all of these endeavours, there is still more growth to come in the building industry in Dubai with regards to technology!



Fig 3. Indian migrants in UAE, K.Hemlata, 2017

- Thailand:

At this point in time, data is driving everything that happens. The construction sector will inevitably have to come to terms with the fact that data is driving their industry as a result of the rapid pace of technological advancement. However, in comparison to other industries, the construction industry presents unique challenges when it comes to the introduction of new technologies. Big data technology, which has an effect on the construction industry, is being utilised in Thailand's efforts to better the country. It is crucial, as a result, that the use of big data technology to construction management be at an advanced readiness level. This study took a qualitative method to determine the readiness factor of the Thai government to implement big data technologies for construction management purposes. As a means of conducting the research, questionnaires of a semi-structured kind and interviews were utilised. A sampling strategy based on convenience led to the selection of more than seven government personnel as Key Informants (KIs). The KIs have been employed in a variety of government agencies, each in their own speciality within the field of information technology. In order to analyse the data, both typology and transcribed analysis were utilised. According to the findings, the Thai government has been working on putting in place the infrastructure necessary to accommodate big data technology. However, in light of the fact that the government has recently introduced a new strategy for the nation, the technological and organisational aspects that need to be addressed are causes for concern. In order to comply with the new regulation, government agencies will need to initiate the use of big data technologies to assist them in their work.



Fig 4. Thailand Construction stay camps, Human Rights Watch, 2010

AR/VR technology is being increasingly utilised in international construction sites to enhance productivity, safety, and collaboration among workers. Here are some examples of how AR/VR is being used in the international construction industry:

- **Design and Visualization:** AR/VR enables construction professionals to visualize and interact with 3D models of buildings and infrastructure projects. This technology allows stakeholders to assess the design, identify potential issues, and make informed decisions before construction begins. It improves design accuracy, reduces rework, and ensures better project outcomes.
- **Virtual Site Walkthroughs:** AR/VR can simulate virtual site walkthroughs, allowing workers to experience the construction site before physical work starts. This helps in understanding site logistics, identifying safety hazards, and optimizing construction processes. It also aids in training workers on site-specific procedures and equipment operation.
- **Remote Collaboration:** With AR/VR, teams working on international construction sites can collaborate effectively, regardless of their physical locations. Using virtual meeting platforms, stakeholders from different parts of the world can view and discuss project designs, resolve issues in real-time, and provide remote guidance to on-site workers. This improves communication and decision-making efficiency.
- **Safety Training and Simulations:** AR/VR technology provides a safe and controlled environment for training construction workers in hazardous scenarios. Immersive simulations can replicate dangerous situations, such as working at heights or handling heavy machinery, allowing workers to practise safety protocols and emergency responses without real-life risks. This enhances worker safety and reduces accidents on construction sites.
- **Equipment and Machinery Operation:** AR/VR can be used to train workers in operating complex construction machinery and equipment. By overlaying virtual instructions and guidance onto the real-world equipment, workers can learn proper usage, maintenance, and troubleshooting techniques. This improves efficiency, minimises errors, and reduces equipment downtime.

- **Quality Control and Inspection:** AR/VR technology can aid in quality control and inspection processes on international construction sites. By overlaying digital information onto physical structures, inspectors can compare as-built conditions against design specifications, identify deviations, and document construction progress. This ensures compliance with standards and facilitates efficient project monitoring.
- **Augmented Work Instructions:** AR can provide real-time visual instructions and guidance to workers on-site. By wearing AR-enabled devices, workers can access relevant information, such as assembly instructions, safety guidelines, or equipment manuals, in their field of view. This improves accuracy, reduces errors, and enhances worker productivity.

These examples highlight how AR/VR technology is transforming international construction sites by improving collaboration, safety, training, and efficiency. As the technology continues to evolve, its applications in the construction industry are expected to expand further, driving innovation and advancements in the field.

4. Research Design

This particular research follows qualitative and observational experimental research methodologies. In order to ensure the authenticity and validity of the findings, the study followed a case study methodology followed by a structured survey. There were many construction workers, including Beldaars(helpers), Mistry, Guards, and Wives, as well as a few young children aged around 12 from four different construction sites. There were about 50 total workers who were informally interacted with. The entire research has been ongoing for about 3 months now. The workers are assured of the anonymity of the respondents and the complete confidentiality of the information that will be shared. The data thus generated is subjected to classification and grouping, though the study is qualitative in nature. Considering the close similarity of the replies, grouping is done and 10 interviews have been mentioned in the appendix section. No statistical tool was implemented for analysing the data since the purpose of the study was to understand the severity of the problems alone.

4.1 Case Study (From Author's Onsite Journals)

There were many interactions with the workers, and one of them really stuck in my memory. He had been in the industry for over 22 years. He is now 42 years old and comes from Dhanbad, Bihar. His major work on site is waterproofing. He needs to take care of underground and overhead water tanks. Being in Delhi for over 18 years, he has now been able to set up his own house, a kuccha house, which is in Nangloi, West Delhi. His work can be very labour-intensive. His son, who is 22 years old, also assists him with work. His wife resides in Bihar, and the father is only able to visit them once or maybe twice a year if all works out for him. When his son was not yet born, he had seen tough times and used to earn his living in tough conditions. He now values the system of "roti, kapda, and makaan." They do not live on site and travel almost 3 hours to work, or wherever the site is located. If the work is more, they live on site and have the bare minimum arrangements.

Then there is a 29-year-old headmaster coming from Bihar. He came to Delhi when he was 15 years old and has been working in this line ever since. He mentions this line as being very superior, as they are making someone's abode. He usually stays on site. His work ranges from 8 to 10 hours daily. He is responsible for brick work, shuttering, and interior works. He has to manage his food by himself. His accommodations are improvised, with bedding made of cement bags or ply supported by bricks beneath, and a small burner connected to a gas cylinder. He says, "I am still gaining knowledge and would like to have a small, decent setup to live in."

Many more were later added. "Since we do not have any identity of our own and come from the informal sector, we are treated poorly for both of these reasons." Within the construction site, we are living in a temporary dwelling that was provided for us by the general contractor. As soon as the job is done, we have to leave the location where it is being done. The contractors only have space available for two to three individuals in the temporary housing they are providing. The modest room that was provided as temporary lodging must be used for all tasks, including the preparation of food, sleeping, and other daily routines. Due to the fact that this is just a temporary living arrangement, the roofs and walls are fashioned out of tin sheets. It is difficult to remain in this temporary home during the summer because the temperature rises to uncomfortable levels, and it is also difficult to stay in this house during the rainy season because water pours into the house. Because of this, we don't have many options when it comes to negotiating, so we simply stick with the alternative that the contractor has provided. The vast majority of working individuals only need to put in 8 or 9 hours of labour each day. However, in the construction sector, in order to meet the deadlines, the employees are required to put in lengthy hours of labour (11–13 hours).

Despite the fact that power facilities have been made available for the building project, the temporary dwellings that have been built on the construction site do not have electric supplies. During the night, the workers are required to rely on candlelight or lamps powered by kerosene in order to carry out their duties toward their families. It has been stated by the contractors that they are unable to temporarily organise all of these amenities for the employees because of the nature of their employment as construction labourers, which requires them to relocate from one place to another. In addition, there is no guarantee that the workers will be employed by the same contractor for any future work that may be performed. The construction business is seeing higher rates of worker turnover, with many employees opting out of working in the construction industry in favour of jobs in other industries. So, the contractors are the only ones who can meet the most basic needs of the workers on the construction site.



Fig 5. Shuttering for slab casting, Saxena, 2023



Fig 6. Brick laying by Mistry with helper(wife), Saxena, 2023



Fig 7. Labour camp sleeping provision by L&T, Saxena, 2023



Fig 8. Makeshift temporary housing on site



Fig 9. Guard's bed with cooking arrangement.



Fig 10. Sleeping arrangement for 2 helpers on site.

5. Research Findings

Major findings of the study can be stated as follows:

- Unorganised workers lose fair wage negotiating. Even agreed upon salaries are not paid on schedule. Even after construction is complete, builders and contractors are continuously looking to consume due pay.

- Their hours are not well regulated. No overtime pay. They work dangerously. Sites have poor working conditions and amenities. Safety standards are not satisfactory. There is no financial and medical help in case of accidents. Treatment is up to the employees. Nobody is responsible for deaths on site.
- Apart from this, there is no recreational facilities, no availability of drinking water, toilets, canteen, etc.
- Female employees face more issues at work and when commuting. Especially pregnant or with young children. No mechanism exists to care for children at work. They can't take leave at this time or they'll suffer financial hardship.
- Living circumstances don't beat working conditions. The problem is likely becoming worse. They'll live in slums without municipal facilities. Unhygienic environment. No drainage, toilets, potable water, power, recreation, etc. No nearby hospital, school, or discount store.
- Construction employees have no social security or Labor welfare protections & guarantees. They lack pensions, insurance, maternity leave, accident and death claims, concession loans, and education and medical help for children.
- An amount of Rs 1000/- is paid to the workers by contractors every week for their food and other necessities. As they are living in south delhi, the expenses are quite high and savings become a hassle. An average of Rs 18,000/- comes to the Mistry and around Rs 12,000/- comes to the wife. A total of Rs 30,000/- comes to the family, in which they have to manage their living, eating and other expenses.

It has been shown that between 100 and 200 workers make up 66.7% of all construction enterprises. The majority of those who work in construction make their homes in tin sheets (71.5%), rubber sheet sheds (17.8%), or huts (10.7%). Within the construction site, Builder Company planned for a temporary shelter to be provided to workers (22.8%). The vast majority of construction workers, almost 66 percent, have erected makeshift homes for themselves close to active construction sites.

It was also determined that the salary structure for construction workers was insufficient when taking their work into account. The daily salary for the vast majority of employees is between 500 and 600 rupees. In this part of the research, a differential pay structure was identified between skilled and unskilled workers. The salary ranges between 300 and 500 rupees (Rs) per day for unskilled labour.

The construction employees do not have access to any facilities for taking time off. Construction workers at certain firms are eligible for unofficial medical leave and maternity leave from their employers. The vast majority of construction sites do not have a policy regarding holidays. The construction crew had very erratic schedules in terms of their hours worked. Even though most construction sites have shifts that last between eight and eleven hours,

The building site does not provide the workers with food that is good for them to eat. The vast majority of businesses do not provide proper nourishment for the employees that work for them. The daily diet often consists of dal, roti, rice, and other vegetables.

Female workers are expected to care for the household and prepare meals in addition to their primary responsibilities. The construction businesses do not provide creches for the employees' children to use during work hours. The vast majority of youngsters are seen roaming about the location while their parents are working there. Given their young age, there is no one to look after these children and ensure that they have improved access to education, healthcare, and care. Many concerns, including frequent relocations from one location to another, economic challenges, and other similar issues, were highlighted by construction employees as obstacles to providing a higher education for their children.

5. Implication Of Technology

The situation of construction employees in India is made abundantly evident by the survey shown above. Many ordinary people are drawn to industry because it offers work opportunities. However, the real story is rather different. These building contractors and subcontractors are committing high-level crimes against disorganised nomads who are working on construction projects. The employees in the construction business are not covered by several acts, such as the Factory Act, which protects the workers' quality of life in other industries (such as firms and factories). Long working hours, inadequate living conditions, infrastructure, a lack of health and safety precautions, atrocities committed against female employees, and the uneducated state of the majority of the population are all problems. Children of construction workers, insufficient compensation considerations, and poorly structured pay and salary structures call for more attention from the government as well as non-governmental organisations to act in this situation, improving the overall quality of life for those individuals in these groups of the population.

While AR and VR technologies primarily focus on design, visualization, and collaboration aspects in the construction industry, there are several other technological advancements that contribute to the well-being and better living conditions of construction workers. Here are a few examples:

1. **Modular Construction:** Modular construction involves the use of pre-fabricated building components that are manufactured off-site and assembled on-site. This method reduces construction time, improves efficiency, and minimizes disruption to workers' living conditions by reducing on-site construction activities.
2. **Smart Wearables:** Construction workers can benefit from smart wearables such as safety vests or helmets embedded with sensors. These devices can monitor workers' vital signs, detect fatigue or hazardous conditions, and send real-time alerts to prevent accidents and ensure workers' well-being on the construction site.
3. **IoT-Enabled Facilities:** Internet of Things (IoT) devices can be used to create smart facilities on construction sites. For example, connected sensors can monitor air quality, temperature, and humidity levels in temporary worker accommodations. This helps ensure a comfortable and healthy living environment for construction workers.
4. **Mobile Apps for Worker Support:** Mobile applications can be developed specifically for construction workers to provide essential support. These apps can offer information on safety protocols, training materials, healthcare resources, emergency contacts, and access to counseling services, promoting workers' well-being and overall quality of life.
5. **Drones for Site Inspections:** Drones equipped with cameras and sensors can be used to conduct site inspections, monitor safety conditions, and identify potential hazards. By reducing the need for manual inspections at heights or in hazardous areas, drones contribute to the safety and well-being of construction workers.
6. **Robotics and Automation:** Robotics and automation technologies are being implemented in Australia's construction sites to improve productivity and safety. Robotic systems are used for tasks like bricklaying, concrete spraying, and 3D printing of building components. Automation helps in reducing labor-intensive work, enhancing precision, and increasing construction speed.
7. **Off-Site Construction Facilities:** Constructing dedicated off-site facilities that provide clean and comfortable living conditions for construction workers can greatly improve their well-being. These facilities may include proper accommodation, sanitation facilities, recreational spaces, and amenities like healthcare clinics and educational centers.

8. **Green Building Practices:** Implementing sustainable and eco-friendly construction practices can contribute to the well-being of construction workers. Green buildings with features like energy-efficient systems, natural lighting, proper ventilation, and the use of non-toxic materials create healthier and more comfortable working environments.

By integrating these technological advancements and practices into the construction industry, the overall well-being and living conditions of construction workers can be significantly improved, promoting their health, safety, and quality of life.

6. Indigenous Design Thinking as a tool for Sustainability

Despite facing challenges as they live a precarious life they are brilliant design thinkers and have a working mind. The quick response to one of their problems which can be illustrated is, that their sleeping condition on site is quite a hassle. The workers generally use foam sheets, cardboard sheets as their mattress surface. These surfaces have to be dealt with all extreme weather conditions, ranging from rains, to dropping temperatures, due to which these surfaces get wet or soiled easily. The quick response to this problem was to locate material on site which could prevent moisture from settling and also make a cushioned effect. They instantaneously do makeshift arrangements with sand, saw dust, wood chips, lying waste and mixed everything up and made cushion like mattress and then added the foam/cardboard sheet on top of it, this prevented the mattress from being in direct touch with the concrete slab. "Jugaad " as one calls it in India- This juxtaposition of the materials resulted into sustainable deployments, used on the site and then will be buried in the earth in the construction process within the site. This not only increased the life of that particular material but had a full/complete life cycle and inturn resulted in reducing the carbon footprint.

One of the rising concerns on any construction site is mosquito breeding.

Machar-dani(mosquito nets) is one of the solutions, others are burning egg crates, heavy fumigation for pest control, and applying ointments(Odomos). These are effective but temporary. Gas cylinders are majorly used for cooking. Those construction workers, who cannot afford cylinders, stick to the sustainable method by either using bricks or mud, to make their stove/bhatti. Such indigenous thinking helps them to stay close to their idea of self and also helps reduce carbon footprint indirectly, as mostly everything is reused. Their transport too contributes to reduction of the carbon footprint as they majorly use public services, like trains and buses or prefer walking when they have to travel to nearby sites.

All these novel and indigenous methods by Indian construction workers are helping in significantly reducing carbon footprint from construction industry which currently constitutes to 40% carbon dioxide emissions globally.

6.1 HCD-AVR as a tool

Mimicking their practices to better aid the solution, helped me realise that their way of living/lifestyle maybe crude and raw, but is sustainable and falls under "Simple living and high thinking". Design thinking is targeted as a human centred approach to innovation. In recent times it is mostly seen and hyped within the domains of technological developments such as AI or VR and AR and their consequent impact on human-environment interaction. Human Centred Design enhances, effectiveness and efficiency, improves human well-being, user satisfaction, accessibility and sustainability which will only come with a well balanced approach of merging technological interventions and social innovation, where the stakeholders (builders, contractors, government officials) will gain from the technological intervention of AI/AR/VR which will allow them to have an empathetic approach towards the workers. They will be able to observe their

condition in a more immersive experience. Using this as an empathetic tool, drawing parallels would be relatable to what the workers are going through and how a product intervention in this social domain would be helpful. A further study of MR (Mixed Reality) can also be ventured.

6.2 Social AVR Applications

To create more empathy and contextualise the lives of those in need for donors, some non-profit organisations are using VR to move visitors into life inside refugee camps. This creates increased engagement and more willingness to support their initiatives. An idea like this could create a shift in the VR design work done by large brands into a non-profit space.

Research has shown in different kinds of VR interventions during the last two decades that immersive experiences can increase components related to empathy in particular conditions. However, meta-analysis studies revealed that "VR was no more effective at increasing empathy than less technologically advanced empathy interventions such as reading about others and imagining their experiences" (Martingano et al., 2021). It has been demonstrated in VR research that in particular and experimental conditions alterations to one's digital self-representation can have a significant impact on how a person behaves in a virtual environment and that affects also its behaviours and attitudes fostering some of the qualities of empathy (Yee and Bailenson, 2007; Fox et al., 2013; Peck et al., 2013; Banakou et al., 2016; Kruzan and Won, 2019). Similarly, virtual perspective-taking through VR has been shown to be an effective method for changing behaviours and reducing negative social stereotyping and implicit biases (Yee and Bailenson, 2006, 2007; Hofer et al., 2017; Van Loon et al., 2018; Ventura et al., 2020).

6.3 AVR for Equity and Inclusion

As the technology behind AR/VR develops and a more diverse group of people try it out for the first time, new opportunities to use it to promote equity and inclusion emerge. Utilising AR/VR's potential as an empathy tool, tailoring its extensive capabilities to meet the needs of users with disabilities, and reducing barriers that arise from physical distance to strengthen communities and enhance person-to-person interactions across locations are three key areas where AR/VR can contribute to broader equity and inclusion efforts.

When compared to other digital options, AR/VR stands out due to its ability to transport the user to any location or situation. Augmented reality allows users to see and engage with environmental changes as they happen. And with VR, a user is completely submerged in a digitally rendered virtual world, complete with digitally rendered environment and physics. This phenomenon, which makes AR/VR users feel like they are "really there" in a virtual experience, has led many to believe that these technologies have the potential to be "the ultimate empathy machine."

Indeed, this type of first-person, immersive experience has been used to help people learn about other people's situations and develop compassion and understanding. Some encounters, for instance, change the user's visual and auditory settings to give them a taste of what it's like to live with a handicap. Some require the user to adopt the persona of someone of a different ethnicity, gender, or some other category. Still others immerse the user in a 360-degree video recording to provide a "ground truth" perspective on locations that are far away or difficult to visualise, such as a refugee camp or the scene of a natural catastrophe.

Over the last two decades, studies have shown that immersive experiences can boost empathy-related components under specific conditions. However, a review of the research on the topic found that "VR was no more effective at increasing empathy than less technologically advanced empathy interventions like reading about others and imagining their experiences." (Martingano et al., 2021). Changes to one's digital self-representation have been shown to have a significant impact on how a person acts in a virtual environment, and this in turn affects one's

behaviours and attitudes, fostering some of the qualities of empathy, in specific and experimental conditions. (Yee and Bailenson, 2007; Fox et al., 2013; Peck et al., 2013; Banakou et al., 2016; Kruzan and Won, 2019). Similarly, taking on a different person's viewpoint in a virtual reality setting has been shown to be an effective way of altering behaviour and decreasing prejudice and discrimination. (Yee and Bailenson, 2006, 2007; Hofer et al., 2017; Van Loon et al., 2018; Ventura et al., 2020).

7. Conclusion And Future Work

The purpose of this qualitative study is to investigate the challenges that construction workers face in India. The study incorporates qualitative research methods in order to draw accurate conclusions from its findings. An investigation into the life of a labourer was the subject of a case study, and an in-depth survey was designed to determine whether or not the information provided by the labourers was accurate. The results of the survey and the case study are in direct agreement with the current situation of construction employees. This is made abundantly evident by the fact that there was a clear correlation between the two. The construction sector is one of the largest employers in India. It accounts for seven percent of the country's total gross domestic product and has seen yearly growth of more than ten percent over the course of the last five years. Despite the fact that the working conditions of construction sector employees are, to put it mildly, appalling, This portion of the population suffers from both social and economic disadvantages, yet neither the law nor the contractors show any compassion for them. It would seem that getting construction companies to comply with the laws of the nation in terms of the fulfilment of fundamental rights connected to the employment, safety, and welfare of employees and guaranteeing a higher quality of life is still a far-off goal. The findings of this research may be generalised to apply to other construction sites around the country that now use or have previously used migrant labour.

The capacity of societies to undergo change and the directions in which they channel their technological potential are reflected in their level of technological development, or absence thereof. Projects in the field of social design employ, develop, and broaden technological capacities in order to address societal issues from a human perspective. Where there is a need for light, social designers create sustainable lamps or devices that illuminate and perform other functions at the same time. Some of these designs are more involved than others, but they all adhere to the principles that guide the work of social designers. Instead of making yet another protective headgear, these innovators are considering the technologies they are developing in terms of their symbolic, practical, ethical, and political significance. They don't just add things; they question, suggest alternatives, and strive to make things better regardless of the outcome. That being said, not every design is social design even though all design is social. Our findings suggest that technology can be used constructively in societal planning. We were able to identify the project's structure, manifestation, purpose, timing, and operation thanks to our framework. However, it is unclear whether this can serve as a viable pre-model study for technology in the context of social design. Overall, technology sped up procedures, mediated interactions, brought people together, opened lines of communication, streamlined operations, and distributed authority over specialised tasks that would have otherwise required more time, effort, and resources to complete. Knowledge was shared, skills were honed, lives were saved, and people were given agency. Potentials in information, communication, and networking systems have yet to be fully realised. It's not the technology itself that people have trouble accepting, but rather how it's presented. So, yes, technology is technically and socially helpful for social design projects, but we are just getting started and there is still a long way to go.



Fig 11. Builder/Government Official/Construction Company realising the precarious situations of the workers through AR/VR tech, edited, Saxena, 2023



Fig 12. Projecting quick setups through AR as solution on site and on camp., edited, Saxena, 2023

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