

Impact of Artificial Intelligence on the built environment professionals

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Abstract— *Human race, and its habitat – mainly the cities, have not seen the kind of growth seen today, ever in the known history. It is at the cusp of evolution where solutions cannot be normal, it demands disruptive change. And if it is for humans, then humans better learn to manage and adapt to disruptive thinking and technologies.*

The construction sector is on the edge of a coming inevitable radical change. The technological advancements (e.g., Self-healing concrete, Kinetic Roads, Photovoltaic glazing, Modular construction, Cloud collaboration, asset mapping, predictive software, 3D printing of buildings, Virtual Reality, etc.) will offer many opportunities, instead of shying away, it must be embraced.

Partnering between policymakers, education institutes and private players is essential. It is a conventional wisdom that high skilled segment of the workforce is the only answer in the ‘Post Knowledge’ ‘Artificial Intelligence (AI)’ driven world which we are going to encounter head-on soon. If so, what skills would be required?

It is strongly believed though that rather than the product, the ‘process’ needs to be improved. What is also more interesting is to study what can be the solution to manage the impact of this inevitable disruption caused by these technologies and thinking?

Keywords— *disruptive thinking, innovation, built environment, construction technology, artificial intelligence*

I. INTRODUCTION

The term artificial intelligence was coined in 1956, but AI has become more popular today thanks to increased data volumes, advanced algorithms, and improvements in computing power and storage.

Early AI research in the 1950s explored topics like problem solving and symbolic methods. In the 1960s, the US Department of Defence took interest in this type of work and began training computers to mimic basic human reasoning. For example, the Defence Advanced Research Projects Agency (DARPA) completed street mapping projects in the 1970s. And DARPA produced intelligent personal assistants in 2003, long before Siri, Alexa or Cortana were household names. This early work paved the way for the automation and formal reasoning that we see in computers today, including decision support systems and smart search systems that can be designed to complement and augment human abilities.

While Hollywood movies and science fiction novels depict AI as human-like robots that take over the world, the current evolution of AI technologies isn't that scary – or quite that smart. Instead, AI has evolved to provide many specific benefits in every industry.

AI is going to change every industry, but we have to understand its limits. The principle limitation of AI is that it learns from the data. There is no other way in which knowledge can be incorporated. That means any inaccuracies in the data will be reflected in the results. And any additional layers of prediction or analysis have to be added separately.

Today's AI systems are trained to do a clearly defined task. The system that plays poker cannot play solitaire or chess. The system that detects fraud cannot drive a car or give you legal advice. In other words, these systems are very, very specialized. They are focused on a single task and are far from behaving like humans.

Likewise, self-learning systems are not autonomous systems. The imagined AI technologies that one sees in movies and TV are still science fiction. But computers that can probe complex data to learn and perfect specific tasks are becoming quite common.

A. *The built environment profession*

“To build is important; builders are not.”

The built environment professionals are architects, engineers, contractors, specialist consultants, vendors, material manufacturers, management consultants, real estate developers, planners, urban designers as well as the concerned government officials and decision makers.

With the advent of advance technology, such as AI, it is hypothesized that there will be a significant impact on the professionals working in this field.

The hypothesis needs to be checked on various fronts, namely –

- Is this true?
- If it is true, then is it true for India?
- If it is true, then in how much time?
- If it is true, then in what ways and to who amongst the profession?
- If it is true, then how does one prepare for it?

To understand this, first a literature study of AI was conducted and understood, before going out to find the answers.

B. *How Artificial Intelligence Works*

AI works by combining large amounts of data with fast, iterative processing and intelligent algorithms, allowing the software to learn automatically from patterns or features in the data. AI is a broad field of study that includes many theories, methods and technologies, as well as the following major subfields:

Machine learning automates analytical model building. It uses methods from neural networks, statistics, operations research and physics to find hidden insights in data without explicitly being programmed for where to look or what to conclude.

A neural network is a type of machine learning that is made up of interconnected units (like neurons) that processes information by responding to external inputs, relaying information between each unit. The process requires multiple passes at the data to find connections and derive meaning from undefined data.

Deep learning uses huge neural networks with many layers of processing units, taking advantage of advances in computing power and improved training techniques to learn complex patterns in large amounts of data. Common applications include image and speech recognition.

Cognitive computing is a subfield of AI that strives for a natural, human-like interaction with machines. Using AI and cognitive computing, the ultimate goal is for a machine to simulate human processes through the ability to interpret images and speech – and then speak coherently in response.

Computer vision relies on pattern recognition and deep learning to recognize what’s in a picture or video. When machines can process, analyse and understand images, they can capture images or videos in real time and interpret their surroundings.

Natural language processing (NLP) is the ability of computers to analyse, understand and generate human language, including speech. The next stage of NLP is natural language interaction, which allows humans to communicate with computers using normal, everyday language to perform tasks.

C. *Technologies that supports AI*

Graphical processing units are key to AI because they provide the heavy computing power that is required for iterative processing. Training neural networks requires big data plus computing power.

The Internet of Things generates massive amounts of data from connected devices, most of it unanalysed. Automating models with AI will allow us to use more of it.

Advanced algorithms are being developed and combined in new ways to analyse more data faster and at multiple levels. This intelligent processing is key to identifying and predicting rare events, understanding complex systems and optimizing unique scenarios.

APIs, or application processing interfaces, are portable packages of code that make it possible to add AI functionality to existing products and software packages. They can add image recognition capabilities to home security systems and Q&A capabilities that describe data, create captions and headlines, or call out interesting patterns and insights in data.

In summary, the goal of AI is to provide software that can reason on input and explain on output. AI will provide human-like interactions with software and offer decision support for specific tasks, but it’s not a replacement for humans – and won’t be anytime soon.

II. WHAT IS THE IMPACT OF AI ON CONSTRUCTION INDUSTRY?

A The first and foremost a preliminary questionnaire survey was conducted to understand the knowhow and view point of the professionals working in the field of built environment.

It was essential to see the perception of people if there is a risk perceived that people in the built environment sector just get Ubered –Something comes in and all of a sudden, the incumbents are in trouble because it’s what the need of the time is, and one gets caught unaware, unprepared, because they were just doing what was always done?

The construction sector is on the edge of a coming inevitable radical change. The technological advancements (e.g., Self-healing concrete, Kinetic Roads, Photovoltaic glazing, Modular construction, Cloud collaboration, Asset mapping, Predictive software, 3D printing of buildings, Virtual Reality, etc.) will offer many opportunities, instead of shying away, it must be embraced. Actually, there is no option.

A questionnaire survey was conducted to answer specifics like whether each disruption requires a specific response? Are there possible strategies for the built environment professionals?

The questionnaire was sent out using Google Form and to personal contacts as well as references. The survey was underway at the time of writing this paper, and this being a preliminary survey a further methodology to establish the solutions to issues identify were to be devised through specific and targeted case studies. The following analysis is based on total 56 detailed responses of people in the built environment sector.

A. Demographics of respondents

The respondents to the questionnaire varied in terms of demographics.

- Over 50% of the responded were in middle to ownership or consultancy roles and only 16% of those were not working.
- Over 50% had over 3yrs to 9yrs experience and remaining had over a year’s experience.
- Nearly 60% of the respondents had post graduate level educational qualification.

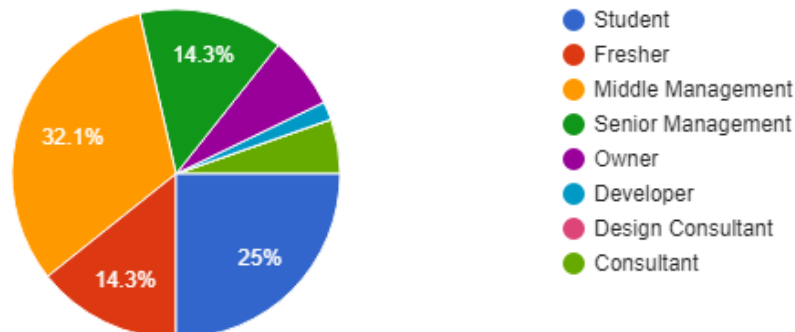


Fig. 1 Roles of respondents (No. of responses – 56)

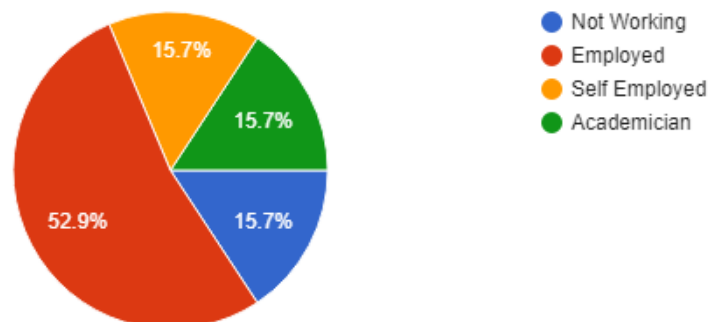


Fig. 2 Employment status of respondents (No. of responses – 51)

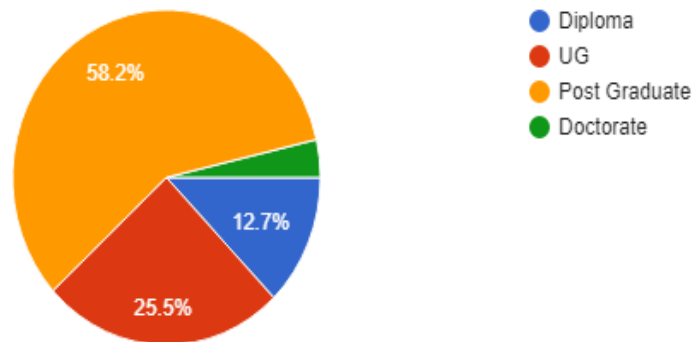


Fig. 3 Educational qualification of respondents (No. of responses – 55)

B. Perception about Artificial Intelligence in built environment sector professionals

They were asked if they knew of any disruptive technologies in construction; to which 2/3rd of them responded of not being aware. Nearly 26% said they had seen no change in their working pattern since they started working and seen no disruption.

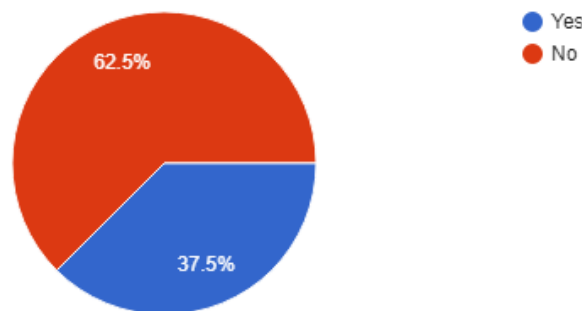


Fig. 4 Knowledge of disruptive thinking or technology in built environment sector (No. of responses – 56)

When they were asked if they were aware of AI, over 80% responded affirmative. When the same question was asked if they were aware of any AI in construction, nearly 60% were aware of that some example. However, only about 20% of respondents had come across any specific use of Artificial Intelligence in Construction.

The respondents were asked to list down the AI technologies in construction if they were aware of. There were various answers such as - Automation bringing in more user-friendly working environments and with introduction of sustainability the built environment sector witnessing energy efficient lighting, HVAC, Building Management systems, etc. From 90's to the 21st Century the disruption and changes in built environment sector made living and working habitat more humane and livable.

There were also examples of Building Information Modelling, 3D scanning and Printing, Use of Virtual Reality in Marketing built spaces visualization, Augmented Reality, Drones for surveys, Block Chain, Robo Labours, Prefabrication, applications for construction management, vacuum technologies for material transfer and hard rock excavation, Self-healing concrete, RFID in fleet management, asset management, etc.

C. Future of AI in Construction

Almost 60% of respondents thought that within a short span of 1 to 3yrs there will be an impact on professionals in the built environment sector with the use of AI. There were some who believed that it was still a far-fetched dream and it can take over 10yrs. These responses have to be analyzed in much more depth and with a larger sample size to be conclusive. Nonetheless, it does give us a sense that the perceived future of AI in construction is very near.

D. Preparedness of Construction Professionals

The respondents were asked if they were preparing themselves for the impact of AI and 50% of them said yes; with an observation that over 2/3rd of people around them were not preparing themselves for it. And the possibility of impact on the work was nearly 60% in the near future.

The majority of respondents were keeping themselves abreast of the happenings in AI in construction through blogs, trade magazines and industry news. There were some who were skeptical about its impact within a decade and were inclined to discourage it. Nonetheless, most of the people who felt it was inevitable were also eluding towards government and private owners' responsibility to demand and have policies for it.

There was certainly one area of teaching of built environment sector where academicians felt that this will not impact them as AI will not be implemented in teaching any time soon. Although with the kind of advancements happening this can be debated and argued, it was beyond the scope of this work. A further investigation with academicians can be a future scope of work.

There were variety of reasons quoted for why people in the construction industry were not preparing themselves for the impact of AI. That will become the basis for further investigation –

1. Lack of awareness
2. Mindset
3. Migratory work and short term teaming
4. It will impact with enormous job losses to which will be discouraged through government policies and hence no need to worry
5. Lack of proper courses and academic options, etc.

E. Changes happening in working methodology as well as productivity of built environment professionals

The respondents were asked if they were anticipating impact on productivity of people with the implementation of AI in construction and over-whelming majority anticipated that. They were also asked to rate the importance and impact of some emerging trends which were happening in the industry listed based on author’s literature study and experience. A four point Likert scale was used to ensure there is no ‘sitting on fence’ response. The following graphs are outcome of the responses to the list –

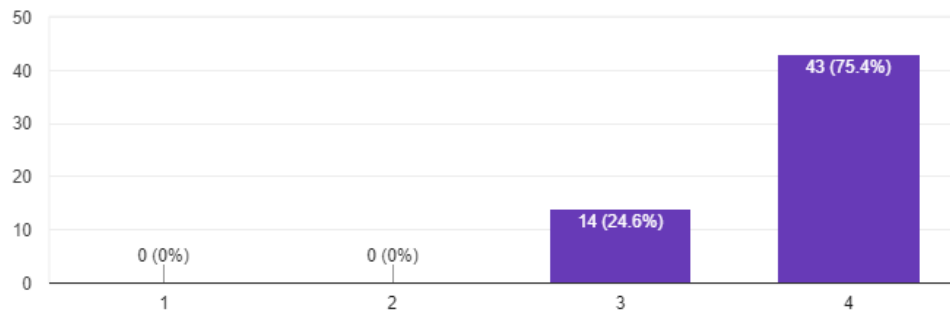


Fig. 5 Importance of technologists in any team (No. of responses – 57)

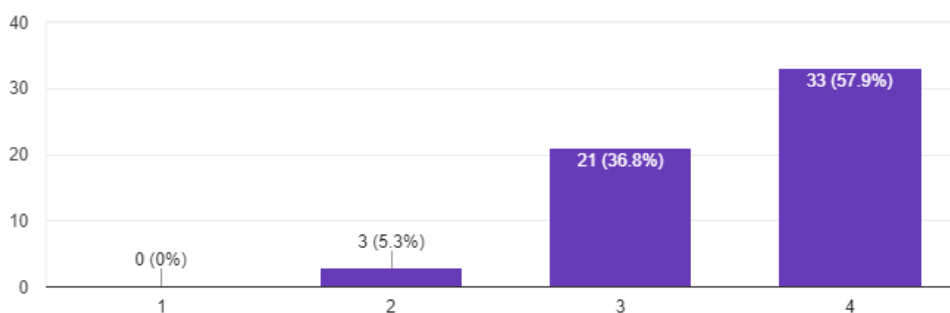


Fig. 6 Need for Speed (No. of responses – 57)

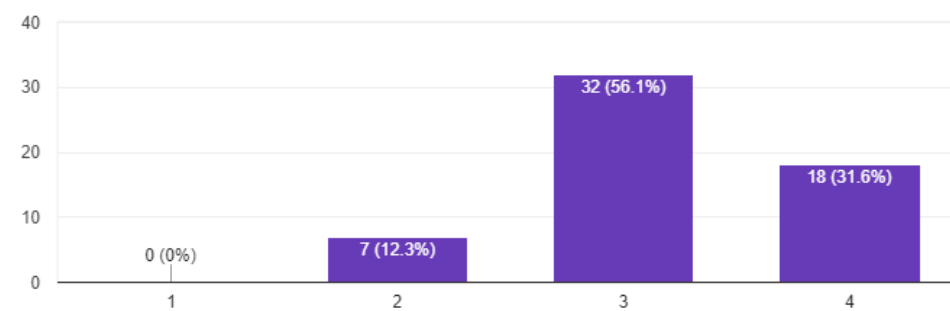


Fig. 7 Prefabrication (No. of responses – 57)

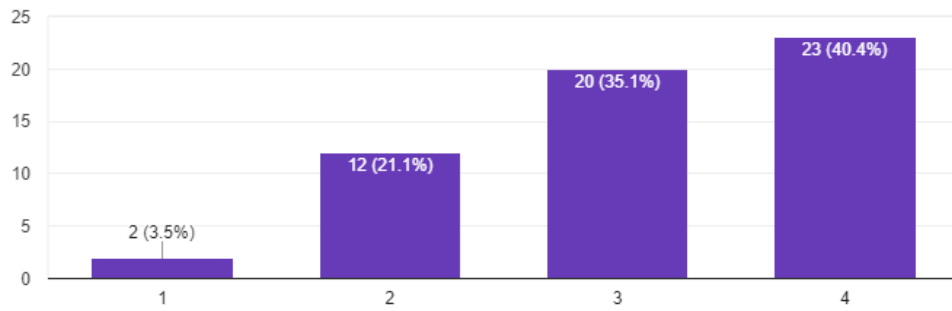


Fig. 8 Skill shortage (No. of responses – 57)

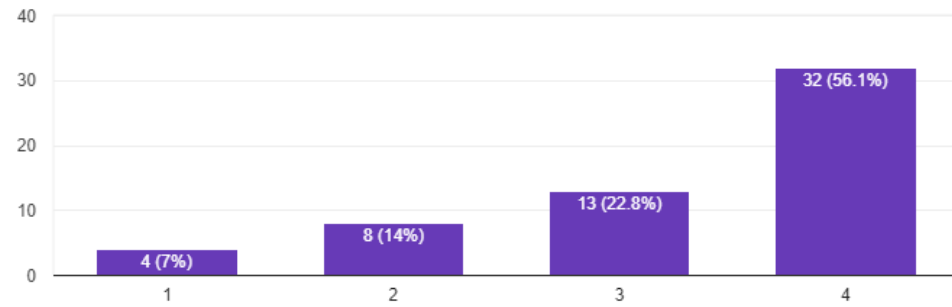


Fig. 9 Use of virtual reality (No. of responses – 57)

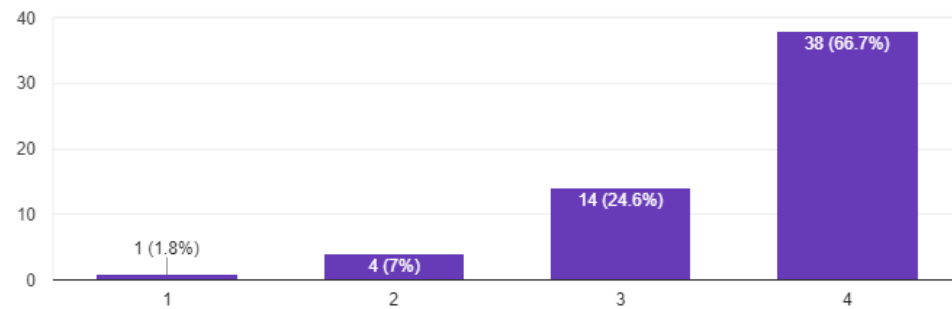


Fig. 10 Use of Building Information Modelling (No. of responses – 57)

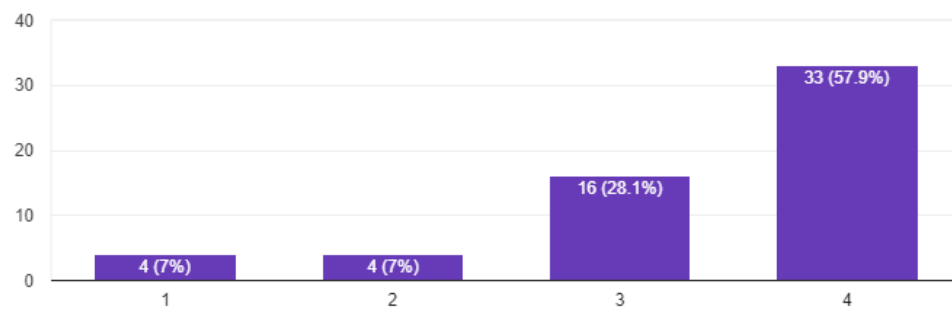


Fig. 21 Use of new breed of machinery, more agile, robotic than available in 2010 (No. of responses – 57)

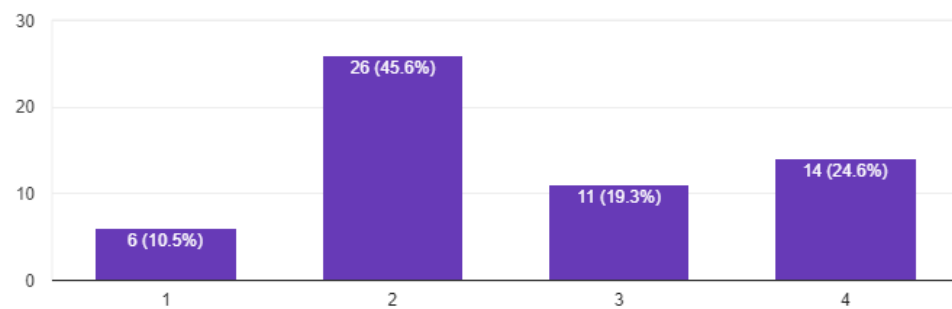


Fig. 32 Lack of quality due to speed (No. of responses – 57)

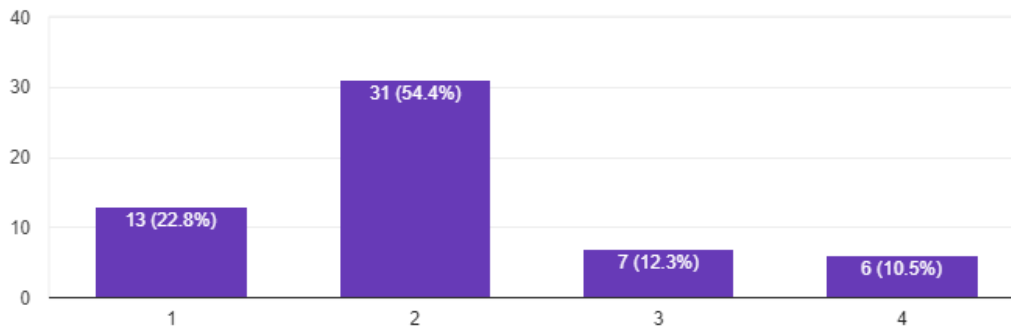


Fig. 13 Lack of quality due to machine working (No. of responses – 57)

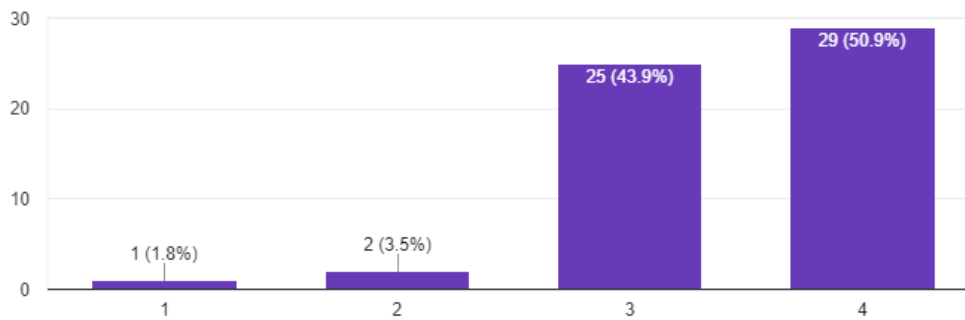


Fig. 44 Increase in quality due to machine working (No. of responses – 57)

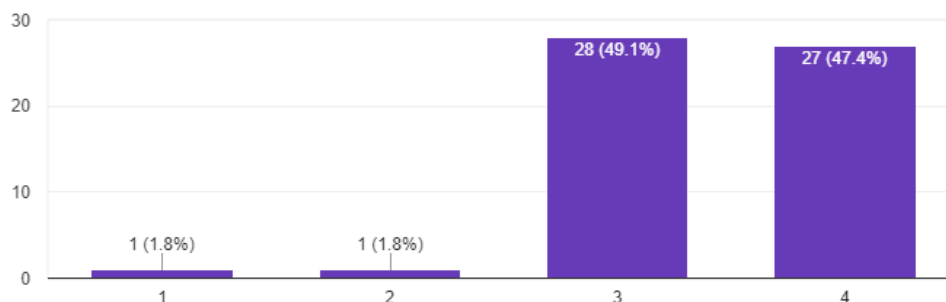


Fig. 15 Need for long term performance of spaces, materials, etc. (Life cycle concept) (No. of responses – 57)

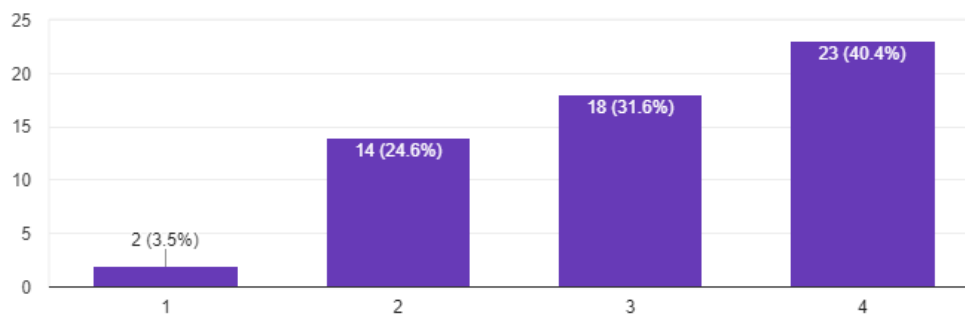


Fig. 56 Lack of maintenance skills in the industry (No. of responses – 57)

The respondents were absolutely clear that AI will have an impact on the lives of people working in the built environment sector in a positive way, with 95% respondents believing that the productivity will increase and their work life will be easier.

III. CONCLUSION

It cannot be argued that advent of AI in construction will definitely have a direct impact on employment. Reliability in humans will definitely be minimized by humans themselves. Definition of job profiles, working styles will change significantly. Reduction in all kinds of resources will be a major change whether that's physical spaces, overall environment, human workforce, materials, energy, time, efforts etc.

There is bound to be major change in the way we manage the construction projects. It is anticipated that lower level jobs and middle level jobs will be done by machines. The design tasks will be reduced to concept level work and creative work only; 3D printing of buildings will also be developed further. With the lack of human interface there will surely be an increase in quality of work and efficiency. However, the loss of traditional craftsmanship to a near extinction as well as the ethical and contractual issues related to AI in construction are yet to be addressed. What is not certain is the timeframe of this, a best guess is that the next decade will be a decade of experiments and major disruption in the built environment sector.

It is prudent that there are models developed with immediate effect for integrating the skills required for managing the impact of AI in construction into the curriculum right now.

The resistance to changing methods of working which leads to lack of acceptance in the industry will need to be managed and could advocate for a policy intervention.

The paper is an attempt to establish a methodology of investigation through a preliminary survey and discussions with experts in the industry at every level. It concludes by emphasizing and validating the already established hypothesis for a doctoral research work of the author.

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