/imagine Futures

Artificial Intelligence: Its Role in the Built Environment and *Advancing* the Green Transition

COPENHAGEN INSTITUTE FOR FUTURES STUDIES

COWI

The Delphi Study Method

A Delphi study is a collaborative futures studies method designed to elicit consensus building among a panel of experts on a series of future hypotheses. The method is based on the principle that collective foresight from a curated group of experts provides superior insights and orientation around potential future developments, particularly when dealing with complex areas with a high degree of uncertainty.

There will be two rounds in this Delphi: In the first round, you will be asked to consider and respond to all hypotheses as you would in any survey. After the first round is closed, you'll be asked to revisit the Delphi in a second round, where you will revisit and potentially re-evaluate your initial responses considering the current consensus (the panel's overall opinion) and arguments from other experts. Hence, it's important that you provide argumentation for your choices in the comments sections throughout the Delphi, as these will be anonymously made public to all participants in the second round.

About the */Imagine Futures* Delphi Study

The dynamics that shape our future are intricately woven into the present, and our ability to anticipate, understand, and harness emerging trends can fundamentally influence the course of our personal and professional lives, our organisations, and societies at large.

Through 'imagine futures' we want to facilitate and spearhead discussions on selected future trends. By bringing together industry leaders and experts, we aim to create engagement, excitement, and knowledge sharing about future scenarios.

In this Delphi study, we delve into the topic of artificial intelligence transition. This expert panel for the Delphi Study consisted of 46 experts, where 19 of them answered the section on Investments in AI, within and its role in the built environment and for advancing the green the built environment. The experts were asked to evaluate a series of questions and hypotheses related to artificial intelligence, the green transition, AI literacy and the work force in the built environment.

AI and its *potential*, challenges, and *impact* within the built environment

Open Question

From your viewpoint, what are the top 3 essential factors we should address today to ensure stakeholders within the built environment are prepared for harvesting the benefits of AI in relation to the green transition?

Excerpts from expert panelist insights

01

- Transparency in the use of AI, particularly how it was trained, and how is the usage being overseen;
- Targeting AI at environmental and public good outcomes – e.g. retrofit
- Ensuring AI doesn't reinforce or worsen inequality in access.

02

- Ensure incentives for all parties to work towards a collective and measurable sustainability objective.
- Establish a data culture that enables data-driven discussions and collaboration via the frequent exchange of data via independent, nonproprietary frameworks that allow for modular extensions and integrations.
- Align on standards and best practices that ensure that high-quality asset and operations data is collected on all new projects.

03

- We need to be able to know where knowledge is harvested from, trust it, and build on it.
- We need to learn to work with AI
- We need some kind of IP or creative commons to share and build/capitalize on knowledge.

04

Literacy in

- Futures thinking
- Systems thinking
- Ethical technology

Summary of findings

Stakeholders in the built environment are currently assessing the advantages, challenges, and broader implications of AI.

Not just the specific applications of AI in the built environment, such as AI driven design, process optimization, and maintenance, but broader topics and concerns regarding, education and upskilling, governance and regulation and its role in incentivizing a green transition and sustainability.

It is becoming evident that a holistic approach involving transparency, education, ethics, collaboration, strategic planning, and sustainability is essential for effectively harnessing AI benefits in the green transition within the built environment.

Open Question

Based on your own insights and observations, where has the AI revolution related to the green transition within the built environment already begun?

Excerpts from expert panelist insights

01 Although a lot of progress is being made, I believe the biggest driver of impact is going to be within monitoring and compliance. AI is already being used extensively from a macro-level, using and analysing satellite imagery to measure the impact of traffic, green areas, etc, to on-the-ground monitoring of the environmental impact of buildings and ensuring compliance with green building standards.

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02 From what I've been observing working with my clients in the built environment, the AI revolution related to the green transition has begun and it's a hot topic companies are dedicating time and resources to research. I see a lot of conversations around it but not much action or agile processes that can lead to prototyping efficiently and quickly. I think the potential repercussions and scenarios that AI could lead to aren't being explored enough.

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03 Predictive Maintenance: AI is analysing data from sensors and drones to identify maintenance requirements, equipment failures, and infrastructure damages. This leads to reduced downtime, optimised resource allocation, and a more sustainable operation.

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04 We use simulations of the light, wind, and the performance of buildings under different conditions and recommend optimizations for energy efficiency and sustainability. It helps in making data-driven decisions at every stage of the project.

Summary of findings

The AI revolution within the built environment is already underway, with various applications and potential impacts. AI is reshaping the rulebook for the built environment, embedding innovation throughout the sector, from revolutionising and accelerating creative design processes to creating detailed virtual models, as well as enhancing sustainability and climate resilience and pushing the green transition.

There are already areas where AI is making its way into the sector from the adoption of digital twins, changing how cities and homes are designed, operated and maintained to areas such as process optimisation where AI algorithms optimise energy consumption, leverage machine learning for predictive maintenance, or the use of sensors to monitor environmental conditions in real time.

Open Question

How do you envision AI shaping the green transition within the built environment sector in the immediate future?

Excerpts from expert panelist insights

01

The reuse of space and building elements is a huge opportunity and demand for platforms where more projects can cooperate - from ideas, over demolition to new buildings. Designing and prototyping with virtual models is not new. However, the capability to include more data points, complexity, and variation will give us the possibility to make more green solutions - both in building and in operation/facility management. A “digital twin” you could call it.

02

AI will enable data-driven real-time decision-making processes by analysing large volumes of data in real-time. Algorithms can help to provide and summarise insights, identify trends, define scenarios, and support informed decision-making.

Improved AI Quality monitoring e.g. of air quality, temperature, and humidity

AI-supported simulations allow effective design solutions by simulating different possibilities

03 AI will be used to optimize energy consumption in buildings by analyzing data on energy usage patterns and adjusting systems accordingly to minimize waste and reduce costs. It will improve the design and construction of buildings and infrastructure by analyzing data on materials, and other factors. AI will be able to identify opportunities for improvement and optimizing performance to monitor and manage the environmental impact of buildings.

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04 Big tech's experiments with deep learning and e.g. Large Language Models (semantic data) segmentation, and computer vision (sensory data) are teaching us a lot within their respective, separate field. I believe the immediate future holds great opportunities and challenges if/when we start combining these complex models and datasets, to predict/foresee ecological footprints, generate early warning systems, map sea surface, etc. If code and data are sourced at the same speed we see today, I believe we will see a lot of creative chaos.

Summary of findings

Looking at the immediate future, AI is set to, influence everything from design precision and construction efficiency to sustainability considerations and real-time decision-making. The emphasis on data-driven insights, predictive capabilities, and integration into existing workflows indicates a broad range of expectations for the role of AI in the green transition of the built environment.

AI is expected to bring more precision to the design of buildings, making them cost-effective and energy-efficient and to assist in life cycle assessment (LCA) calculations and heavy sustainability data analysis.

To more hands-on applications in processes, from example an architectural perspective, in rapid image generation, design option testing, and development/ optimization of designs in CAD/BIM modeling programs.

Open Question

How do you envision AI shaping the green transition within the built environment sector in the long term?

Excerpts from expert panelist insights

01 AI's role in the built environment will transcend beyond functional and operational efficiency to creating spaces that are adaptive, intuitive, and aligned with the natural ecosystem. The intersection of AI with other emerging technologies like biotechnology, biomimicry, and nanotechnology, will usher in an era of innovation where the built environment is not just sustainable but regenerative, enhancing the natural environment and human well-being.

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02 AI can enable buildings to become more autonomous and adaptive by continuously learning and adapting to their surroundings. AI-driven building systems can optimize energy usage, comfort levels, and resource allocation based on real-time data and occupant behavior. This can lead to highly efficient and sustainable buildings that dynamically respond to changing conditions.

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03 Fully designed scenarios showing the impact of each tactical and strategic decision in the area, the local communities, society at large, and future generations.

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04 Data crunching will be done by AI on energy, heat, and GHG emissions. This big data crunching has the power to transition ownership of net-zero back to individuals and disrupt the current energy/water stakeholders aligned with the built environment sector. AI will enable stakeholders in the built environment to do real ESG Reporting on any project. AI will enable a nexus of shared expertise and data insights, between the built environment, climate data, and human mobility data to enable cross-fertilisation of solutions in response to crises and non-crises in construction.

Summary of findings

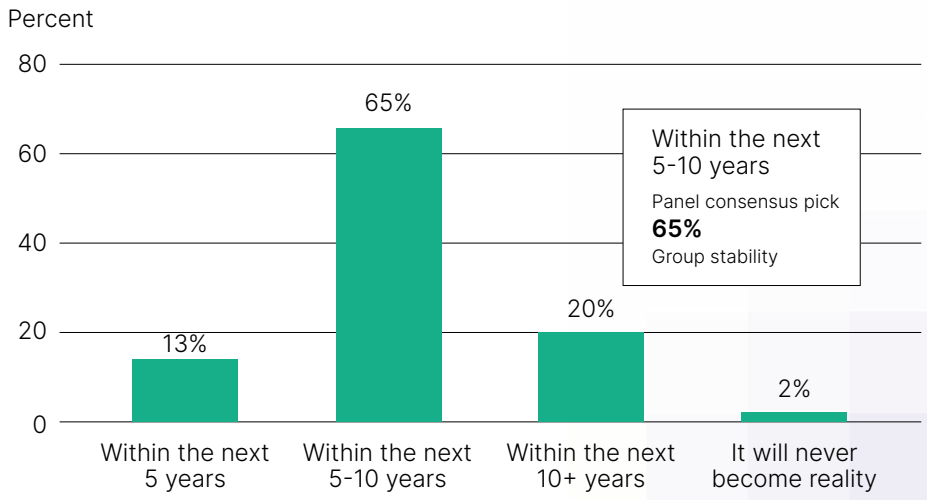
In the long term, AI holds transformative potential for the built environment, enhancing sustainability, efficiency, and adaptability.

From AI making modifications to existing buildings easier, thus avoiding demolition and new construction to potential new business models, new markets, and an unprecedented level of engagement in urban governance.

The integration of AI can be seen as a potential key driver for positive changes in building design, construction, and management for long-term environmental and social benefits. However, anticipating AI's development is not without uncertainties. The transition to AI-driven systems in the built environment is complex, posing challenges in existing building compliance, navigating green transition complexities, and ensuring seamless integration into diverse contexts.

Multiple Choice Question

When will AI reach the "Plateau of Productivity" in the built environment?



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Excerpts from expert panelist insights

01 I think probably a lot of the things that can work in silo of each other will see a plateau in the next 5-10 years. However, the system level affects that are needed to start integrating, overcoming red-tape and creating policies means at a system level likely in the 10+ years. I think this is where we will see most of the dramatic changes.

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02 Planning legislation and practice take years to change; the building stock is (in the developed world) mostly already with us; the property sector is slow to innovate, in the UK there are multiple layers of sub-contracting and low skills development. How we manage existing stock will improve reasonably quickly 5-10 years; what and how we build will take longer.

03 5-10 years is very optimistic, but we (the planet) do not have many years to transform the way we construct buildings. It is not enough that the large engineering and architectural companies use advanced tools - all actors in the business need to engage in the process. The whole industry will have to undergo a very swift transformation, and AI is a tool that can facilitate this transition.

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04 The built environment (particularly construction) is one of the least technologically advanced sectors, it therefore has a lot of catching up to do in comparison with other sectors (e.g. finance).

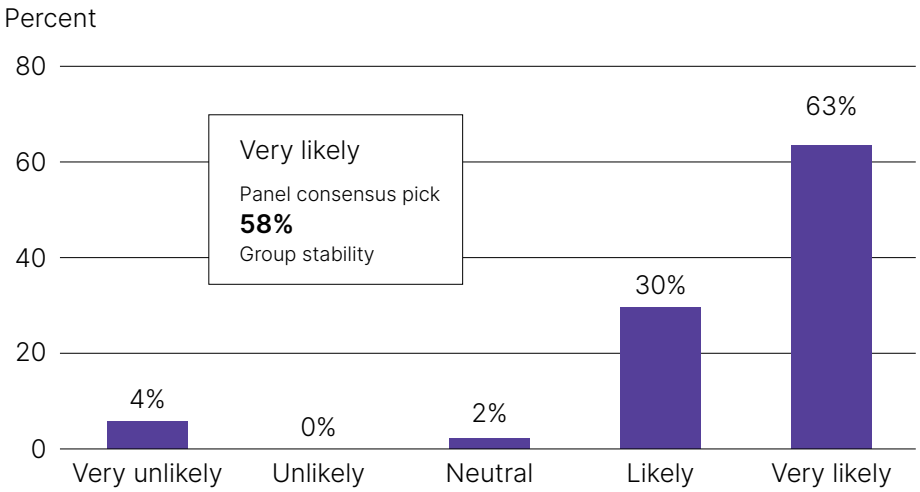
Summary of findings

The complex landscape surrounding the built environment will impact the adoption of AI. Traditionally, the sector has been slow to adopt new technologies, influenced by extended planning cycles, conservative practices and the long-term nature of its projects. The complex dynamics within the built environment, involving diverse stakeholders, layers of subcontractors, and suppliers, present unique challenges compared to industries with clearer hierarchical structures.

The integration of AI into the built environment is expected to be uneven, with specific applications and solutions maturing at different rates. While the transformative potential of AI is vast, the need to overcome challenges across technological, cultural and ethical dimensions for a successful and widespread integration is crucial.

Multiple Choice Question

By 2030, 50% of projects in relation to the built environment sector will be using integrated AI as a standard tool.



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Excerpts from expert panelist insights

01 AI will be in everything whether people know it or not - in accounting software, business process management, procurement tools, etc. So, it will be integrated anyway. And there is so much low-hanging fruit in this industry that AI will be applied to lots of problems/opportunities.

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02 Using AI-driven tools can identify where a process is not efficient, streamline it, and offer short-term benefit to all the stakeholders operating in the built environment. It can also remove personal views and perceptions around complex topics (this very often slows down projects) and offer a data-driven approach that aligns construction companies, architects, landlords, tenants, and all key stakeholders in such a complex sector.

03 I think the current hype and trajectory of AI is so strong, that nobody dares to not think about implementing it - or at least experimenting with it. Anyone interested in maximizing their ROI will seek opportunities to lower costs and increase returns. AI is framed as a perfect opportunity to do so, which makes it increasingly likely that any project professional, manager, owner and investor will seek to implement AI where it is possible to do so.

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04 There will be some frontrunners who use the new technologies fairly quickly, but we will also have some who still do as they usually do and will be a little harder to get on board with AI technology. This is the pattern I have seen with BIM and ICT in the industry.

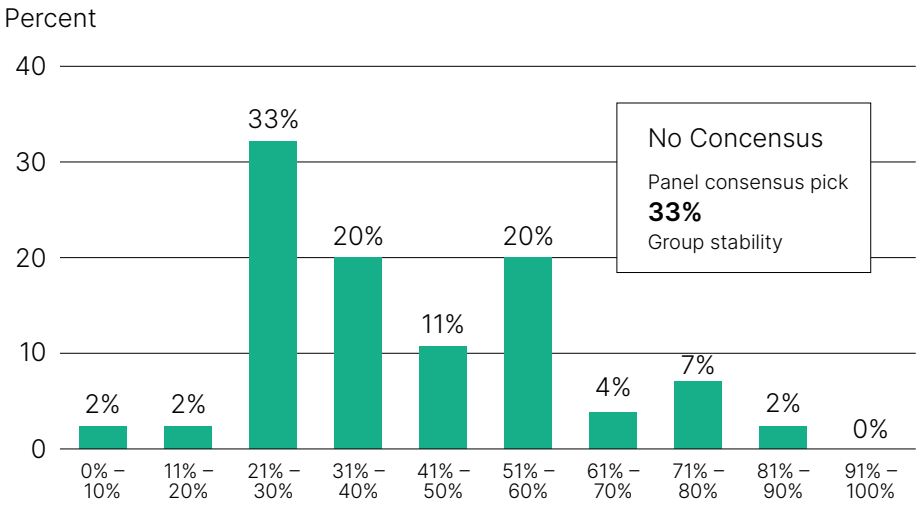
Summary of findings

The rapid pace of AI development and its open accessibility are recognised as factors likely to drive further adoption in the built environment. There's a widespread perception that AI integration is not only possible, but essential to the survival of the sector in the long term, with an ongoing trend of AI adoption in the built environment, making it a long-term shift rather than a short-term trend.

While it is suggested that it may be possible to ease the integration of AI within the built environment, there are more nuanced perspectives on the adoption and implementation of AI, suggesting that its impact may vary across different aspects of projects.

Multiple Choice Question

Consider how a project is typically carried through today – in 2030 how many resources could be saved by leveraging AI?



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Excerpts from expert panelist insights

01 I think AI has a huge potential and will imply a revolution in some areas. At the same time, I don't think AI will become the "everything killer". We have for decades made things more efficient, automatic, professional, digital. We have already trimmed a lot of the fat with regards to tasks that should be automated. AI will give this a huge boost in the years to come, but I don't see everything being changed by AI. At least not in the next 7 years.

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02 AI's ability to handle data collection, tracking, and reporting will significantly streamline tasks, allowing human professionals to focus on more strategic and creative aspects of project management within the built environment. This substantial reduction in resource expenditure is a result of AI's efficiency and automation capabilities.

03 I think it depends on the verticals, sectors, industries, size of projects, and especially degrees of complexity.

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04 I think it will be lower than predicted in the built environment, based a lower level of digital maturity in the sector. For large infrastructure projects specifically, a lack of integration across companies' systems, data inconsistency, different schemas, etc., will all hinder the adoption of AI. If these issues are tackled, then AI adoption could certainly increase.

Summary of findings

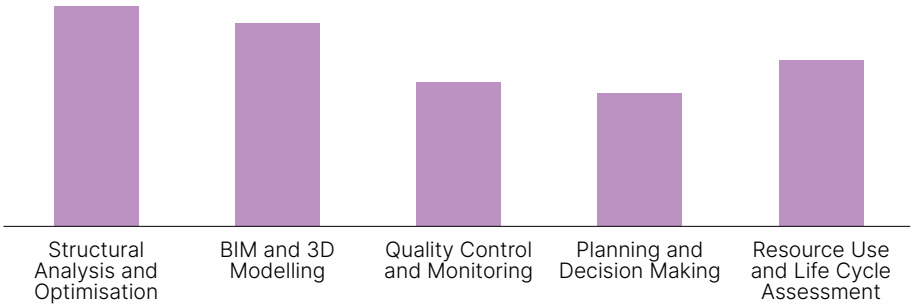
The impact of AI is anticipated to vary across different industries, project sizes, and levels of digital maturity, while AI might bring about efficiency, it may not be equally suitable for all projects. In short, there is a recognition of the need for a balanced and strategic approach to integrating AI into projects.

While AI can perform certain tasks efficiently, there is a belief that it should be viewed as a complement to, rather than a replacement for, human skills and expertise, especially in decision-making, negotiation, and addressing the social and human aspects of projects.

The conversation extends beyond cost savings, emphasising AI's potential to drive positive societal change, provided that the challenges of adoption, integration, and ethics are addressed.

Open Question Grouped Into Categories

Top 5 areas and phases that AI will have the most impact on by 2030



Excerpts from expert panelist insights

01 I think planning and decision making will have the greatest impact. The way you can overview large amounts of data, experience and rules will be of great importance in making the right and good choices from the start. This one can have an impact on all the other topics.

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02 I believe the fields which will include human abilities, capacities and skills such as creativity and design processes, operations and overall management are least likely to be impacted by AI. Mechanical and technical processes, however, will probably see an increase of AI application.

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03 I believe the huge upside of AI in built environment in the relative near-term future is how it can be used to provide more insight and stronger analytical capabilities. That means that life cycle assessment, quality control, structured analytics, reduced energy use, more efficient material use, and similar areas will be most affected.

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04 BIM and 3D modelling is a use case I have been aware of for 5+ years. Resource use and LCM is maturing quickly given ESG targets and tech advancement. Supply chain and creative design are natural application of Generative AI. Quality control and monitoring is a regular feature of the built environment now and will become ubiquitous if the price of sensors and compute power remains low.

Summary of findings

It is a pivotal moment, prompting a critical examination of the areas and phases within the built environment impacted by AI advancements. From the innovative advancements already seen in the creative space to the data-intensive areas of planning and quality assurance, AI is on the verge of reshaping the way we design, construct and manage the built environment.

In the field of planning and decision making, areas where AI is anticipated to have a significant impact are often part of the discussion. AI's ability to analyse large amounts of data and scenarios will play a key role in making informed and strategic decisions.

Open Question

From your viewpoint, what are the top three essential factors we should address today to ensure an ethical development and use of AI in the built environment

Excerpts from expert panelist insights

01

- Openness and transparency of code, process, and data (tapping into collaboration, quality of solutions, and accountability)
- Engagement of users from day one in design, planning, and implementation (tapping into inclusivity, equity, participatory design, human-centered design, and data representation/bias mitigation)
- Auditing and legislation (tapping into governance and accountability)

02

- More education on AI and its long-term repercussions on society
- Making sure researchers conduct research and that research is not conducted by architects, engineers, or developers with little knowledge about data bias and data protection
- All projects in the built environment are human-centric and go beyond the study of material performances, latest technological deve-lopments and sustainability best practice, but start looking at the built environment as a sector that shapes society, its value, and its habitat

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03

AI systems rely on data to make decisions, and if that data contains biases, those can be reflected in the AI outputs. For an ethical use of AI in the built environment, it is crucial to ensure that the data used is representative and that biases in decision-making are mitigated. This also includes considering and addressing the implications of AI decisions on different user groups to avoid any potential discrimination or unfair treatment.

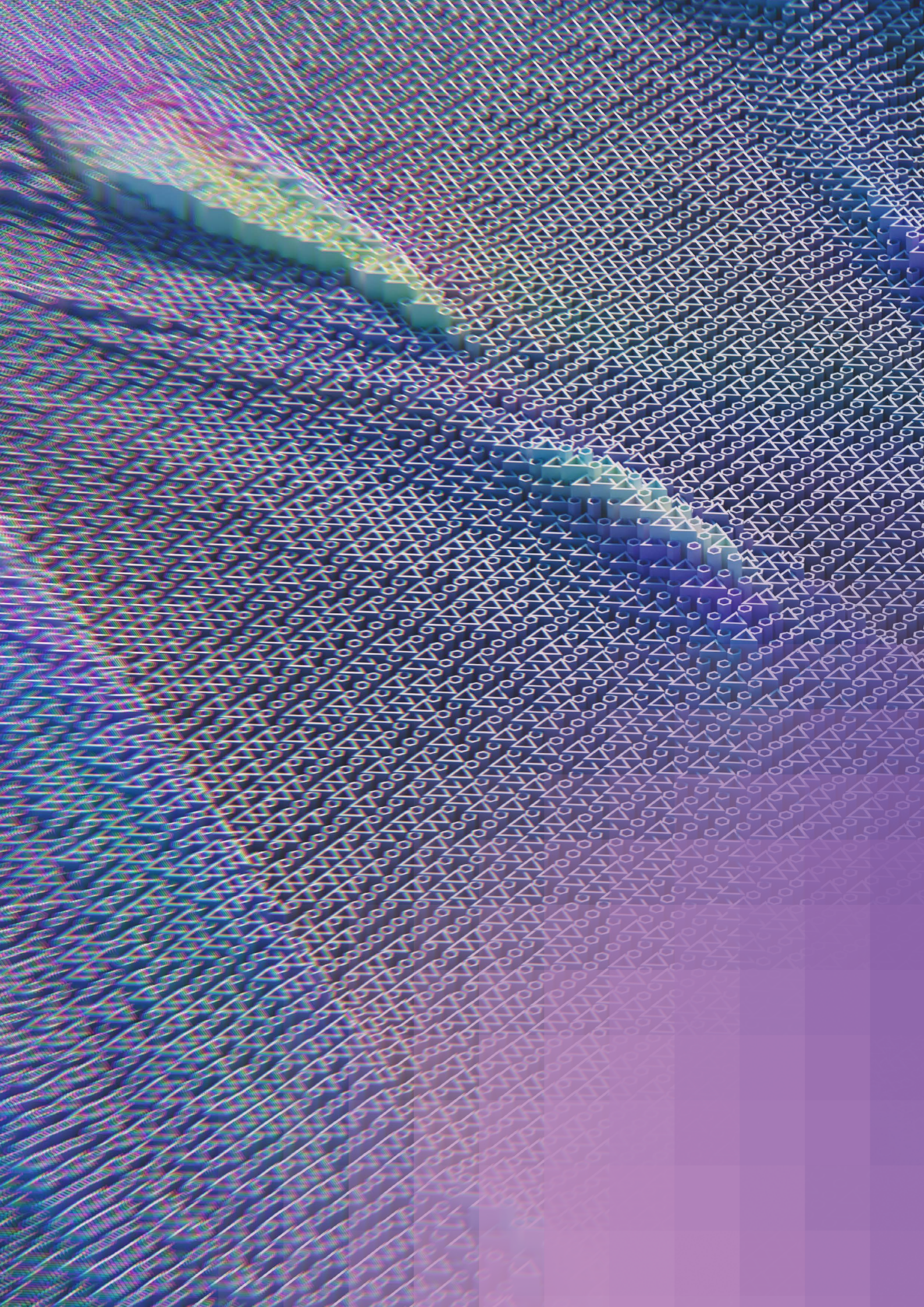
04

As AI in the built environment often involves the collection and processing of vast amounts of data, including potentially sensitive information, it is integral to have robust data privacy and security measures in place. This involves ensuring that data collected is only what is necessary, is securely stored, and is processed in a manner respecting users' privacy rights.

Summary of findings

Ethics in AI presents multiple challenges, including addressing biases that can result in unfair outcomes, addressing privacy concerns related to data collection, defining accountability when AI makes decisions, ensuring transparency in non-transparent AI models, and managing the social impact of AI.

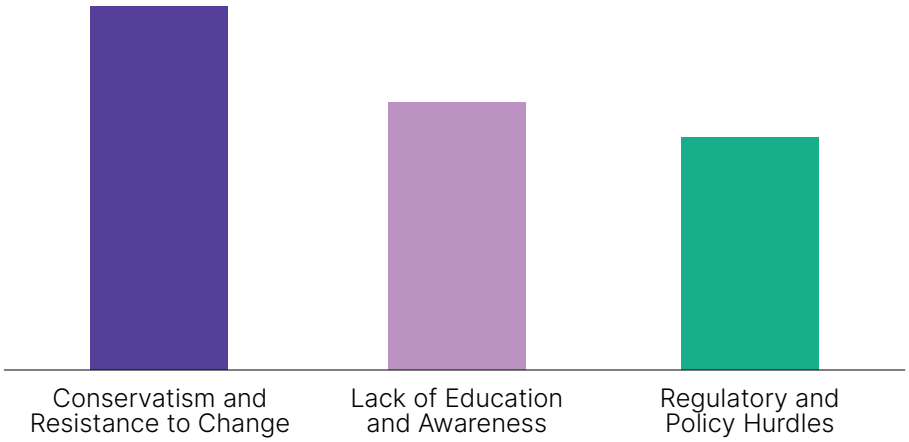
Addressing the ethical development and use of AI in the built environment requires a multifaceted approach that includes transparency, accountability, fairness, inclusivity, environmental considerations, regulation, and ongoing education and awareness. The combination of these factors is essential to ensure that AI benefits society without compromising fundamental ethical principles.



AI and the *green transition* in the built environment

Open Question Grouped Into Categories

Top 3 most important BLOCKERS for AI and the built environment sector towards 2030



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Excerpts from expert panelist insights

01 Lack of Regulation: Inadequate regulations pose a significant hurdle, creating uncertainties and ethical concerns, thereby slowing down the implementation of AI. 2. Data Security Challenges: Ensuring the security of the vast amount of data AI relies on is a major obstacle. Data breaches could erode trust and hinder the adoption of AI solutions. 3. Resistance to Change: Resistance from traditional sectors within the industry might impede the adoption of AI technologies due to entrenched practices and skepticism. 4. Limited Interdisciplinary Collaboration: Insufficient collaboration among AI experts, architects, engineers, and policymakers can hamper the comprehensive development of AI solutions tailored for the sector. 5. Ethical Concerns: Addressing ethical dilemmas related to AI decision-making, such as biases and transparency, is crucial for gaining public trust and acceptance.

02	Unclear responsibility as seen from a legal standpoint. 2. Ethical concerns as to what the AI introduction will imply in the long-term. 3. Lack of investment caused by lack of understanding of the upsides. 4. Accidents or clear examples of highly negative impact of introduction AI at a large scale. 5. Governments introducing limits on AI use, caused by concerns about human cost relating to workplaces lost, etc.
03	Conservatism, competition, Lack of incentives
04	Conservatism in the industry: Traditionally, the construction industry is very conservative and demand-driven, creating tailor-made buildings based on proven solutions and materials. Characterised by a large number of players, including a large number of subcontractors - making it difficult to make all engage a common system. Contractor and subcontractor skills: a high level of digital skills are requiring to engage in modern IKT/BIM systems. AI will only complicate the systems further. Many SME contractors does not currently have the capability to participate in such a system Lack of reliable data: (refer to my previous comments on data). Without relevant, up-to-date and elaborate data for the construction project (alle aspects), AI systems will not work properly. Lack of courage at construction clients: Suggesting new types of building with new methods, materials etc. will make many clients insecure. Investments in new AI tools will be an investment that - at least at first - will make construction more expensive

Summary of findings

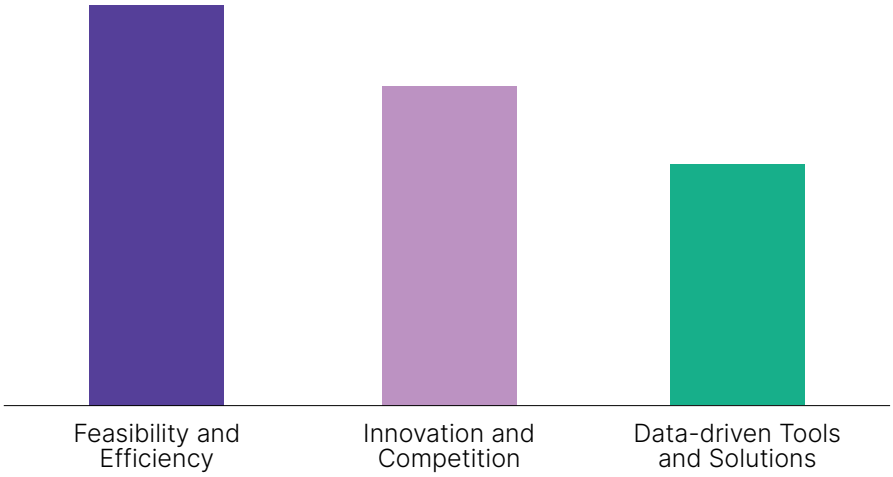
Substantial barriers hindering the rapid adoption of AI technologies in the built environment sector, such as pervasive conservatism. This resistance to change is deeply ingrained, with stakeholders accustomed to traditional processes and decisions often embedded in proven and familiar practices.

Limited literacy about the capabilities and implications of AI within the industry restricts the sector's ability to harness the full potential of cutting-edge advancements and their potential applications for green transition.

Inadequate regulations and uncertainties about AI implementation further contribute to a complex landscape. Clear and supportive regulatory frameworks are essential to navigating these challenges and ensuring a smooth and ethical integration of AI.

Open Question Grouped Into Categories

Top 3 most important DRIVERS for AI and the built environment sector towards 2030



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Excerpts from expert panelist insights

01 Better buildings: Potentially, AI can help to facilitate buildings that are greener, better looking, cheaper, easier to operate and maintain, and eventually dismantle and recycle. Successful cases can provide a strong driver for other projects. Climate regulation and marked driven schemes as EU Taxonomy criteria for green investments: For instance, today the CO2 limits in the Danish Building Code is a very strong driver for green transition in the industry. AI-based tools can facilitate this transition and make it more efficient. Makes tasks easier (or better): Any aspect where AI can automate tedious tasks or make worldwide searches that would never happen by hand. When project manager or other professionals realise that their workday can be easier by use of AI. (the trick is to stop the accountants of this world from capitalising on these expectations long before they are a reality...)

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02 Sustainability Goals and Climate Change Mitigation 2. Government Policies and Incentives 3. Stakeholder Collaboration and Partnerships

03 Government Support and Funding: Strong governmental backing and financial support can act as a driving force, encouraging research, development, and widespread implementation of AI technologies in the construction sector. 2. Technological Advancements: Continuous advancements in AI technology, especially in machine learning algorithms and data analytics, will drive innovation and efficiency within the built environment, promoting AI adoption. 3. Environmental Sustainability Focus: Growing emphasis on eco-friendly practices and sustainable construction methods can drive the integration of AI for optimizing energy use, reducing waste, and enhancing overall environmental performance. 4. Industry Collaboration: Collaborative efforts between AI experts, construction professionals, and urban planners can foster creative solutions, pushing the boundaries of AI application in construction projects, ensuring more intelligent and efficient buildings. 5. Public Awareness and Acceptance: Increasing awareness among the public about AI's potential benefits and addressing misconceptions can create a positive environment for AI adoption. Acceptance and demand from society can act as a driving factor for AI integration in the built environment.

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04 Monetary incentive. 2. Possible to accelerate the green transition. 3. Lower carbon footprint. 4. More efficiency. 5. Nobody dares to miss the upsides of AI. Leads to investments and use.

Summary of findings

A diverse array of factors could contribute to the successful incorporation of AI in the industry. AI solutions are practical, cost-effective, and can be seamlessly integrated into existing infrastructure. Its applications are viewed not only as technologically viable but also financially and operationally feasible for widespread adoption.

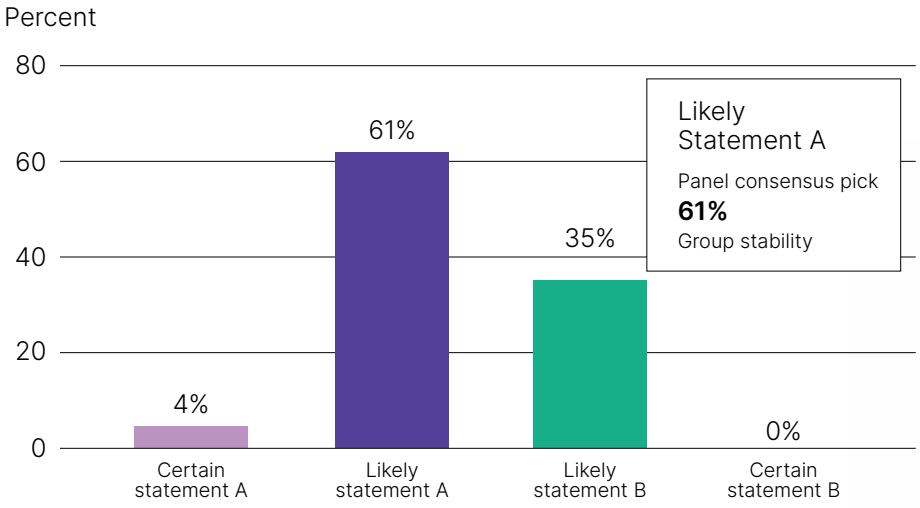
Constant innovation is crucial for staying competitive in the dynamic landscape of the built environment sector. AI serves as a catalyst for groundbreaking advancements, driving firms to continually push boundaries in design, construction, and operations to gain an advantage. Ultimately, data-driven tools help actors in the sector with informed decision-making to meet their sustainability goals.

Multiple Choice Question

Which of the statements below aligns most closely with your views about the likely impact of AI on the green transition by 2030?

STATEMENT A: By 2030, AI WILL be a foundational element driving the green transition in the built environment.

STATEMENT B: By 2030, AI WILL NOT have made a significant impact on the green transition within the built environment.



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Excerpts from expert panelist insights

01 It is a crucial area. By nature, the projects in the built environment requires feasibility, predictions, and visualization all strong tasks for AI. It will be particularly strong in opening up new opportunities because this is the stage where in the AI weighs the heaviest.

02 The challenges with the green transition is based shifting how we provide energy, build, manufacture and transport. All these things can be optimised using software, but we have so much built in legacy that takes decades to change for Ai to make a significant contribution.

03 AI will be a fundamental helping tool that allows us to cover more ground - BUT not fundamentally the only way to reach those goals. ie. not the foundation, but more like a booster. We can already reach goals within planetary boundaries today, but it comes with certain costs, not inclined to be implemented by current elected politicians etc. AI can be used to greater good or to secure anti sustainable development by lobbyists representing global companies who oppose regulation.

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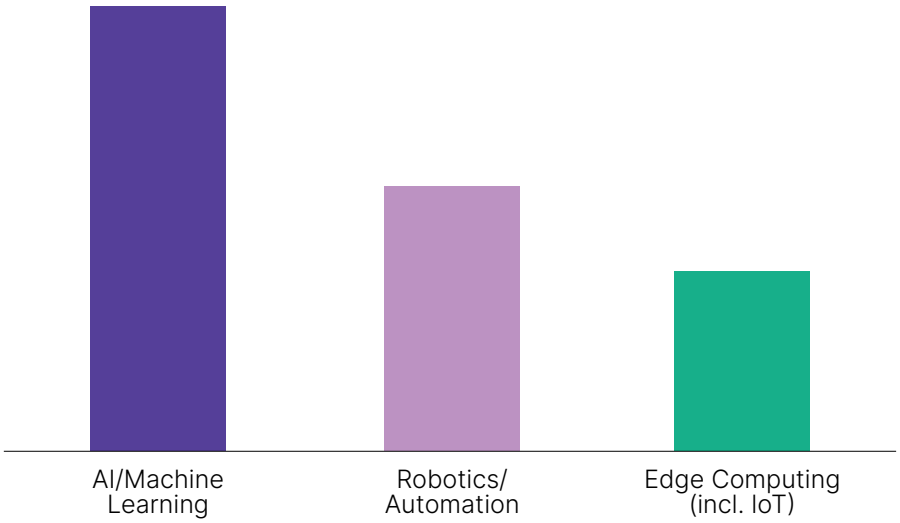
04 So many actions are needed for significant progress on the green transition with the built environment that to say that AI alone will do that in 7 years is not likely without a huge transformational breakthrough. By 2030 i would expect impacts in defined areas but not universally across the sector.

Summary of findings

AI can be recognised as a key driver in the green transition towards 2030 since its applications can have measurable benefits for the built environment sector. AI systems could fine-tune building management through predictive maintenance, identifying potential inefficiencies and malfunctions before they escalate. Generative design algorithms could be helpful with functional aspects of the structures, taking into account environmental parameters. AI's role in optimizing supply chains for construction materials could further contribute to the reduction of embodied carbon in building materials, a critical aspect of sustainable infrastructure.

Open Question Grouped Into Categories

Top 3 technological areas that will play a significant role in the green transition of the built environment towards 2023



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Excerpts from expert panelist insights

01 AI/Machine Learning: AI's ability to optimize energy usage, design eco-friendly buildings, and enhance sustainability makes it the most significant factor in Denmark's green transition. 2. 5G: High-speed and low-latency 5G networks can facilitate real-time data collection, enabling efficient monitoring of energy usage and environmental factors in buildings. 3. Edge Computing (including IoT): Edge computing, coupled with IoT devices, enables decentralized data processing. This technology is vital for managing smart building systems, ensuring energy efficiency, and reducing waste.

02 IoT will be the most important tool for collecting data which can be used for planning, logistics, maintenance, energy saving, administration and for the use of AI. The use of VR/AR will be crucial for understanding, testing and selling. AI will be the main tool in finding ways to develop new and improve "green solutions".

03 I see a potential in automation and robotics enhancing some of our mechanical, production processes, but AI will play a greater role in making informed decisions and providing us with precise and valuable analytics for how to make infrastructures and food systems more efficient.

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04 AI and ML technologies can optimize energy consumption, improve building performance, and enable predictive maintenance, contributing to the green transition in the built environment. IoT devices and sensors can collect real-time data on energy usage, occupancy, and environmental conditions, allowing for better monitoring and control of building systems, leading to increased energy efficiency and sustainability. BIM technology enables the creation of detailed virtual models that can simulate and optimize building designs, construction processes, and energy performance. It facilitates collaboration, reduces waste, and supports sustainable decision-making in the built environment

Summary of findings

Identified technological areas encompass distinct elements for advancing green transition.

AI and Machine Learning can optimize energy consumption, predict usage patterns, and enhance the efficiency of building systems. They enable predictive modeling, that adapt and learn from building performance data

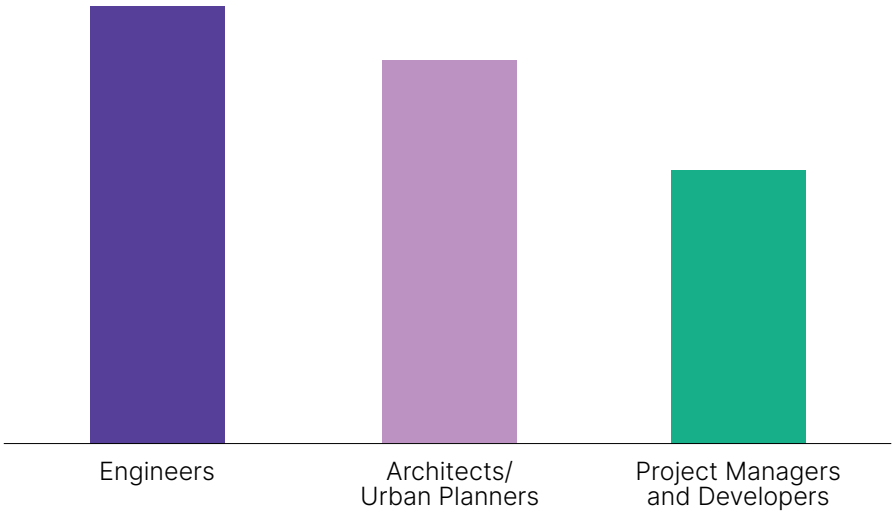
Automated construction processes can enhance precision, reduce material waste, and accelerate project timelines. Prolonged construction activities are associated with a higher environmental footprint and expediting them through automation could be critical.

Edge Computing, on the other hand, empowers real-time data processing at the source, allowing for swift decision-making in response to environmental variables.

AI literacy and the *workforce* within the built environment

Open Question Grouped Into Categories

Towards 2030, which stakeholders will experience the most pressure to develop AI literacy within their field?



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Excerpts from expert panelist insights

01 Engineers are critical to build, renovation or maintenance activities. Architects strike me as closer to the technological edge and can adopt quicker than other occupations listed. I selected suppliers particularly in relation to energy and resources suppliers, who may be expected to partner with developers/owners/ managing agents to enable energy/resource efficiency.

02 Based on the anticipated impacts and necessary adaptions, I believe engineers, architects/urban planners and government will experience the most pressure to develop AI literacy: Engineers are central to implementing technological solutions. As AI continues to evolve, engineers need to understand, adapt, and optimize their workflows around these technologies to create efficient, sustainable, and safe built environments. Architects and urban planners are tasked with designing spaces to be functional, sustainable, and conducive to wellbeing. AI literacy will be essential to utilize data analytics, simulations, and predictive models to make informed planning decisions for greener buildings and more sustainable humane spaces. Government officials are responsible for policy-making, regulation, and oversight. Understanding AI will be crucial to create supportive legal frameworks, ensure ethical AI deployment, and leverage AI for public services and governance. The speed and equity of decision-making will also be vastly improved.

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03 The pressure to develop AI literacy may come from various sources, such as advancements in technology, changes in job requirements, or competition within the industry. Mostly engineers and creative industry will need to develop AI literacy to design buildings and other elements; and to operate and maintain AI-powered machinery.

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04 Architects, Urban Planners: Given their central role in designing sustainable and smart buildings, architects and urban planners will be under significant pressure to understand AI concepts and their applications in construction. 2. Engineers: Engineers, especially those involved in designing infrastructure and energy systems, will face substantial pressure to grasp AI fundamentals to optimize designs and ensure eco-friendly solutions. 3. Government Officials: Government officials, responsible for shaping policies and regulations in alignment with AI technologies, will be pressed to develop AI literacy to make informed decisions regarding their implementation.

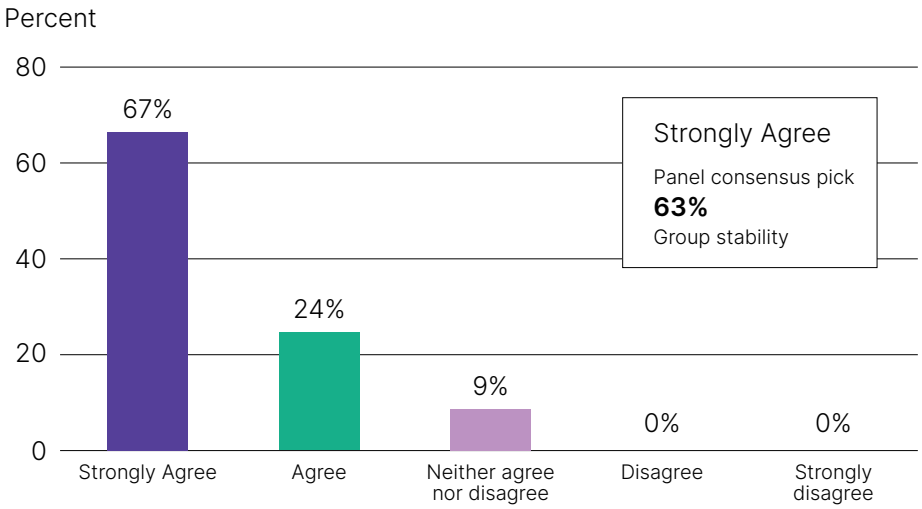
Summary of findings

AI literacy is the ability to understand and work with AI concepts and features. It involves grasping the fundamentals of AI, recognising ethical implications, and understanding practical applications. It's an evolving skill that requires continuous learning to keep up with AI advances and promotes responsible use of AI.

The pressure to develop AI literacy can come to be felt across various sectors, with a strong focus on engineers, architects, government officials, and the private sector. The adoption of AI is seen as crucial for efficiency, sustainability, and staying competitive in the changing landscape.

Multiple Choice Question

By 2030, it should be the norm for educational programs related to the built environment to have AI literacy as core component in order to harvest the full potential related to the green transition?



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Excerpts from expert panelist insights

01 Embedding AI literacy in educational programs related to the built environment by 2030 is crucial to fully leverage its potential in the green transition. This ensures professionals are equipped to drive sustainable and innovative practices in construction and urban planning. AI will be a natural choice of tool to effectively enhance Innovation over all.

02 AI is rapidly becoming integral in the design, construction, and management of built environments. Professionals need to understand how to leverage these technologies effectively and ethically. It is essential that upcoming professionals in this industry get the right tools and frameworks through education.

03 As the demand for AI-driven solutions in the built environment continues to grow, educational programs that prioritize AI literacy will ensure that learners are prepared for the emerging job opportunities and can contribute effectively to the green transition

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04 As indicated in the beginning, building AI into the fundamentals of engineering, building, architecture and other built-environment professions will be needed to build a new generation of professionals who will progressively incorporate AI in the built environment.

Summary of findings

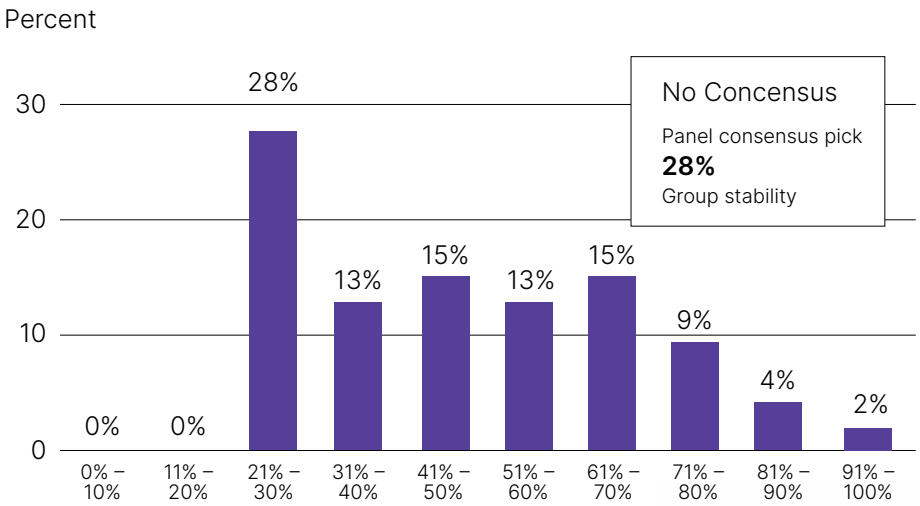
As AI is set to transform the built environment, is the education system set to prepare the next generation of professionals for the future and provide the skillset and knowledge to navigate the built environment sector that might be very different from today.

There is a potential that embedding AI literacy in educational programs might be driven by the increasing demand for AI-driven solutions in the built environment, related to the need for sustainable and innovative practices in construction and urban planning.

The importance of AI literacy in the sector is recognised, but there are differing views on the timing of its implementation, the depth of understanding required and the overall impact on the sector. This highlights the complexity of integrating AI into education, and the need for thoughtful consideration of its role in shaping future professions.

Multiple Choice Question

Towards 2030, what percentage of the workforce do you think should have to have a solid understanding of AI to harness its full potential related to the green transition?



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Excerpts from expert panelist insights

01 I think it's going to be very few who won't utilise any kind of AI functions. Whether they know it or not. Question is "solid understanding". I don't think most people will have a solid understanding of AI. But they will have a solid understanding of the tools and systems they use. Which most likely will have some sort of AI element to them

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02 A significant portion of tasks, especially repetitive and data-intensive ones, will be automated. The remaining workforce in direct contact with AI applications will need a higher level of AI literacy to manage, optimize, and innovate with these technologies. That said, AI does not operate in isolation. A combination of human skills and AI capabilities will drive the green transition. My estimation foresees a balanced workforce with AI literacy and other essential skills like creativity, critical thinking, and emotional intelligence.

03 I don't think everyone needs to understand it. For many workers it will be sufficient to just know the basics and carry out tasks. Investors, managers, project leads, developers will be the critical groups that NEEDS to understand it.

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04 Without a workforce that's highly proficient in AI and its repercussions on buildings, society and the environments, we will only see gimmicky manifestations and there's not going to be the change that is needed.

Summary of findings

The complex nature of integrating AI into the workforce to enhance the green transition involves considerations of education, sector-specific needs, societal attitudes and the evolving nature of technology adoption.

As there may be a need for a broad understanding of AI across the workforce, it will be important to ensure inclusivity in AI education and skills, recognising that there are disparities in terms of education, skills, and sectors. The need to make AI knowledge accessible to a diverse groups becomes essential, while the level of understanding of AI may vary across roles, tasks and sectors.

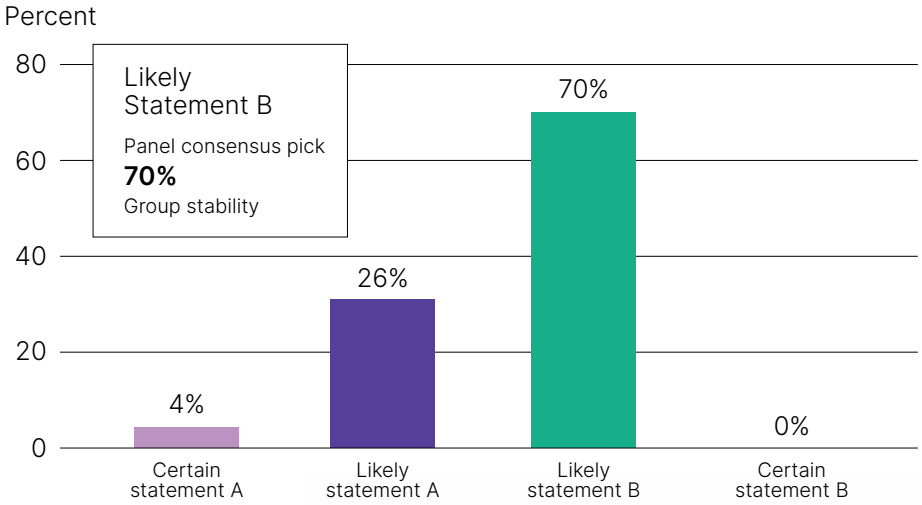
To unlock the potential of AI for meaningful change, not just the green transition, a skilled workforce is essential. However, it's important to ensure a balance by building a workforce equipped with both AI skills and other qualities such as creativity and critical thinking.

Multiple Choice Question

Which of the following statements aligns more closely with your views about the development and impact of AI in within the built environment by 2030?

STATEMENT A: By 2030, AI offset the effects of a reduced labour force with automation and digital solutions, e.g. by being a primary, ubiquitous tool in various activities

STATEMENT B: By 2030, AI's role in compensating for the diminished labour force will be limited, e.g. because its application will remain segmented, addressing specific needs rather than being universally integrated.



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Excerpts from expert panelist insights

01 The current decisionmakers are likely to resist for as long as possible if its not a direct benefit to them despite the need for action. We have seen examples where beneficial technologies have been hampered by distorted interests and power struggles, it is unlikely that 'doing good for societies' will suddenly become the norm

02 Considering AI advancements and the pressing need to compensate for a shrinking workforce, it is likely that AI will become a primary tool in various activities. Also, Automation and digital solutions will play a significant role in addressing the challenges posed by the reduced Labor force.

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03 AI is transforming the way we work and build our worlds but there is a high degree of complexity in the built environment, mainly due to a large group of stakeholders with a very different set of needs. Technical tasks will be executed by AI-driven processes, but the role of property developers, engineers and architect (and urban planners) is going to be more and more about dealing with constant change, and this requires creativity, resilience, and emotional intelligence.

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04 I don't believe that anyone has a view on what the workforce or AI adoption will be in 2030. However, I do believe that AI will continue to develop in an exponential manner. I also believe in Amara's law in relation to AI.

Summary of findings

With AI potentially disrupting the workforce, there is an emphasis on the potential societal consequences, the need to rethink the nature of work and the emergence of new types of jobs. The segmentation of AI use is also part of the discourse, with some leaning towards the idea that the role of AI may be limited and not universally integrated, citing potential resistance to change in companies and industries. The built environment is known to be conservative and there is a strong possibility that the implementation and adoption of AI will be met with resistance, limiting its impact.

Anticipating the state of AI and the workforce in 2030 is challenging, with uncertainty around the timeframe for compensating the potential reduced workforce. Geographical differences in AI development and adoption should be regarded, for example differences by location and governance.

Open Question

What types of entirely new jobs and roles do you anticipate will emerge in the built environment sector by 2030 due to AI?

Excerpts from expert panelist insights

01

- Universal Design Engineer - AI checks any new project for gender equity and universal design compliance.
- Built Environment Conservationist - data crunching on nature metrics to show compliance and contribution to a country's NDC targets.
- Built Environment VR Educator - using VR to engage students in regenerative projects, enabling them to visit city-based biodiversity spots, use real-time emissions data etc.

02

- AI democratic innovation lead,
- AI commons coordinator/commons curator

03

- Climate Resilience Engineer: Leverage AI to develop built environments that are resilient to climate change, extreme weather events, and environmental challenges.
- Smart Infrastructure Coordinator: Oversee the integration of AI in infrastructural development, ensuring it contributes to sustainability, efficiency, and adaptability.

04

- Chief Human Sustainability Officer
- Future Generations Guardian,
- Chief AI Officer

Summary of findings

While AI is set to take over roles and jobs as it is further advanced and implemented, new roles and jobs may emerge in response to this development.

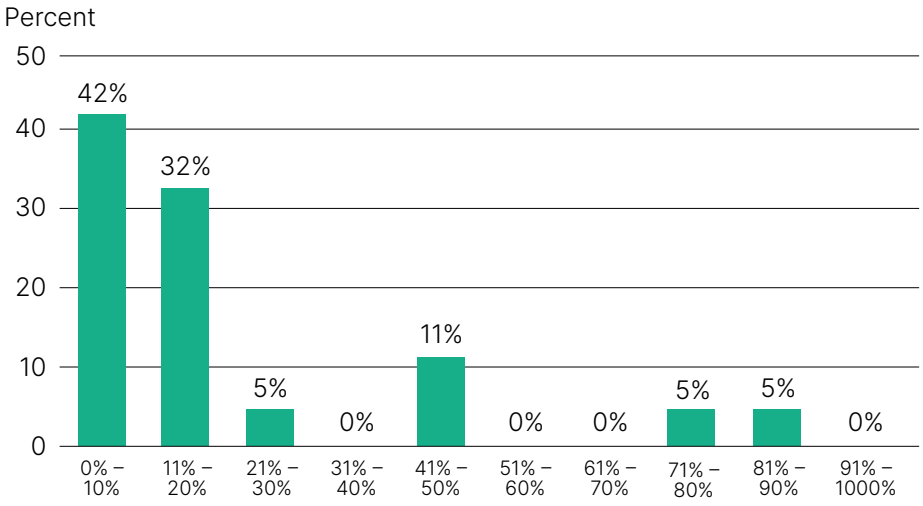
This may result in a dynamic landscape of emerging roles, spanning technical expertise, ethical considerations, sustainability and the integration of AI across various aspects of the built environment sector. The evolving nature of work in this sector is expected to encompass a wide range of skills and roles to manage the complexities introduced by AI technologies.

From roles dealing with the need for bridge between human needs and AI, with an emphasis on individuals who can bridge the gap between human needs and AI capabilities to jobs related to AI, data, ethics, with a focus on data management, analysis, and ethical considerations in AI applications.


Investment in *AI*

Multiple Choice Question

For the upcoming year, what percentage of your R&D-, Business development, IT/Digital budget do you anticipate allocating to investments in AI?



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Excerpts from expert panelist insights

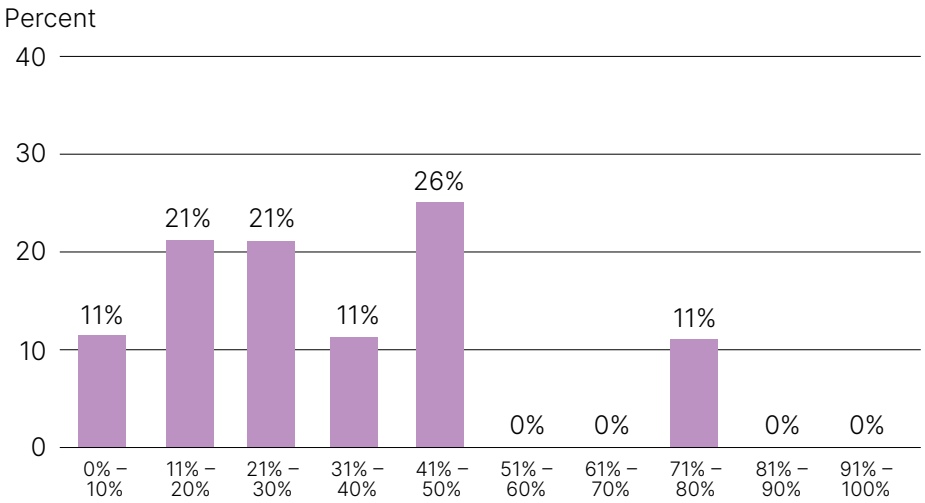
01 We use AI both internally and externally, for clients to make our product easier to use by creating suggestions. Most of our current greenfield projects are essentially applying AI.

02 Allocating 41% - 50% of our R&D budget to investments in AI aligns with our proactive approach, ensuring robust AI integration and fostering innovation within our organization. All employees are encouraged to use and investigate AI in their daily work. New innovations is adjusted to integrate AI if possible.

03 We are still having all main costs on labour costs as well as standard CAD/BIM software, where the AI is integral part of the software packages and subscriptions.

Multiple Choice Question

Towards 2030, to what extent do you anticipate this budget to increase?



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Excerpts from expert panelist insights

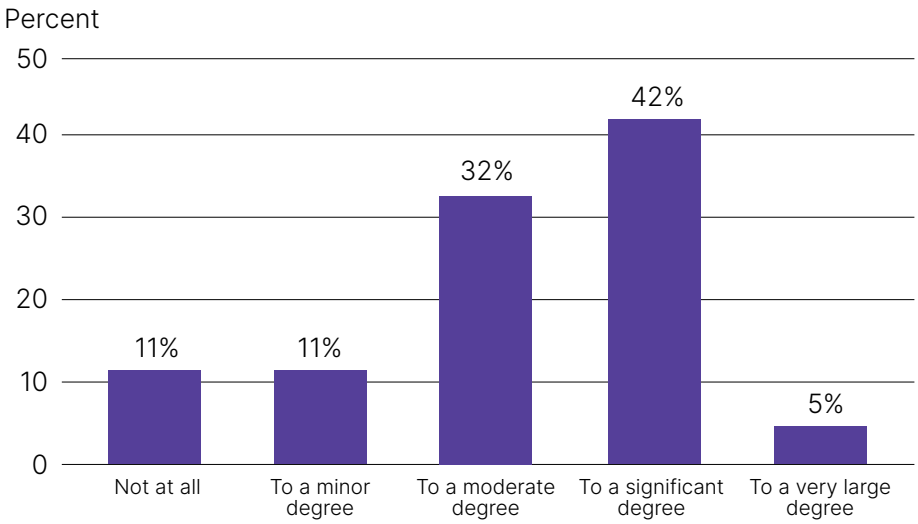
01 We expect to maintain high level of investment as it reflects our ongoing commitment to harnessing the full potential of artificial intelligence in our operations, knowing that this is not the only technology that will have a major impact on our organization.

02 AI will be integrated into our software, and our workforce will be adjusted accordingly to hours/needs pr. project. AI costs will be indirect costs.

03 We are currently in an AI phase and once we learn how will materialize its applications into our business, I am sure we will build back up to higher mark over the next crucial years.

Multiple Choice Question

How would you say the returns on investments in digital systems and infrastructure have met your expectations so far?



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Excerpts from expert panelist insights

01 Our investments have truly lived up to our expectations. We're experiencing remarkable innovation, accomplishing new projects at a significantly faster pace. Our efficiency has soared by 40%, leading to substantial time and financial savings. It's evident that our digital investments have proven their worth, and we're exceptionally pleased with the outcomes.

This means more projects and thus more employees to build our applications and exhibitions.

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02 Since we are a small company often the system investments take years to gain back.

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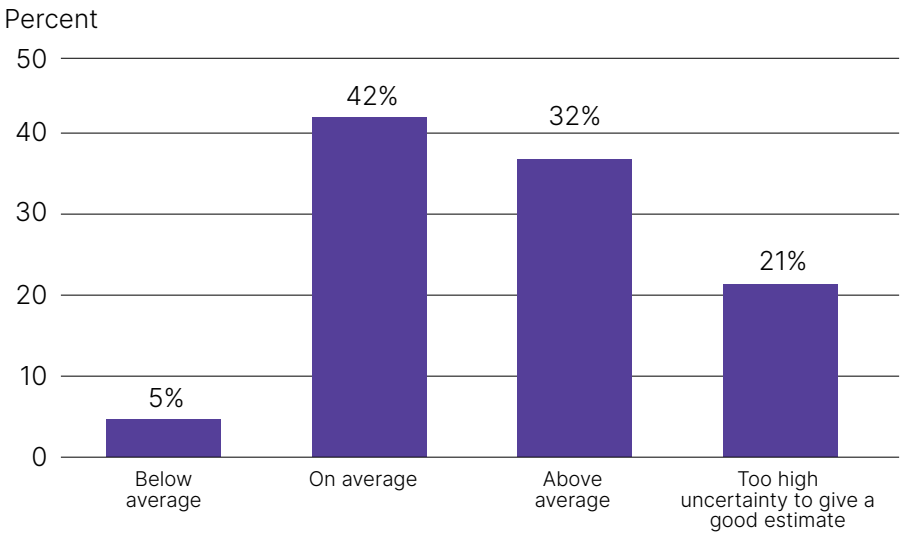
03 Too early to fully say but it has made preparation under deadlines a lot easier and have also squeezed lot more work in.

Multiple Choice Question

How would you expect the returns on investments in AI towards 2030 compared to other IT investments?



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Thank you to participating experts:

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