Education + Training

Built Environment Professionals' Perspective on Digital Technology Skills

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Purpose – This study aims to explore the opinions of Built Environment Professionals (BEP) on the usage of fourth-generation digital technologies in the construction industry.

Design/methodology/approach – This study adopts a qualitative research approach and conducts semi-structured interviews with Black, Asian and Minority Ethnic (BAME) professionals to explore the adoption and utilisation of fourth-generation digital technologies in the construction industry. The semi-structured interviews allowed the participants to elaborate on their experiences, and thematic analysis was employed to identify and analyse significant themes related to the topic.

Findings – Accounts from BAME construction professionals reveal that the increased popularity of fourth-generation digital technologies, also known as Industry 4.0 technologies, does not necessarily result in increased usage. This is because many of these new technologies have not been embraced and are unpopular in certain circles. A more significant revelation is the impact of BAME community settings on determining the career pathways of most individuals, which often do not support the construction or digital technology pathways within the construction industry.

Originality/value – The study provides critical recommendations that are relevant to Further and Higher Education (HE) institutions, industries, construction organisations, government bodies, etc. Recommendations include a call for collaboration between educational institutions, industry partners and local communities to facilitate awareness and orientation programmes within the community.

Research limitations/implications – Research targeting ethnic minorities may not necessarily yield a large response due to the sensitivity of the issues raised. However, conducting nationwide research with a larger sample size drawn from various locations in the UK could achieve more robust findings and uncover additional issues. Meanwhile, the results of this research can serve as a framework for more extensive investigations.

Practical implications – The research offers valuable recommendations to industry and academia regarding the need to address the specific challenges faced by the BAME community in terms of digital technology adoption. These issues are often overlooked in most discussions about digital technology.

1. Introduction

The skills gap is one of the most pressing issues worldwide, especially with the emergence of new technologies that demand new skill sets. Unfortunately, many workers have not yet developed these skills. Not many workforces and industries have developed the necessary skills and competencies to meet the demands of the digital age. Nevertheless, some sectors, such as the construction industry, have begun to make notable transitions (Construction Industry Training Board [CITB], 2018a). However, the reality of the skills gap hinders the possibility of a successful transition due to a shortage of personnel possessing the required skills for the future. The skill gap refers to the significant difference between the skills required in the industry and the skills currently available, which consequently impacts productivity. Most industries cannot fulfil their obligations to society because they lack the skilled workers needed to execute relevant tasks, which can be attributed to varying levels of educational training standards (Chan & Dainty, 2007). Of course, inadequate training standards can impact the ability to develop the required skills among the existing and new workforce. This necessitates a closer examination of the current educational training and standards across the board (CITB, 2018b). Developed and developing countries also experience a skill gap due to a lack of qualified personnel. For instance, countries such as China, the USA, the UK, Australia, Canada, Northern Ireland and Germany have all experienced a skill gap (Arditi and Mochtar, 2000; Abdel-Wahab, 2008). Most of the unemployment problems faced in these regions are not solely due to job unavailability but rather a lack of skilled personnel to fill relevant roles. In the UK, the National Skills Survey has consistently revealed the significance of skills shortages in many sectors, including the construction sector, where significant shortages persist, particularly in digital skills (Department of Education, 2020). According to the survey, there is a significant shortage of various skills, including personal skills, numeracy skills, literacy skills, generic skills or employability skills, vocational skills and discipline-specific skills.

Employers have often expressed their dissatisfaction with their workforce for lacking the necessary skills, especially employability skills and discipline-specific skills required by the business (Ekundayo *et al.,* 2021). Similarly, several studies have expressed employers' concerns about graduates not meeting their skill expectations. Specifically, employers are worried that graduates lack the necessary employability skills that companies require. This has become a recurring problem for employers. Meanwhile, according to the UK Department of Education (2020), 26% of those starting new roles have not received the required training. For example, 68% of the construction skills gap is linked to personnel who have only partially completed their training and are unable to meet the demands of the business when employed. This validates the dissatisfaction expressed by employers.

Employers' perspectives on the skill gap, particularly employability skills, have been extensively discussed in the literature, some of which will be explored in the literature review section below. However, there is limited discussion on digital skills compared to other discipline-specific skills and soft skills demanded by employers, such as communication skills, interpersonal skills and problem-solving skills. This gap in the literature needs to be addressed. Moreover, digital skills are where the construction industry experiences the most shortages but are rarely discussed. According to the Learning and Work Institute (LWI, 2021), basic digital skills, such as proficiency in Microsoft packages, have become essential in today's workforce, alongside literacy and numeracy skills. Even so, demand for advanced digital skills, such as specialist skills in computer-aided design (CAD) and coding, is increasing. Three in five employers expect their reliance on advanced digital skills to increase in the coming years, as clearly proven by the pandemic (LWI, 2021).

Aside from this, the UK's carbon reduction targets and net zero strategies require the use of digital skills, yet only a few literature sources shed light on the subject. Meanwhile, industry reports such as HM Treasury's (2021) 'Build Back Better: Our Plan for Growth', CITB's (2021) 'Building Skills for Net Zero', CITB's (2023) 'Construction Skill Network – the Skills the Construction Needs', CITB's (2022) 'How to Attract the Next Generation – A Step-by-Step Guide', the Construction Leadership Council's (CLC) (2019) 'Industry Skills Plan for the UK Construction Sector 201-2025' and CLC's (2019) 'Future Skills Report' all emphasise the need to develop digital skills amongst the current workforce and the next generation of workers to facilitate a significant transition into the new digital future. As such, the research aims to explore the adoption and utilisation of fourth-generation digital technologies (DTs) in the construction industry, both by new and existing professionals. Specifically, the research aims to gather the opinions of Black, Asian and Minority Ethnic (BAME) construction professionals. Currently, there is limited research focused on this minority group, which is crucial in order to obtain a diverse range of opinions on the subject matter. This is particularly important as the industry seeks to address the issue of low representation within the sector. Two research questions were considered to clarify the aim, and subsequent sections helped to explore critical issues related to the subject matter.

2. Research Questions

o   What advanced DT skills are currently in demand by UK construction employers?

o   What are the barriers to achieving high-level DT skills within the BAME community from the perspective of BAME construction professionals?

3. Literature Review

Across various fields, including the built environment, a significant body of literature reveals employers' perceptions of employability skills. These skills are the ones needed in the professional world or required to be deemed employable. A similar definition is presented by Yorke and Knight (2006), which refers to the understanding, attributes and knowledge that prepare graduates or labour market participants for employment and enable them to be effective in their roles. However, several studies have identified a significant gap between the skills demanded by employers and the skills possessed by graduates. For example, according to Perera *et al*. (2017), Quantity Surveying (QS) graduates are not meeting the expected level of competency, particularly in the mandatory, core and optional areas of the Royal Institution of Chartered Surveyors (RICS) competency requirements. In the Real Estate undergraduate programme, Poon *et al.* (2011) and Poon (2012) identified gaps between the skills that employers believe graduates should have and the skills that graduates believe they have acquired. Poon (2012) reported employers' concern about graduates lacking commercial awareness skills, amongst other soft skills that real estate graduates should possess. Similarly, Ayodele *et al.* (2020) revealed that Nigerian real estate graduates were grossly lacking in soft skills such as responsibility, business negotiation, logical thinking, marketing and dispute resolution. In addition, they also lacked discipline-specific technical skills such as valuation, property investment analysis, feasibility and viability appraisal, market research methods and facility management. In the sub-Saharan region, Damoah *et al.* (2021) performed a gap analysis of the skills that employers perceive as important and how graduates performed in these skills. The skills examined in the study include knowledge skills, enterprise leadership skills, interpersonal skills, technical management skills, numeracy skills, communication skills, creativity and innovation skills, IT literacy skills and improved learning skills. The results were disappointing, as none of the graduates met the employers' expectations for these skills, leaving them dissatisfied.

Other studies simply unveiled the employability skills in demand by employers rather than highlighting the skill gap. For example, Chhinzer and Russo (2018) uncovered the employability skills that employers are looking for when assessing candidates' work experience. They revealed that professional maturity skills, soft skills plus problem-solving, continuous learning, academic achievement, General Mental Awareness (GMA), generic skills, time management, teamwork, attention to detail, professional attitudes and behaviours, subject-specific knowledge, willingness to work and responsiveness to feedback are essential employability skills for emerging graduates. Barbosa and Freire (2019) also identified cognitive competencies such as analysis and synthesis, creative thinking and decision making, as well as emotional intelligence competencies like

adaptability/flexibility, autonomy, discipline and focus and social intelligence competencies such as assertiveness, empathy and leadership, as crucial employability skills for management graduates. Tejan and Sabi (2019) also focused on reading skills, listening skills, adaptability and flexibility, problem-solving skills and creativity skills. Borg and Scott-Young (2020) emphatically stated that communication, passion and technical construction knowledge are key skills for project management graduates. Zaheer *et al*. (2021) identified personal management skills, technical surveying skills, knowledge of the RICS and competencies as essential skills to be possessed by Building Surveying (BS) graduates. In addition, client management skills, goal-driven and self-motivated attitudes, optimistic personality traits, strong mental resilience, knowledge of building maintenance and management and time management skills are equally important in determining a work-ready BS graduate.

However, Aliu and Aigbavboa (2020) demonstrated that employers are somewhat satisfied with the academic records of built environment graduates but not in the areas of work experience, communication skills, technical competencies, critical thinking or numeracy skills. These skills are important employability skills needed for the world of work. Some researchers attribute this gap to an ineffective educational system. For example, Nwajiubu *et al.* (2020), Aliu and Aigbavboa (2020), Ayodele *et al.* (2020) and Guardia *et al.* (2021) all identified educational problems. Nwajiuba *et al.* (2020) firmly established that Nigerian Higher Education Institutions (HEIs) lack the financial resources, human resources, technological resources, curriculum structure, pedagogical design, industry partnerships and effective quality assurance standards to support the development and training of graduates in the desired employability skills. Additionally, Fredua-Kwarteng and Ofosu (2018) assessed teaching in a West African university classroom and found no evidence to support the lecturers' prelogical skills. However, it is assumed that they possess these skills alongside their specialist skills. Other studies have also identified similar issues in the educational system, especially in developing countries (Okunuga and Ajeyalmei, 2018).

3.1 Built Environment (BE) Professionals' Perception of Employability and Digital Skills

As discussed above, several studies have explored the perceptions of employers and graduates regarding whether graduates possess or have acquired the required skills. Examples include Nilsson (2010), Poon *et al.* (2011), Raty *et al.* (2020), Ekundayo *et al.* (2021), Succi and Canovi (2020) and Pitan and Muller (2021). However, there is very limited research specifically related to the perception of employability skills among BE professionals, apart from the studies conducted by Ayodele *et al.* (2020) and Ebekozien *et al.* (2021). Even so, literature that focuses on the perception

of high-level DT skills among BAME professionals in the UK is rare. Yet these skills are becoming essential as industries shift towards the digital age. According to Ebekozien and Aigbavboa (2021), technologies associated with the fourth industrial revolution, such as Artificial Intelligence (AI), Machine Learning (ML), blockchain and data analytics, are becoming increasingly important in the built environment. These technologies are also creating a new demand for specific skills within the industry. However, whether these new skills are being pursued in the industry is a different matter. Balogun *et al.* (2021) report that these new technologies have not been effectively embedded into HEI curriculum design. Specifically, BAME construction undergraduate and graduate students do not feel confident or adequately prepared for the use of these new technologies. Similarly, Abidoye *et al.* (2022) report a significant gap in the knowledge of property graduates regarding the use of new technologies such as blockchain, smart building cities and the sharing economy. These technologies are important analytical tools for the future of the property industry. Additionally, their knowledge of Industry 4.0 technologies such as ML, AI and big data analysis is very limited. This research could help uncover any underlying issues related to the limited digital skills, particularly advanced digital skills, within the BAME community. The study, therefore, aims to investigate the perspective of BAME construction professionals on advanced digital skills and identify potential barriers to acquiring these skills within the BAME community.

4. Research Methodology and Design

Interpretivism is the philosophical orientation that underpins the research and aligns well with the adopted qualitative research strategy. Studies such as Barbosa and Freire (2019), Borg and Scott-Young (2020), Nwajiuba *et al.* (2020), Monteriro *et al.* (2020) and Ebekozien and Aigbavboa (2021) have all employed a similar approach to investigate topics similar to those addressed in this research. This justifies the use of the same methodology in this research. A purposeful sampling strategy and semi-structured interviews were considered in this research, specifically targeting BAME construction professionals. The interviews were conducted to gather the opinions of professionals regarding the DT skills that are in demand by UK construction employers, as well as the potential barriers that hinder the development of these skills within the BAME community. Participants were contacted through LinkedIn, and at first, connections were established with 50 BAME professionals in the built environment construction industry. These professionals held various titles, including Quantity Surveyor (QS), Building Surveyors (BS), Project Managers (PM), Estate Surveyors (ES), Facility Managers (FM), Mechanical and Electrical (M&E) engineer, architects and civil engineer. Upon receiving an introductory email, followed by several reminders, seven professionals agreed to participate in the interview. According to Guest *et al.* (2006), a sample size of 12 to 15

participants is considered sufficient for purposive sampling. However, BAME-related research raises sensitive issues and poses a threat to the number of people willing to participate, particularly in the UK. This is due to concerns about racial inequality and disparity amongst BAME individuals (Pathmajothy, 2020; Gumble, 2021).

Meanwhile, the participants in the research have credible academic and industry profiles, enabling them to provide deep and reliable responses that are relevant to this research. The issues raised in this research can also contribute to broader research inquiries in the future. More so, after the seventh interview, a consistent theme connected to the research question began to emerge, providing sufficient data to conduct the thematic analysis. All interviews were conducted via Microsoft Teams, and each interview lasted approximately 45 minutes. Interviews were transcribed to facilitate thematic analysis and coding. Coding was achieved by highlighting and grouping together similar issues identified in the transcripts linked to the research question which led to the development of themes. The semi-structured interview allowed respondents to share their own narratives related to the topic at hand. The approach allowed for the emergence of other important matters, some of which were not directly linked to the research question. However, these discoveries were still significant and contributed to the thematic analysis. Participants' profiles are provided in Table 1 below.

[Insert Table 1 here]

5. Findings and Discussion

Section Five presents the relevant findings, themes and discussions from the thematic analysis.

5.1 RQ ONE: What advanced DT skills are currently in demand by UK construction employers?

Interviewees highlighted that demand for DT skills largely depends on the role and type of project. Further, interviewees revealed that they were aware of some of the Industry 4.0 DTs, although they were unable to use them because they were not relevant to their role or within their area of expertise.

 GG states, *'I am aware of these technologies, but I don't understand how they work. From my perspective, I am aware of the various technologies, but it is important to consult with the experts. These technologies are in their early stages of development and need the right people driving them so that the desired results can be achieved*.

AA states, *'Of course, I have knowledge of Revit work and some other technologies. However, I don't use them and don't have any reason to develop skills in these other technologies'*.

It, therefore, implies that interest in developing any emerging DT skill will depend on the role and discipline. For example, project managers should have knowledge of Microsoft Office Projects for planning and managing construction projects. In addition, they should be able to use Primavera or P6, which are commonly used in project management. Power BI is also applicable to project managers for effective data visualisation. Interviewees also revealed some contract management and administration tools they use within their project management role since transitioning from paper-based contract documentation to a digital format. The DTs used within the QS discipline include Microsoft Excel, Kobit, COS x and Keto for calculating quantities, performing costing and writing detailed reports. **AA** expressed that these DTs perform similar operations; however, Keto offers a superior data presentation experience. Meanwhile, respondents noted that DTs within the design and building disciplines are more advanced compared to infrastructure or project management. This is true because the design aspect sets the tone for the actual construction, and if it is done correctly, there will be fewer problems moving forward. Even so, sustainability and sustainable construction criteria are better integrated during the design phase. Essential DT skills noted within the design discipline include Building Information Modelling (BIM), Revit, AutoCAD 2D and 3D, clash detection and Construction Operations Building Information Exchange (COBie).

CC argues that *'everyone in construction should be aware of BIM. Because it connects everything, and it has reached the point where it even connects commercial cost'*.

Roles expected to utilise this collection of digital skills include civil and structural engineers, architects, M&E engineers, BIM managers and consultants. In the civil and infrastructure disciplines, possessing skills in 3D modelling software such as AutoCAD Civil 3D and hydraulic design for drainage is highly valuable. However, a basic understanding of engineering concepts will be necessary before these technologies can be applied.

Surprisingly, the interviewees within their specific discipline revealed that the in-use or in-demand DTs do not encompass most of the Industry 4.0 technologies, except for BIM. This suggests that there is limited utilisation of these technologies, despite the extensive discussions surrounding them. Ebekozien and Aigbavboa (2021) argue that technologies associated with the fourth industrial revolution, such as AI, ML, blockchain and data analytics, are becoming increasingly valuable assets in the built environment. However, it is being identified that most of these technologies are not widely used in the industry. According to Balogun *et al.* (2021), there is still limited awareness of these technologies in the industry. Similarly, Mann (2021) also confirms that BIM is the only DT

experiencing increased usage compared to other Industry 4.0 technologies such as laser scanning, AI, robotics, big data, ML, Internet of Things (IoT), Design for Manufacture and Assembly (DfMA), blockchain, digital twin and Lida survey scanners. This raises the question of when there will be more widespread use of these technologies, considering their potential for achieving sustainable construction and net zero. Aside from this, interviewees revealed that new entrants had not developed skills in these technologies, confirming the findings of Balogun *et al.* (2021) that Industry 4.0 DTs are not fully embedded into the curriculum and that new construction graduates are not necessarily equipped with these technologies. Borg and Scott-Young (2020) raised the question of whether graduates are equipped with the necessary skills to hit the ground running in their roles. However, as demonstrated in this study, Industry 4.0 technologies are not necessarily essential skills required by new graduates to hit the ground running. This raises the question of whether it is even necessary to embed these technologies within the curriculum if they are not currently being utilised in the industry. **AA**, **CC**, **EE** and **FF** alluded to the fact that Industry 4.0 DTs are not an entry requirement for graduate roles and can be learned on the job if required.

AA states, '*The main point is that you can interpret a drawing as a quantity surveyor. By using software, you can easily identify the location of walls and windows, which are the starting points for measurements. That is what you need to start clicking in order to increase your quantity. So, to me, it's not really a matter of the software, as I mentioned earlier. In most companies here, when they hire you as a graduate, they provide training if they want you to use a specific software. So, it doesn't matter whether you know how to use it or not'*.

Meanwhile, LWI (2021) studied how young people perceive digital skills and their interest in a digital career. It was discovered that only 42% of young people would be interested in careers requiring advanced digital skills (such as those considered in this study) because they consider themselves to lack the required knowledge or find such careers boring. Additionally, the study showcased that many young people are unaware of the opportunities to acquire advanced DT skills. However, the current revelation presents an opportunity to re-enlighten the younger generation about the opportunities available within the sector and employers' willingness to provide training for new entrants to learn relevant skills on the job.

5.2 RQ TWO: *What are the barriers to achieving high-level DT skills within the BAME community from the perspective of BAME construction professionals?*

The main barriers identified by participants to attaining high-level DT skills are:

- Community and cultural barriers
- Lack of guidance, mentorship and absence of role models

5.2.1 Community and Cultural Barriers

Several concerns were raised within the community, including cultural barriers. First, there is a lack of awareness and popularity of these new technologies amongst the BAME community, particularly the black minority group.

As **FF** points out, *'I don't really see people I know of black origin who are actually rising up and wanting to pursue this area or progress in it'*.

Similarly, **EE** mentions a lack of interest in developing these skills amongst the black community.

'I would say it's a lack of interest. That is, one must be willing to invest in learning the software, as it often requires payment and can be quite expensive. So, I would say lack of interest and perhaps perceived cost".

BB argues that *'even though the technologies are there, I think that our upbringing plays a significant role. We are not very curious about exploring and utilising technology well. So, you would see those two individuals, one being a xxx person and the other a xxx person, can utilise the same technology with varying levels of proficiency based on their inherent abilities. I'm not saying that black people cannot. They can. But then, if they immerse themselves in it, they can also do much better. And I know some people who do better, but it's just that sometimes, due to our nature, we can't'*.

Meanwhile, **FF** contends that the black community is mostly motivated by the healthcare *sector*.

'When I look at the people that I know, it seems like they would prefer to pursue other fields that do not necessitate advanced DT. So, you'll find that many of them are interested in nursing'.

BB mentions, *'If there is an option to pursue a course, such as nursing, where you can easily secure employment. Somebody would advise their kids to pursue a career in nursing. If they cannot pursue a career in medicine or any other helpful profession, because it may be difficult for them to find employment'*.

This perhaps explains why most young people from the black community are in the health sector, as it is predominantly popular within the community. It further explains the reasons for the poor representation of BAME individuals in the construction sector and the disparity in BAME award gaps in UK higher education institutions. Even so, these issues are well reflected in the workplace, as you typically find only one person from a BAME background in most UK construction companies. For

instance, six out of seven participants claimed that they were the only individuals from BAME backgrounds in their office.

FF stated, *'I have always asked myself, what impact does the industry have in relation to black and Asian minorities? So why is it that in the entire office, I am the only black person? And when we had a nationwide event involving the entire studio, there were only two black individuals within the company'.*

Moreover, the lack of knowledge of relevant DTs does not hinder employment, as most DTs can be learned on the job. Therefore, it cannot be the sole reason for the low representation of BAME individuals. However, if an employer were to allow a BAME graduate to develop relevant DT skills on the job, it would be a different matter.

Similarly, within some BAME communities, there are mixed feelings about job roles linked to new DTs, such as BIM consultant or manager or Revit designer. These roles are sometimes perceived as less dignified compared to established roles like civil engineering, QS and BS, which have gained credibility within society over the years. This lack of awareness within the industry, particularly regarding the shift towards technology, prevents the younger generation from exploring these areas due to concerns about acceptance within the community. For example, **GG** alludes to the fact that

'from a black, South Asian, and ethnic minority perspective, our families play a significant role in this. If we go back to our families and say, "I'm a civil engineer" or "I'm a project manager", that's great. If you go back to your family and say, I'm working in BIM. You know, it's like, what is that? So I wouldn't. I think our communities are the ones not allowing us to step into these areas in the first place'.

It, therefore, suggests that more awareness and exposure regarding how technology is driving the industry needs to be reinforced within the BAME community. This will enable the younger generation of BAME students to develop self-esteem and confidence to explore these new areas.

5.2.2 Lack of Guidance, Mentorship and Absence of Role Models

Lack of guidance and mentorship for the younger generation was also pinpointed as a barrier preventing BAME students from pursuing careers in new DTs. It has been highlighted that individuals from BAME backgrounds require more role models within their community to provide guidance and mentorship. This will help them understand the changes happening in the construction sector and the skills they can develop to pursue better career opportunities. There are vast opportunities within the construction sector; however, if the younger generation is not mentored and advised to consider this route, it creates a significant limitation. For example, **BB** explains that

'we have all these influences within the community, but we don't have enough role models in our society who can tell us that it is possible'. BB also states that *'when it comes to DT, they're not exposed to it and don't even know the possibilities, so they are not even considering it in the first place. There are no examples around because their parents never delved into that area, so they don't know what is out there. So all the advice they can give their child is based on their knowledge'*.

CC also mentions, *'You can have the confidence that I can achieve this too if I see someone similar to me in that position. It means I can get there'*.

Therefore, more role models are required to mentor the younger generation of BAME students in order to address this problem. As earlier pointed out, only one or two individuals from the BAME community are usually found within a cooperative organisation. This means that there are fewer people to serve as role models for the younger generation, which constitutes a significant barrier to acquiring high-level DT skills, such as Industry 4.0 technology skills. **BB** and **CC** propose the development of a mentorship scheme within the BAME community to address this problem.

*'**BB** emphasises the importance of mentoring schemes and networking events for young people, as they provide opportunities to meet individuals who have more exposure and can engage in meaningful conversations that broaden their perspectives. I think that's the only way people can now realise that there are different possibilities out there for them because we are just as clever as anyone else. The problem is simply that there is not enough exposure. We are so close'*.

The mentorship scheme, for example, will provide a platform for a BAME construction professional to mentor someone from the community in their specific area of expertise. This will allow them to serve as role models for these individuals.

6. Conclusion and Recommendations

This research presents an important and sensitive issue within the field of digital construction technology: the skills gap. The study adopted a qualitative and interpretive approach to examine the perspectives of BAME construction professionals regarding the digital skills currently in demand in the industry. It also explored the barriers faced by BAME students in developing these skills and how Industry 4.0 technologies have been utilised. First, the literature review suggests a mismatch between the skills that graduates possess and those that employers expect them to have. These skills include a combination of discipline-specific and soft skills, commonly referred to as employability skills. It is important to note that these skills do not necessarily require advanced digital skills or extensive knowledge of Industry 4.0 technologies. Moreover, it has been discovered that the increased popularity of Industry 4.0 technologies does not necessarily result in increased

usage. In fact, there is less awareness of these technologies in certain areas. The study has revealed a variety of DTs being used in different disciplines, as confirmed by the experts. However, it does not include many of the Industry 4.0 technologies, which suggests that these technologies are not widely adopted. More so, individuals only need to develop digital skills that are relevant to their specific roles rather than trying to acquire competencies in all emerging technologies. Even so, Industry 4.0 technologies are not yet a requirement for most employers, and any DT required in the workplace can be learned on the job. Meanwhile, since most employability skills lean towards soft skills and other discipline-related skills (not necessarily advanced digital skills), it validates why Industry 4.0 technologies are not necessarily an entry requirement in most roles.

A striking revelation is how the community and cultural environment shape the interests of BAME students, which often do not favour the choice of a construction or DT pathway within the construction industry. For instance, factors such as interests and attitudes, the perceived cost of education, cultural background, community acceptance, job prospects and the popularity of other professions within the community can influence the decisions of a BAME student. Meanwhile, since these issues are prevalent in the community, addressing them requires a community-based approach. The community-related problem undoubtedly affects the availability of guidance, mentorship and industry role models for BAME students within the community. Nearly all the participants assert that they are the only individuals of BAME origin within their organisation. It implies that a young BAME student will not have enough role models to offer appropriate guidance and mentorship in the field of construction or related areas.

In view of the above discussion, the study recommends:

- Collaborations between institutions and organisations, such as government bodies (e.g., the Department of Education), educational establishments (e.g., Further Education (FE) and Higher Education (HE) institutions) and industry and research groups, aim to facilitate awareness and orientation programmes within local communities and suburbs. The goal is to promote the numerous opportunities available in the construction sector. Such awareness and orientation programmes will enable the locals to connect with industry experts who can serve as role models for interested candidates, providing them with accurate guidance and mentorship within various construction pathways.

6.1. Practical Implications

The research findings benefit various stakeholders, such as academia, including HE and FE institutions, as well as secondary schools. Other stakeholders that benefit from the findings include

construction employers, outreach and community engagement teams and government policymakers. This research focuses on the unique challenges faced by individuals from a BAME background within the construction industry, as well as those who are considering a career in this sector in the future. For example, it is likely that a secondary school student from a BAME background may not consider pursuing a career in construction due to the barriers highlighted in this study. These barriers contribute to the widening of the BAME award gap and the underrepresentation of BAME individuals within the sector. This research discusses the various barriers and presents practical recommendations for addressing them. Similarly, the findings highlight the importance of HE and FE institutions and government and non-government organisations to develop community-focused knowledge awareness programmes. These programmes should aim to showcase the industry's transition towards technology so that individuals within the community can gain a better understanding of this shift and the various roles available within the sector. Also, findings from this study provide the rationale for creating a government-funded built environment community project. This project could involve partnering with local secondary schools, higher education establishments and further education establishments to offer relevant training platforms and awareness programmes in support of the sector.

6.2. Theoretical Implications

The research contributes to the existing literature on skills gaps, employability and digital construction technologies. Studies within this field have been discipline-specific, with little or no consideration given to the specific challenges faced by individuals from BAME communities, particularly in relation to advanced DT skills. This research addresses the aforementioned shortfall by presenting the perspective of BAME construction professionals. Through this exploration, important discoveries were made, and a framework was provided for future studies seeking to investigate the subject further.

6.3 Limitations and Future research

The research provides important recommendations and implications, but it is not without limitations. For instance, it would be beneficial to have a larger sample size, such as including the perspective of BAME construction professionals from across the UK, in order to obtain a more comprehensive understanding of the subject matter. In addition, it would be helpful to gather the opinions of other industry professionals, not necessarily BAME professionals, to further enrich the discussion. Future studies are therefore encouraged to consider these limitations when conducting investigations.

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List of Tables and Titles

Table 1 Summary of Participants' Description

Designation	Role	Experience	Highest qualification	Sector
AA	Consultant QS	20 years	PhD	Consultancy
BB	Project Manager	18 years	MSc	Consultancy
CC	Planner	17 years	MSc	Contractor
DD	BIM Consultant	10 years	MSc	Consultancy
EE	Civil infrastructure designer	9 years	MSc	Consultancy
FF	Architectural Assistant	5years	BSc	Consultancy
GG	Project Manager	6years	BSc	Local council

Additional findings from the research but could not be added to the main paper because of the 7000 wordcount restriction.

5.2.3 Fear of Prejudice

Also, the white elephant in the room, also known as prejudice, was highlighted as a barrier to attaining high-level DT skills. People from BAME backgrounds are sceptical about the construction industry due to concerns about prejudice within the industry. According to Engineering News-Record (ENR) (2020), the construction industry ranks high amongst industries where racial disparity and unconscious bias are likely to occur. **CC** notes, '***In terms of roles such as project director and above, there is a lack of representation of black people, and we need to address this issue. I'm not saying that the ability is not there. I think we can do it. But how do we get there?*** Meanwhile, **AA** reveals that individuals from a BAME background must constantly prove themselves and work twice as hard to be recognised at work**.** According to **AA,** *'colour is one of the barriers. It's always there because, as someone from the Black African and Asian minority ethnic group, you have to be almost, I'll say, twice as good as your xxx counterpart in order to be recognised. Yes, in the industry, that's the truth. You have to be prepared, and if you're struggling at the university level, you will face difficulties when you enter the professional world. For example, if you're in the office, you might be called a senior quantity surveyor, whilst someone who started working with you or even after you may become a director. This is because they can be sent out to clients, and it is easier to convey to the client that the person coming is not just a senior, but a director. This gives the company more credibility.* Similarly, **CC** reveals that several of his BAME colleagues are not given the proper recognition or placed in the appropriate salary band or level at work, despite their skill set. This can only be attributed to prejudice**. CC** states*, 'I know quite a few colleagues who, despite working for big companies, are not at the level of knowledge expected of them due to their background, which limits their career progression.*

Even so, **DD** noted that there were occasions when she needed to take a strong stand at work due to being a minority and female; otherwise, she was often ignored. *'First of all, being a woman, it's already challenging because people don't take you seriously. And I've had situations where I've had to ensure that my voice carries across the meeting room to effectively convey my point, even though it's not my usual style. Do you know how I'm talking with you now? Quite casual and all, but if there's a client who clearly only pays attention to my male colleagues, I have to speak up, even more, to ensure that my point is understood'*. **DD** further affirms that *'Imagine having a slight accent that isn't English. Suddenly, they know that you're BAME or from a different ethnic background. In that case, they already have these assumptions about you that you*

don't know anything, and Yeah, I've seen it happen. I once had a colleague from xxx, and he had an accent. He has lived there all his life, and he is very clever. He probably knows more than I do, and I was born and raised here. When we were in the meeting, it was an internal meeting with other design teams. This happened quite a few years ago now. And whenever he would say something, it wouldn't be taken seriously. There were a few instances where I had to repeat his words, and when I did, I made sure to speak firmly. And so that other people would listen to me before it was taken seriously'. Surely, these issues are prevalent within the construction sector and reduce the interest of new BAME entrants. **DD** laments, *'You could be at the top of your game. Still, if people are always biased, it doesn't matter. There will always be something that someone does not like about you or assumptions made about you based on your gender or ethnicity. It's unfortunate, but that's just the way it is'*.