

Industry Agenda

Infrastructure and Urban Development Industry Vision 2050

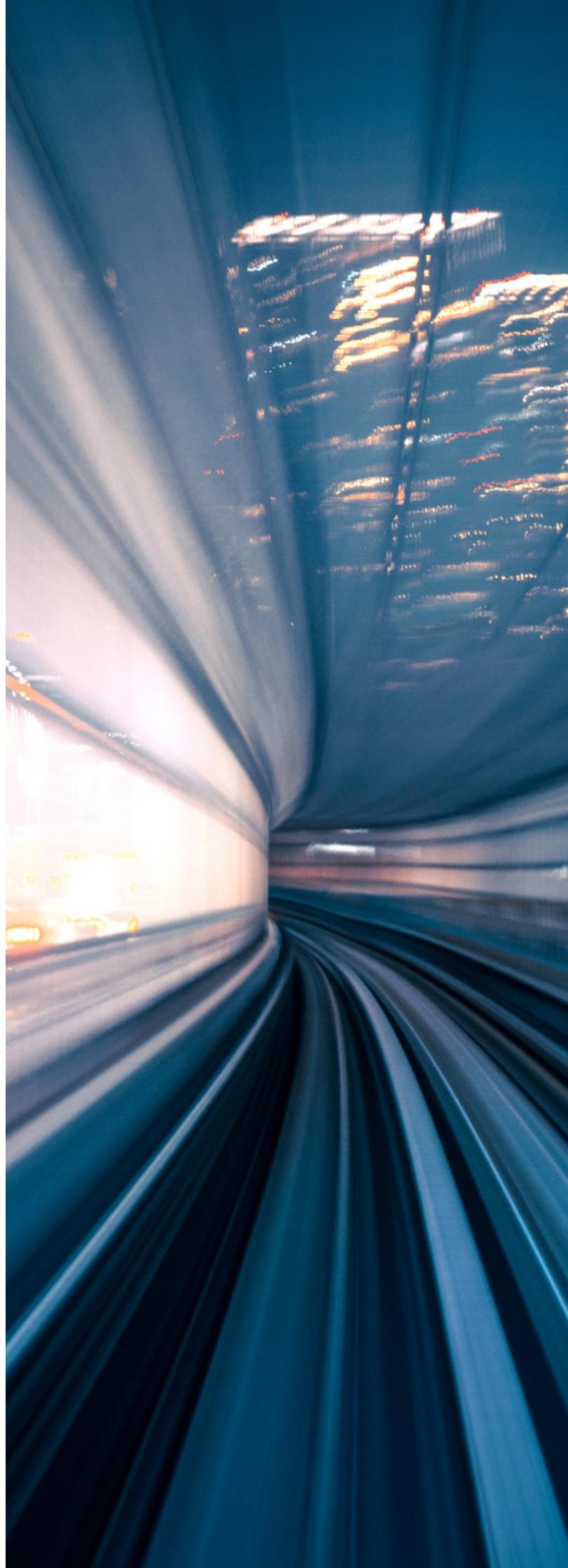
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Foreword

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In a world confronted with resource shortages, climate change and rapid demographic shifts in emerging and developed countries, it is more critical than ever to think about how the construction industry and what is built can provide an environment that is affordable, sustainable and healthy for as many people as possible.

Considering the accelerating urbanization and population expansion underway in the developing world versus shrinking middle classes in the more industrialized nations, and the fact that up to 80% of ageing building stock will likely still exist in 2030, it is important to be aware that the future of the infrastructure and urban development sector is not solely about industry-specific issues, but also about the future of the built environment, communities and, ultimately, the well-being of societies.

The Fourth Industrial Revolution is an opportunity to establish an ethical code and rules to ensure that there remains a choice between a utopian and a dystopian world; the time to factor in the human element into the equation is now. The Fourth Industrial Revolution continues to drive the convergence of technologies that blur the lines between physical, digital and biological systems. Our interdependence will not diminish, and more agile, inclusive and collaborative responses are urgently needed to address the increasing complexity and uncertainty in global systems. Therefore, we must hone our capacity to lead and manage these systems that underpin our prosperity and security. We must embrace responsive and responsible leadership and help with “Creating a Shared Future in a Fractured World”, which is the theme of the World Economic Forum Annual Meeting 2018. The emergence of a multipolar world cannot become an excuse for indecision and inaction. It is imperative that leaders respond collectively with credible actions to improve the state of the world.

Under the leadership of the Governors, the World Economic Forum Infrastructure and Urban Development Industries community can report another year of significant achievement. The community now consists of 50 Partners representing a vast number of professional interests, needs and activities across the entire industry value chain – from real estate and urban services, to construction and heavy industry engineering services and equipment. Our strategic objectives remain to leverage the strengths of an integrated value chain approach while ensuring the highest level of servicing to the specific sector priorities.

In 2017, mandated by the Governors Steering Committee and implemented by the Strategy Officers community in close collaboration with the six working groups of the Shaping the Future of Construction initiative, we have developed an Industry Vision 2050 for the Infrastructure and Urban Development community. This shared vision is intended to be our industry commitment to driving change in nine key areas, which we call vision pillars and are detailed below.

Each pillar presents a clearly targeted objective, describes a concrete implementation process for government and business to drive that vision, and lays out an impactful roadmap. The pillars are supported by illustrations of how they might play out in the future. The inspiration for these examples comes mostly from breakout session discussions held at two Future of Construction scenario workshops in Berlin on 27 July 2017 and in London on 18 October 2017.

Message from the Co-Chairs



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Dear Governors,

It is our honour to welcome you to the 48th World Economic Forum Annual Meeting 2018 in Davos-Klosters, Switzerland. In the context of the theme of this year's Annual Meeting – “Creating a Shared Future in a Fractured World” – we have sought to get our Infrastructure and Urban Development community to establish a Shared Industry Vision for 2050 that is meant to steer our actions through the uncertainties and challenges that lie ahead.

Creating a common vision is pivotal at the crossroads between utopia and dystopia. If we introspect on our industry, we have struggled so far to adapt ourselves to the Fourth Industrial Revolution and to let go of our more traditional ways of running our businesses. This in turn, creates a less attractive industry to budding talent, which may put us in a vicious cycle that, at best, will keep the industry at the status quo.

Bill Owens, Governor of Colorado (1999-2007), once said: “We know that, when it comes to technology and the economy, if you're not constantly moving forward, then – without a doubt – you're moving backwards.” Thus, the establishment of the Shared Industry Vision is meant to bring into focus our industry on a common cause and create general guidelines that unite us on the path ahead for our community's development.

The future of our industry should promote a systems-oriented, performance-focused delivery of assets with equitable risk and profit-sharing. Our industry will be at the heart of the Fourth Industrial Revolution, developing digital systems that will optimize the use of the right resources and will serve as the backbone for Internet of Things-enabled infrastructure and solutions. This would be built on a transparent procurement process that fosters fairness and collaboration, which would jointly lead to the long-awaited increased certainty in delivery – on time, on budget, to the right quality and with stellar safety performance.

At the centre of all decision-making will be the human element, whether it will be the diverse or talented workforce that we attract to lead our product planning, development and delivery, or the users' functional and emotional requirements that will set us in motion to deliver excellence. Our industry will also create value for society in consultation with all key stakeholders across the entire built environment value chain. We will lead the way in low-carbon, green, resilient, affordable and lifecycle-optimized solutions aligned with the United Nations Sustainable Development Goals. Most importantly, we will develop responsible leaders that will carry the torch and guide our industry and society to prosperity.

Building on this general description, our Shared Industry Vision for 2050 is founded on nine key pillars which involve an industry that is: collaborative and fair, performance-based, human-centred, holistic and systemic, smart and connected, sustainable and affordable, safe and secure, long term, and responsive and responsible. We also focus on the target vision – the implementation process from the government, industry association and private-public company perspective – and we provide illustrations of how our industry could look like in 2050.

This is a call for action from the industry and the broader built environment ecosystem and we welcome feedback and suggestions from the community on this Shared Industry Vision to achieve consensus and alignment that will drive the required change.

Introduction

In today's increasingly complex, fast-paced and interconnected world, breakthrough technologies, demographic shifts and political transformations are having far-reaching societal and economic consequences. Societies are facing systemic global challenges that can no longer be addressed through the conventional linear approach of hierarchical corporate and governmental structures. A multi-stakeholder approach is needed.

The World Economic Forum, through six working groups of the Shaping the Future of Construction project, has developed future-looking scenarios, which serve as the basis for the Infrastructure and Urban Development Industries' Shared Industry Vision. Based on nine pillars – collaborative and fair, performance-based, human-centred, holistic and systemic, smart and connected, sustainable and affordable, safe and secure, long term, and responsive and responsible – a vision for 2050 is outlined and various strategies to achieve it are put forward.

By 2050, the ability to access any information on the built environment in real time will be available, and machine-supported decision-makers will become better at analysing the incredible amounts of data connected systems will produce. This information will be able to be used with considerably tighter feedback loops and for immediate response. Most of these decisions might not even be human decisions. This has the potential to streamline processes and make more productive and affordable the use of available resources.

By 2050, the challenging shift from “grey” to “green” infrastructure will be complete, further contributing to the health of the planet. The shared vision is a call for action to start working towards that goal. Promising examples are current lifecycle thinking and the tentative establishment of a circular economy. Growth should not be the single most important aim of the global economy; a more equitable distribution of wealth should be one of its leading characteristics.

Innovation will also be key to the success of the industry, as it looks to find more productive and efficient ways to provide energy, food, safety and shelter for an increasing world population against a background of climate change and growing concerns about the occurrence of natural disasters. Vulnerable critical infrastructure has to become more resilient by introducing smart, robust and self-healing systems. Green energy is getting more affordable and more built environment assets prove the business case for sustainability.

By entering the Fourth Industrial Revolution, the importance of a human-centred approach to the design and the maintenance of urban centres will be more crucial. Art, culture, music, a sense of place and a feeling of belonging will increasingly be seen as critical to the physical and mental happiness and well-being of the global population, thus fostering a culture of enjoyment and a personal creative responsibility for socially stable and vibrant communities.

A Shared Industry Vision

The Infrastructure and Urban Development Industries community of the World Economic Forum sees the need to develop a shared vision to inclusively build future communities, which are embedded in a desirable and supporting built environment.

The industry has a key responsibility to provide essential infrastructure and urban solutions that meet basic human needs that support well-being, the movement of people and ideas, and deliver critical services, assets and goods. These needs could be even elevated and expanded by giving serious consideration to quality of life and community happiness. Thus, the core purpose of the industry is to provide indispensable value for society, such as safe shelter, clean air, clean water, safe sanitation, and physical and social interconnectedness.

Aligned with the Paris Climate Agreement, the industry will pursue all socioeconomic efforts required to limit the global temperature increase to 1.5°C above pre-industrial levels. To achieve this, the industry is committed to a human-centric approach to infrastructure and urban development to increase well-being and value for asset end-users, clients, workers, employees and society, as well as all other stakeholders critical to a sustainable and affordable built environment.

The UN Sustainable Development Goals (SDGs) set out an agenda and the infrastructure and urban development industries are critical to meet the success of the vision. With the proactive contribution of civil society, the industry is in the best position to become a forward-looking community of thought leaders to support governments globally in providing the necessary long-term vision. Reinstating responsible relationships and direct collaboration between all stakeholders of the built environment ecosystem towards common goals will be critical to overcome an increasing lack of trust in leadership and institutions.

The infrastructure and urban development industries need to develop a clear framework to define the best outcome of infrastructure and urban solutions and projects, as well as provide guidance on design and prioritization schemes. In a performance-based systems approach, outcomes will need to be translated into key performance indicators, which will provide metrics for reducing negative externalities from waste and toxic chemicals, energy and water consumption, greenhouse gas emissions and the carbon footprint, as well as job creation, tax and debt burden. It will also need to address access to reducing negative externalities from waste and toxic chemicals, energy and water consumption, greenhouse gas emissions and the carbon footprint, and sustainable energy and water, and as well as improvement in education, social services and connectivity.

Concentrating on the drivers of change for existing and new infrastructure, which will be enabled by following a rigorous

performance-based process that includes incentives and total cost of ownership considerations, the industry will be able to address critical gaps in the following key areas: productivity, resources efficiency, collaboration, financing of bankable projects, information, risk and profit-sharing, and talent and innovation. To enable the global infrastructure transformation, the industry will translate these key areas into adjustment needs linked to each key stakeholder in terms of regulation, contracting, management practices, project methodologies and industry standards.

The infrastructure and urban development industries are committed to driving change under the following nine pillars:

1. *Collaborative and fair* – The industry will strive to form fair and understanding relationships by fostering collaborative practices and cooperation, not confrontation. This includes early and alternative dispute prevention and resolution as well as transformation practices with a focus on stakeholder needs and interests to jointly and effectively resolve critical issues rather than to adopt an adversarial approach.
2. *Performance-based* – The industry will promote a systems-oriented, performance-based delivery of high-quality assets and services contracted in an equitable risk and profit-sharing manner, creating increased certainty to deliver on time and on budget, and improving the productivity of the sector.
3. *Human-centred* – The industry will be known for its talented and diverse workforce and will put the customer experience, human needs and interests in the centre of decision-making.
4. *Holistic and systemic* – The industry will create value for society in consultation with all key stakeholders across the entire built environment value chain.
5. *Smart and connected* – The industry will promote and develop digital systems and solutions that maximize economic, environmental and social benefits while serving as the backbone for Internet of Things-enabled infrastructure and business models.
6. *Sustainable and affordable* – The industry will lead the world in low-carbon, carbon-neutral or carbon-positive, green, resilient and affordable construction solutions, which will meet and exceed the SDGs.
7. *Safe and secure* – The industry will strive to protect people and assets by reducing risks and deploying systems, which respond quickly and efficiently to prevent harm or value loss.
8. *Long term* – The industry will propose full lifecycle optimized solutions, which are designed for affordable and flexible repurposing and recapitalization driving long-term asset and community value.
9. *Responsive and responsible* – The industry will develop responsive and responsible leaders who are committed to inclusive development, equitable growth as well as credible and ethical behaviour.

Collaborative and fair

Fostering collective practices and cooperation



Pillar impact

According to a [report by McKinsey & Co.](#), over 90% of mega-projects face cost overruns. This is a recipe for an unhealthy and non-collaborative culture. Poor project performance resulting in project disputes, can impact long-term stakeholder relationships negatively, not only between owners and contractors, but all throughout the value chain – from raw material extraction down to operations, even affecting the asset end user by providing poor services. Liability costs in the global economy – the direct costs of commercial claims resolved through litigation – can be estimated at approximately \$870 billion globally, of which the liability costs in the United States alone are \$306 billion, according to a [report on international comparisons of litigation costs](#) published by the US Chamber of Commerce in 2013. The US was the largest country in the legal services market in 2016, accounting for about 45% of the global market.

A recently published World Economic Forum report on [“How can we avoid costly disputes?”](#) highlights that the total costs of disputes can paralyse capital projects and hinder the ability of companies delivering those projects to compete and prosper. The direct costs are only the tip of the iceberg since additional direct costs include expert fees, document preparation costs and investigator fees, as well as costs to the legal system largely swallowed by the taxpayer. More important, litigation imposes significant indirect costs, such as increased borrowing cost, waste of time and resources, not to mention organizational stress and deterioration of

business relationships, which is commonly priced at a multiple of direct costs reaching trillions of dollars a year globally.

Target vision

There is international consensus that the industry’s future relies on careful management of resources and that good communication and collaboration, as well as firm agreement on basic principles, are paramount. The industry will have to embrace the importance of relationships and collaboration as the key premise for successful project delivery. Reforming and redesigning the approach to open and collaborative contracting will enable a shared risk management that avoids suboptimal risk allocation between the parties. Furthermore, selecting the appropriate strategic, integrated procurement and delivery systems will foster transparency, equitable share of profits and the necessary collaborative environment.

An open platform approach to Building Information Modelling (BIM) will see the use of its full capacity, and contractors will no longer see sharing full BIM project information with their clients as something undesirable for their profitability, which they used to make through claims that will only occur on rare occasions in the envisioned future. Information asymmetry between value chain constituents is no longer a source of leverage for one party over another and completely transparent information sharing would be the norm. This collaboration will manifest itself in better performance (time, cost, quality, safety, environment

and profitability) on projects of the future and better results overall for customers and end users. This will in turn have value chain constituents focus on matters of concern to the various project stakeholders rather than building claims and resolving disputes.

Implementation process

What do governments need to do to achieve the vision?

Governments and project owners who have long co-existed with a procurement process that was not providing desired outcomes from projects should take the initiative to break the status quo. This would entail establishing new models of cooperation, new ways to jointly identify, assess, allocate and manage issues and risks, adopt alternative procurement processes and contracts that incentivize information exchange and collaboration and that include dispute prevention and resolution mechanisms after having consulted with the value chain. This would potentially provide visibility of project profitability of each of the value chain constituents throughout the various phases of the project and ensure a minimum profitability for a minimum level of performance to alleviate the various parties' lack of trust. Once trust is built into the system, value chain constituents will work better together to deliver excellence for the customer.

Most importantly, unbalanced or unclear risk allocation inevitably can lead to an infinite expansion of contractual liabilities towards the contracting party, inducing a significantly higher probability to breach obligations with the potential of subsequent disputes. An insensible, imbalanced and solitary risk shedding instead of a risk-sharing approach between the contractor and the project owner will, therefore, lead to higher overall total capital project costs with the utmost likelihood of conflict.

Short-sighted project owners often ignore the most beneficial distribution of risks, which is to allocate each risk to the party that is best able to manage, mitigate, or diversify it. Even uncontrollable external risks of loss and damage, such as force majeure, which cannot be attributed to any of the parties and which are not insurable, often do not reside with the party that has the higher long-term interest in the project, typically the project owner. Unfair and inappropriate risk allocation and its intrinsic incapacity to properly assess the cost of the risk always lead to unrealistic tender pricing due to higher price uncertainty and intrinsic risk premiums.

What do industry associations need to do to achieve the vision?

Industry associations will quickly acquire the role of mediator and educator, working closely with regulatory bodies and universities to determine strategies for collaboration between companies and authorities. An entirely new discipline will arise, of professionals who are trained to balance equality, sustainability and economics with international law. In the infrastructure and urban development business, it is principally down to industry associations to align traditional professions towards this new role. Industry associations

dealing with contract standard forms would need to adapt the forms of contract to the new procurement process.

What do private/public companies need to do to achieve the vision?

Increasingly, larger capital projects combined with a lack of trust between the parties inevitably lead to more complex contracts. When necessary skills and expertise are not on site, inadequate contract administration and ineffective change management practices can soon lead to substantial difficulties in understanding and anticipating the contractual consequences of conflicts. A complex stakeholder ecosystem exposed to ineffective management, supervision and coordination, together with lacking skills and authority issues, will be unable to translate complex contractual requirements into effective project controls capable of monitoring quality, scope, schedule and cost. In the worst case, the lack of competence and professionalism of project stakeholders can lead to reactive or even non-existent risk management and lack of anticipation. As a result, lack of clarity, arising conflicts of interest, ineffective deployment of resources and power struggles can create an increasingly adversarial culture leading to destructive conflict. As a consequence, an effective conflict management process needs to transform tension into constructive dialogue.

Envisioning the future

It is 2050 and Peter is a project manager on a major public transportation project with 35 years of construction experience. As a contractor, when he first started his career he used to avoid providing certain information to his clients that might compromise contract claims that his bosses were contemplating. He used to have two separate BIM models, one that he used internally to make decisions to drive his team's work, and a stripped down version that he would share with his client.

With a new procurement process introduced 15 years into his career, everything has changed. Peter's suppliers, subcontractors and client now sit in the same office and have access to the central database that has the complete project information. This has opened a path to comprehensive and open collaboration and a focus of efforts to solve the project's non-financial issues in order to be able to meet the required schedule.

Peter provided additional value added services to his client by providing off-contract consulting support to determine the best transport ticket pricing once the facility opens. He also established a separate team for corporate social responsibility, which engages with the local community to support its needs. His project established an internship programme for the local community and a local university visit programme to promote engineering to the younger generation, and six months relocation for select client personnel to one of his firm's international projects to gain new skillsets. In this future, collaboration and relationship building is at its best.

Performance-based

Creating a collaborative performance culture



Pillar impact

The [IHS Herold Global Projects Database](#) estimates that today's large infrastructure, mining, and oil and gas projects, on average, cost 80% more than budgeted and run 20 months late. Poor planning and execution, unbalanced contract terms and conditions, a highly fragmented supply chain, inadequate controls and lack of proper risk management are prevalent. Innate conservatism are words that can describe the construction industry building on the fact that it is a low-margin industry that has not spent heavily on research and development as compared to other industries. According to a [study by McKinsey & Company](#), construction is among the least digitized industries and construction labour productivity has not kept pace with overall economic productivity; performance in the industry has been lagging behind for decades.

Target vision

A vision of the industry's performance needs to embrace a new environment where interaction between humans and machines matures beyond imagination. It is marked by a culture where all stakeholders seamlessly work together to create business environments, where advanced work scoping and contracting, both at the micro and macro levels, are supported by big data and information modelling is widely used and universally understood. Focus will be on output performance of the ultimate service delivery and end-user experience, and where supporting infrastructure and real estate assets need to be sustainable, affordable, flexible

and agile. The world is heading towards an era where smart systems and intelligent robots manage procurement while operating in an environment where building codes and regulations are harmonized globally. This will require an innovative culture in which business deals shift from transactional to relational.

Implementation process

What do governments need to do to achieve the vision?

To provide better value to the public in the future, governments and industry need to seek approaches together. Some examples include:

- Improving flexibility of long-term contract agreements. These multi-decade agreements should be able to capitalize on new technologies and management approaches that will evolve in their term and should anticipate and adopt future advanced services. This requires establishing adaptive pathways within contract terms to incentivize private partners in their use by releasing barriers to experiment.
- Forming standards to secure the operations and maintenance requirements of publicly financed assets equal to similar public-private partnerships. This entails that government gets remunerated for asset performance, provides stronger frameworks for asset longevity, and provides incentives to reduce asset lifecycle costs.

- Creating lifecycle evaluation standards in project prioritization and procurement methodologies. The public is better served with more robust and flexible assets developed under lifecycle considerations. This intends to shift focus from lowest cost and technically acceptable procurement methods that favour short-term financing concerns to aiding agencies in addressing their long-term budget commitments.

What do industry associations need to do to achieve the vision?

To respond to accelerated technological progress, the construction industry must evolve from an input-based specification model to an output-based performance specifications model. With this in mind, developers are looking to optimize their approaches and use of materials. This change in thinking will unlock innovation and creativity, enabling companies to leverage innovative technologies such as 3D printing and modelling, building information modelling, artificial intelligence and robotics.

In some jurisdictions, the public-private partnership model has been transforming the outcome of large, public infrastructure projects due to owners' inclusion of output-based performance specifications as part of the requirements. In that model, if the asset does not function as planned, the developer is financially penalized. As a result, the developer considers the asset's whole lifecycle, optimizing both construction approaches and material use. Taking this type of approach of risk transfer to private or smaller public projects (e.g. bid-build and design-build) through appropriate long-term warranties will have the potential to transform the industry.

What do private/public companies need to do to achieve the vision?

To achieve this shared vision both public and private companies must redefine the industry culture from the conservative environment of today – defined by redundant processes and systems – to an open and lean culture that eliminates waste and non-value adding work. To enable this transition, companies must develop financial, technological and organizational frameworks that enhance transparency and build trust. Financial and organizational frameworks must create efficient partnerships through equitable risk sharing, elimination of barriers and fostering new ways to share information and resources across various business entities. Technological frameworks must establish means of securely sharing trusted data among parties to streamline information flow and access so each stakeholder is delivered information when it needs it to improve speed and quality of decisions. Technological frameworks must provide predictive capabilities that enable new levels of risk mitigation, allowing project teams to reliably anticipate the future not report the past.

Envisioning the future

Martina has just completed her first major project in her third career. Her first career as a tax attorney ended after two years, when machine learning nearly eliminated audits in the mid-2020s. Her second career as a computer programmer ended five years ago, in 2045, when artificial intelligence virtually eliminated coders. Today, she is a construction project engineer who believes this career will take her to retirement age.

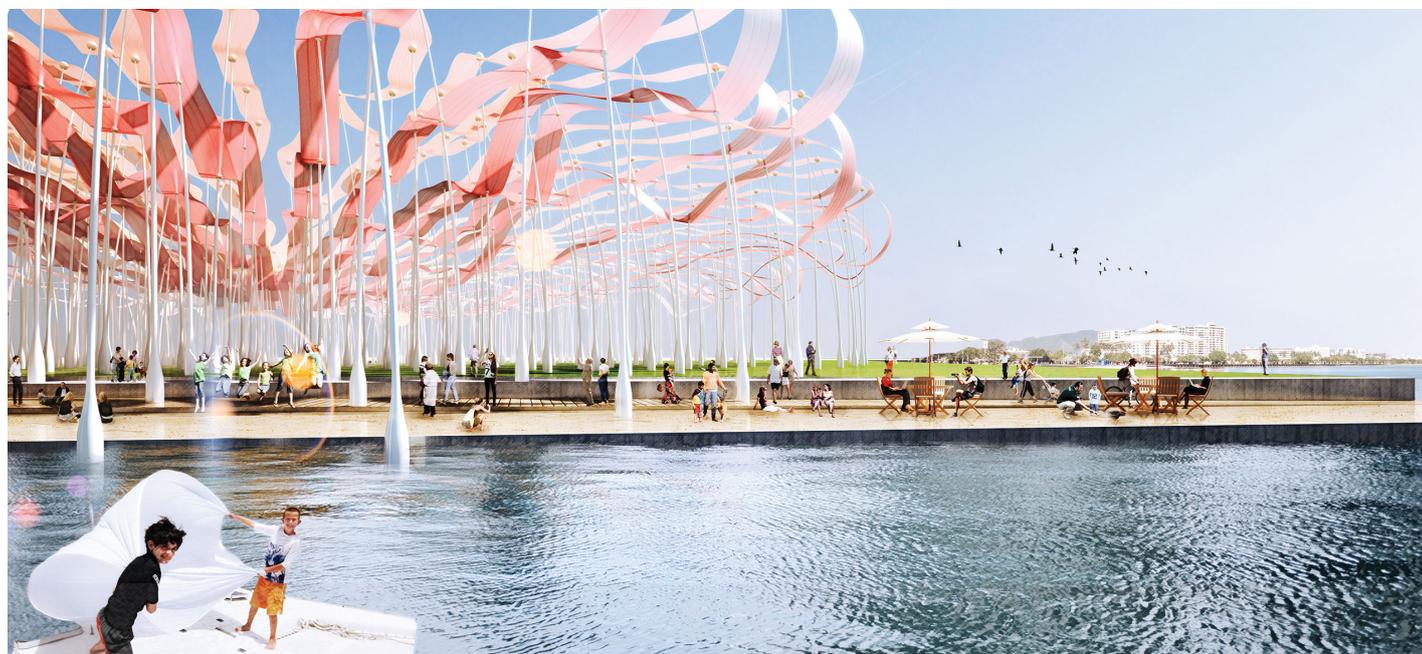
She never could have imagined during her days as an attorney that the low-tech construction industry would be in her high-tech future. But construction today is nothing like what it was in those days; today she helps build adaptive cities. Martina reflects on how the industry transformed itself to support today's 100 million-plus inhabitant gigacities. She believes the transformation centred around three major pillars: systemic innovation protocols, predictive management systems and shift to full lifecycle view of facilities.

The engineering and construction systemic innovation protocols ignited productivity after decades of stagnation, providing an intellectual property commons that addresses benefit sharing and cross-industry sharing of best practices. It leveraged the millennial generation's views on information sharing and led to widespread use of additive manufacturing, robotics and incorporation of cyber-secure adaptive intelligence into systems and components. Productivity skyrocketed and the built environment began to perform in a more dynamic and sustainable manner in both the short and long term.

The introduction of a predictive systems management approach for large, complex projects was also a game changer. It increased attention to the flows that govern successful mega-project execution. Teams can now manage complexity and stakeholder early engagement like they have managed cost, schedule and risk for decades. AI-based sentiment analysis and predictive analytics facilitate earlier management action driving better, more predictable project outcomes. Lifecycle-based prioritization resulted in performance-based standards and building codes opening doors to broader innovation that fully considered all dimensions of sustainability and resilience. Martina feels like this is the work she was meant to do, literally building a better world.

Human-centred

Working backwards by starting with the customer experience



Pillar impact

Regardless of the type of infrastructure under consideration, it all comes down to purpose, flexibility, liveability, well-being and happiness. Identifying the key stakeholders of a venture, from employees to end users, putting the customer or asset end-user in the centre of the planning process including their functional and emotional requirements upfront, forms the basis for the human-centred approach.

[A report by Imperial College in London in collaboration with Atkins](#), highlighted six design features that would make humans more productive, and concluded that if all offices in the United Kingdom (20 million workers in 1.6 million organizations where 75% of economic activity occurs) were upgraded and workplace productivity enhanced by 5-8%, it could impact the UK's GDP by £12 billion (\$16 billion) to £20 billion (\$26.6 billion). According to the study, thoughtful design does require up to 21% increase in upfront investment; however, the payback period would be between two and six years.

In what relates to the workforce planning, delivering and operating assets, the industry faces difficulties recruiting due to competition from technology firms among other industries, the worst gender gap among industries, and an ageing workforce finding it hard to adapt to the new trends. Based on the World Economic Forum's Future of Construction talent survey, people like the industry's purpose that makes a difference to people's lives, but perceive the work negatively by being strenuous and least likely to require higher education. Add that to changing

demands and skillsets for the new workforce, and we have a problem on our hands.

Target vision

New technologies have led to an unforeseen change in the way people work, live and behave. Many industries are being disrupted and people fear negative consequences, such as job loss and social instability. The situation is similar to the Industrial Revolution, which despite fear, eventually brought important progress. The industry will strive to attract top diverse talent with exciting career paths and that is the basis to improve the industry. Far from being replaced by machines, people specializing in abstract, social and creative tasks will profit from automation due to its efficient, cost- and time-saving work completion.

To successfully address customer needs and augment the asset end-user experience, human-centered design (HCD) will be the most effective approach. HCD is a design and management methodology that develops solutions focusing on the human perspective throughout the problem-solving process. HCD requires to build a deep empathy with the customer you're designing for. Typically, HCD consists of three phases, the inspiration phase to understand the needs of the asset end-user, the ideation phase to identify opportunities for design and to prototype possible solutions, and the implementation phase which brings the best solution to market. When applying an HCD approach, the asset end-user satisfaction is generally higher compared to other methodologies since the very customer to serve was always at the heart of the process.

Virtual and physical art platforms and their communities will be increasingly used to unlock HCD's full potential, in particular during the ideation phase.

Art platforms have always been a human-centred breeding ground for creative narratives, abstract thinking, value-free experimentation and positive social exchange, which is much needed to strengthen the human skills in demand during the era of the rise of the machines. Additionally, art and culture illuminate people's lives and allows them to build and strengthen social relationships, an essential part of healthy, vibrant and flourishing communities that build a more just world.

In past years, the construction industry focused mainly on sustainability; today it focuses on the well-being of people, who are the actual users of real estate and therefore the key stakeholders. The advent of the Internet of Things can provide a lot of data on customers and key stakeholders' behaviours, which could assist in understanding their needs and continuously improving human-centred designs. The construction industry envisions a people-focused approach with a positive social impact, offering real-life encounters between people from diverse socioeconomic groups. Further, it aims to provide places for people to improve their cognitive and creative skills and apply them to their work and lives. The construction industry envisions "human playgrounds" in the form of interactive, multidisciplinary platforms and entertaining art programmes and experiences as part of their developments in order to create a space for a playful experimentation and constructive failure, where the discovery, serendipity and self-consciousness matters most.

Implementation process

What do governments need to do to achieve the vision?

Up to now the focus of education for the industry lies in scientific disciplines. These tasks are more efficiently fulfilled by algorithms than human brains. In the near future, the focus on creativity, leadership and problem-solving will be key to differentiate humans from machines. Creative skills, such as art and poetry, transfer cultural values that lead to positive social impact in cities, leading to better health, more safety and better education. Creative skills also attract an interesting urban target group with income to spend. To attract these people and for positive social change, cities and their governments need to give long-term incentives to developers and artists participating in related platforms and initiatives. These can be in the form of income and property tax reductions or offering space for lower rent.

What do industry associations need to do to achieve the vision?

Art platforms are the vehicle to build creative clusters of high-valued people, who have many followers. It is a marketing tool to address and attract such a crowd. This has to be valued by the industry and be seen as a long-term investment for successful development, full of interesting and consuming people socializing with each other. Industry associations can leverage the ascent in the use of big data

to analyse customer behaviours to tailor their codes and standards accordingly. This is a huge opportunity for the construction industry to build attractive places and at the same time create well-being in society.

What do private/public companies need to do to achieve the vision?

Private and public companies have to change their focus from just selling products (functional benefits) to clients to selling experiences (emotional benefits) to convince them about the product. Using human-centred design, companies can create a narrative and enhance their product promise and at the same time increase their customers' well-being by giving them encouraging experiences. They have also a social responsibility for their own employees, and by involving them in social activities they can ignite their employees' imaginations, inspirations and collaboration. Companies should become ambassadors for the industry in academic institutions and other channels to promote and advertise the noble purpose that the industry serves and its attractiveness. Dynamic leadership development programmes that are both well-thought and well-followed through are critical to attract the best talent.

Envisioning the future

It is 2050 and Max, an architect, is working in an environment where lighting, ventilation and air quality, thermal comfort, noise and acoustics have been optimized for peak user performance. He is done with work for the day and is ready for some entertainment. He consults his personal operating system, which within seconds offers him several activities that meet his interests. The system shows him a map locating his friends and places where other people are gathering. He selects a nearby art hub that offers an interactive art experience. On his tablet, the artworks are displayed and he swipes through them. By picking the ones he likes, he is matched with people who share the same taste. He is soon connected with "Lisa" and ready to meet at the hub to explore it together.

Max is picked up by a levitating car that drops him at the art hub right. He meets Lisa and together they look at artwork and also talk to the artists in person, or on holograms about their inspiration and techniques. By using creative techniques, they then examine a diversity of solution-based artworks led by artists, scientists and technologists. They even create their own artwork that becomes part of the public collection to be seen by other visitors. It makes them feel human, to create and enjoy the social activities and their creative dialogue. The next day Max is full of new ideas and inspired to do a workshop with his colleagues by using creative techniques to develop human-centred architecture solutions for housing that leads to positive social impact.

Holistic and systemic

Managing the whole that is greater than the sum of its parts



Pillar impact

Holistic systems thinking considers the interdependent, inter-relational and contextual aspects of phenomena and applies an integrated, inclusive mindset to problem-solving. Holistic approaches are concerned with the assumptions, knowledge, methods and implications of various disciplines and treats them as an integrated whole, or ecosystem.

The construction industry ecosystem seems to evolve very slowly, affected by misaligned incentives across the value chain along with fragmentation and lack of transparency. [The new McKinsey Global Institute \(MGI\) Construction Productivity Survey](#) confirms many reasons for this poor performance: the industry is heavily regulated, depends on public-sector demand and is highly cyclical. However, there are large regional differences and major variations within the industry. According to the MGI report, the sector splits broadly in two categories: large-scale players engaged in heavy construction and a large number of firms engaged in fragmented specialized trades such as mechanical, electrical and plumbing work that act as subcontractors or work on smaller projects. The first group tends to have 20-40% higher productivity than the second. Extrapolating this on the wider construction value chain, integration and alignment to form a holistic and systemic industry is key in creating shared value to customers and society at large.

Target vision

A combination of improved infrastructure functionality with total positive effects for the environment is possible thanks to the adoption of hybrid infrastructure strategies that combine, in an optimal way, the functionalities of existing grey infrastructure with the ecosystem services provided by nature-based solutions or green infrastructure. The adoption of hybrid infrastructure strategies will increase society's resilience to climate change.

Shared information from the built environment and lower production costs enable societal actors to share physical and virtual spaces for increasing mutual understanding. Increasing data produced by individual assets enable linkages between their owners, managers and users, helping them to economize resources, create new services and promote social inter-dependence. Institutionalization of system thinking increases awareness of the vulnerabilities resulting from higher functional interdependence between elements. Governments, industry and citizens will collaborate to identify and mitigate unintended consequences of big data uses and other measures that might push the limits of the urban system, while they will consistently implement safety contingent measures, and create financial and functional buffers to increase resilience of the urban system.

Implementation process

What do governments need to do to achieve the vision?

Governments should define targets aimed at reducing the gap of living space quality between different sectors of society, assessing the built environment system as a whole. This holistic and systemic perspective includes looking across sectors, and identifying and exploring the most important interdependencies and resilience implications. Decisions on urban renewal should have clear targets for avoiding gentrification and other unintended consequences. In this regard, government ministries, agencies and regulators will need to adopt structured methodologies to consider interdependencies and priorities across infrastructure networks and economic sectors.

Building information systems and three-dimensional visualizations help governments involve different stakeholders in the renovation and further development of the urban environment, increasing their capability to identify feedbacks and trade-offs between infrastructure, economy and social welfare, as well as the environment and citizen habits. Better coordination between different public clients will allow them to engage with the private sector at a strategic level; lowering transaction and coordination costs for multipurpose infrastructure projects that offer greater value for money and ensure sustainability. Governments cannot develop a holistic way of making decisions without the active participation of businesses, households, communities and citizens.

What do industry associations need to do to achieve the vision?

As customers require sustainability and hybrid (green and grey) infrastructure strategies, engineering and construction industry associations need to develop new standards to prevent poor green infrastructure quality and performance. These standards will need to cover all lifecycle phases of this new type of green or nature-based infrastructure. The consulting industry would need to develop the tools to test and evaluate value for money offered by different providers of green-grey infrastructure strategies, where direct and indirect impacts of these strategies are quantified at watershed level versus project or site.

What do private/public companies need to do to achieve the vision?

Corporate leaders have to operate in increasingly uncertain and complex environments. A key ability of holistic or systemic leadership is to see the larger system. Systemic leaders see complexity not as confusing and threatening, but as an essential opportunity and a necessary condition to lead effectively. This understanding enables all systemic players to jointly develop solutions not evident to any of them individually and to work together for the health of the whole system rather than chasing symptomatic fixes to individual elements. Systemic leaders create dynamic social systems by embracing uncertainty and risk, encouraging entrepreneurship and novel organizational approaches by seeing interrelationships rather than things, allowing experiments, learning from failure and supporting collective action.

Through a holistic approach, companies will be able to deliver projects faster and at lower cost, as a contribution to reduce segregation in urban planning. In this regard, industry leaders need to strengthen a culture of social responsibility and commitment with guaranteeing a safe and comfortable place for all. Additionally, the construction industry is required to quickly react and foresee the implications of introduction of new technologies as well as the introduction of innovative business models in the dynamics of the built environment.

There is also shared responsibility on sustainability matters along the different actors in the industry. Designers need to design sustainably, increasing long-term value and making evident the multiplicative effects of holistic solutions. Asset operators will require a renewal of their asset portfolio, in an effort to reduce water and energy footprints. The construction materials and products industry should: contribute to new standard for holistic vision for lifecycle assessment in infrastructure; provide reliable and certified data on their products and their use in infrastructure all along the lifecycle; and reinforce its action to contribute to circular economy development.

Envisioning the future

Maria is the project director of a new, large infrastructure project that has grabbed the attention of a number of interested parties including the city council of a large capital in Europe. The level of complexity of this project implies a large number of spatial and economic interdependences, and that is why the city council must carefully discuss with involved agents the risks and benefits of such an investment. Since the operation of integrated asset management information in the city, shared data has led to the simulation of different infrastructure designs and estimates the impact of different public infrastructure solutions. The decision involves the construction of new infrastructure for adapting the city to the most recent technology for mobilization as well as to make it resilient to increasing climate variability. User-friendly visualizations facilitate the discussion between different stakeholders. In fact, in a previous private-led project, the renovation of housing made use of this information for alleviating initial concerns about eventual gentrification. The renovation not only was a successful experience providing comfortable and safe housing for citizens, but it also contributed to social integration with the creation of green spaces. The use of nature-based solutions for water management in combination with grey infrastructure for the retrofit of this neighbourhood allowed for inclusive urban regeneration, transforming a deprived neighbourhood into a socially, ecologically and economically thriving place.

Maria proposed a holistic approach for the planning process of the urban environment which has facilitated the uptake of ground-breaking innovations from other industries, and the implementation at neighbourhood scale of individual sustainable solutions. Cutting-edge technology including printing, robotics, modularization, and factory-based production, in combination with state of art eco-engineering, were helpful for lowering the lifecycle cost while maximizing ecosystems services such as reduction of the urban heat island effect and storm water management, guaranteeing affordability and climate resilience. Information at project and portfolio level, combined with remote sensing monitoring, big data analytics and block chain, provided sound evidence to asset managers and city authorities for decision-making and optimization in urban planning at catchment scale.

Smart and connected

Getting up to speed by embracing the digital age



Pillar impact

Information and communication technology is changing the way in which cities organize policy-making and urban growth. Smart cities base their strategy on the use of information and communication technologies in fields such as economy, environment, mobility and governance to transform the city infrastructure and services. Barcelona, for example, has made extensive use of sensors to help monitor and manage traffic. City planners there recently announced their plan to remodel the traffic, which they say will be reduced by 21%. The city is doing more than using smart-city technology to reduce traffic; it has installed smart parking technology and smart streetlights, and sensors for monitoring air quality and noise. From smartphones and watches to autonomous vehicles, advanced public transport systems and drones, growing cities need new ways to cope with high interconnectivity and the use of big data to make better decisions.

The need for cities to fully harness the potential of data constantly flowing through them has never been more urgent. A recently published report by the Forum's Global Future Council on Cities called [Data Driven Cities: 20 Stories of Innovation](#), highlights examples from around the world of how cities are doing exactly this: using new technology, data collection and analysis to improve services and liveability for their citizens. The report is part of a wider initiative by the Forum to empower city leadership in employing Fourth Industrial Revolution technology to improve the urban experience, and using data to define and

measure their preparedness for the transformation of the Fourth Industrial Revolution.

Target vision

The digitization of the built environment will revolutionize how we innovate in novel advanced urban services and how we build and deliver the underlying infrastructure and real estate assets. According to Peter Madden, former CEO of Future Cities Catapult, the market for these services is huge. With the speed and scale of urbanization creating exceptional demand for services and integrated solutions in the world's cities, investment into cities and their infrastructure over the next decade alone is likely to be over \$20 trillion. Therefore, the true opportunity will be new service provisions rather than the delivery of the underlying assets.

In 2050, smart and connected infrastructure assets will improve safety, performance and sustainability across the lifecycle of infrastructure and real estate assets. From informing new designs to safety and productivity on the jobsite to reduced costs and increased services in the operations phase, smart and connected assets will safeguard and improve people's lives. In 2050, knowledge management and a strategic vision beyond the project level will be key. Expert clients will drive the process of continuous innovation engaging in production development and customization processes with integrated service providers for selected project elements that are crucial to achieve strategic fit, while driving standardization and optimization of production processes for the elements that allow it. This close collaboration is enabled by in depth

understanding of asset performance and of known versus unknowns.

More complete information about the project and its risks along its entire lifecycle will allow the construction industry and supporting industries, such as the finance and the insurance sectors, to move from risk avoidance to well-informed risk and opportunities management. A more open discussion between all parties required to deliver continuous delivery of infrastructure services will result in faster uptake of innovations and enable the sector to deliver sustainable infrastructure.

Implementation process

What do governments need to do to achieve the vision?

To achieve this vision, governments – both as a client as well as a regulator – are key in creating an enabling environment for the uptake of digital innovations in advanced urban services and giving long-term certainty for the private sector to invest in the required expertise and technology to become providers or smart and connected infrastructure assets. Ministries and national parliaments need to draft long-term plans and stick to them, and work diligently with government agencies responsible for procurement in the creation of significant project pipelines. New regulators, such as Artificial Intelligence regulators, will need to gain more understanding of the technology and the sector and work together with other economic regulators of infrastructure in creating a coherent, robust and far-sighted regulatory framework that provides the right incentives for all key actors in the supply chain.

Clients will need to acquire new staff to strengthen their in-house technical and risk management expertise that enables them to engage with providers in product development. Clients and service providers alike will need to adopt tools that allow them to make a clear distinction of what they know from what they do not know, as well as robust knowledge management systems that facilitate continuous learning and sharing of lessons learned. Knowledge management systems need to be accompanied with a change in paradigm where clients dare to test and learn and where failure is an option.

What do industry associations need to do to achieve the vision?

Design consultants will be required to work even more closely with contractors. In many cases, they would need to reinvent their business models. To offer the wisdom on the more holistic systems thinking and its interconnectedness, consultants will need to work more actively between projects and take a more proactive role as catalysers of innovation and change adoption in the industry.

What do private/public companies need to do to achieve the vision?

Contractors will define working methods that harmonize the economies introduced by automation, and the more qualified labour addressing emerging conflicts between them. Providers of sub-assets, such as advanced building materials and construction products, will also need to innovate to not only provide twice as longer durability of assets, but also to provide clients with web-based product traceability plus quality tracking and maintenance forecasting and management functionalities for key assets. The insurance and financial industry will also need to embrace the possibilities for informed risk management versus (uninformed) risk avoidance brought forth by big data and the Internet of Things in the construction sector. Embracing this new paradigm will require them to make changes in key procedures such as due diligence.

Envisioning the future

The company where Jason works provides data and analytics services for the construction industry. His new project is optimizing the lifecycle performance of an entire block of smart buildings in the centre of his small city, based on the detailed access performance information of existing structures in the area. Thanks to the data collected from the first generation of thousands of smart buildings, Jason and his team have access to performance data in a volume and at a granularity never seen before and use it for the design of this new project. The new design enriched by historic performance data and its analysis is clearly superior from both a cost and performance perspective, compared to the last similar project carried out just a couple years ago in a nearby town.

Jason's company also played a role during the construction phase, where real-time biometric data on people along with hazard proximity detection and early warning systems reduced the probability and severity of construction site injuries. Autonomous drones and construction robots eliminated many of the traditionally hazardous construction jobs, while also increasing quality. This is already the third generation of large-scale projects where 3D printing replaces traditional construction.

Jason's company is part of a larger consortium in charge of the entire project lifecycle. In the operations and maintenance phase, solutions generated by Jason and his team allowed assets to be people aware; by understanding the movement patterns and behaviours of people, the solutions allow facilities to automatically adapt to their needs. Changing light levels and temperature settings automatically are just the most basic features. More interesting is the implementation of a system that permits buildings and infrastructure to interact with residents' calendars, including the owners of some offices in the complex. Installed building sensors facilitate daily working activities, such as communication, movements and meeting locations. The work Jason is doing guarantees that additional services will be offered when and where needed and desired.

Sustainable and affordable

Paving the way for future generations



Pillar impact

About 3.5 billion people live in cities and that number is projected to double to about 7 billion by 2050. Rapid urbanization has brought major challenges, including growing numbers of slum dwellers, increased air pollution, inadequate basic services and infrastructure, and unplanned urban sprawl. One of the 17 UN's Sustainable Development Goals (SDGs) relates to establishing sustainable cities and communities to make cities and human settlements inclusive, safe, resilient and sustainable. This goal is needed to build the foundations for a sustainable and affordable future.

Target vision

The purpose is to implement the triple bottom line approach to people's right to the city in a sustainable, resilient and equitable way. The key is to achieve this goal while recognizing lifecycle cost and affordability of housing. The industry will lead the way in low-carbon, carbon-neutral, or carbon-positive, green, resilient and affordable construction solutions, which will meet and exceed the SDGs. To achieve this, the industry needs to adopt a multistakeholder approach that tackles issues related to sustainability, affordability and resilience.

Implementation process

What do governments need to do to achieve the vision?

The role of government role in achieving affordability is crucial and central. Beyond providing the enabling regulatory framework, governments need to work with different stakeholders to co-plan and co-create the industry's future. There are several areas where government can play an important role.

- Enhancing transparency of the market through strong regulatory framework and data sharing on market performance. This will enable market players to have more headway to plan. By promoting more transparent data, the government encourages innovation-driven competition. Smart cities technologies can create efficiency and cost reduction when it comes to managing cities resources; housing is a key component of the city's infrastructure.
- Recognizing that social and environmental sustainability complements economic sustainability. This requires developing affordable housing within the urban structure of the city rather than building affordable clusters away from economic and social centres of the city. Public health is an important aspect that cannot be separated from providing homes.
- Imposing green building codes on new developments as it is important for the lifecycle cost of ownership. For example, old stock of housing can be retrofitted to become more energy efficient.

- Transforming or scaling down public-private partnerships into more human and micro-placed partnerships where small associations can participate in small batches with the state to secure their homes and means of production. Government needs to apply democratic planning tools that leave no one behind. Such inclusive planning will support social inclusion in the city.
- Leading research and development efforts to drive innovation by funding and co-innovating.
- Promoting innovative financing tools that democratize the home buying process and make it available to everyone.
- Adapting urban governance where relationships and powers are shared in a way that leads to a more sustainable industry.

What do industry associations need to do to achieve the vision?

Industry associations have a big role to play in planning the future of infrastructure and urban development. They can:

- Working on international standards as a key vehicle for delivering projects closer to budget and initial timescales both of which have a significant impact on affordability. Having an international code of ethics is important to the sustainability of the industry.
- Developing standardization of modular projects on a triple bottom lifecycle basis while addressing project prioritization for infrastructure investment. Major capital projects will be expected to be carbon neutral over their lifetimes and where possible net energy producers.
- Designing procurement and contracting processes that migrate to outcomes based life cycle cost performance standards.
- Promoting a traditional basis of design used by design professionals drawn from owner's project requirements (OPR); this will have been replaced by an expanded basis of design that brings construction as well as operation and maintenance considerations to the front of the design process.
- Working on advancing innovation in construction delivery methods through circular construction/prefabrication. Prefabricated units are going to be instrumental in reducing costs and construction time. This enables cities to meet urgent and specific housing demand and also help with housing refugees, the homeless, seniors, millennials and low-income populations. Industry needs to revolutionize the prefabrication business model by cutting down overhead costs and requiring no special skills for assembly.

What do private/public companies need to do to achieve the vision?

By 2050, a large part of cities will be rebuilt or newly built using up-cycled high performance products that need to be cradle-to-cradle certified, or rely on complex prefabrication concepts. Companies would need to build Fourth Industrial Revolution capabilities such as additive manufacturing, robotics, etc. The private sector will support in achieving the vision of the industry by feeding in with technology innovation and scalability of solutions.

Envisioning the future

Rami is working for the government on a project proposal to scale the citizen sector and remove current risk imposed by speculative developers and investors to give power back to the people. While pitching the project, he highlighted the fact that people are getting more involved in the planning of housing projects and computers will promptly analyse if their needs, dreams and wishes are realistic and achievable with a limited amount of risk.

Low-cost digital fabrication machines combined with the web, pattern automation, digital regulation, smart supply chains and big data will make it simple for any citizen, group, or business to design a home on-demand, and to see instantaneously the cost and future energy and health savings. In a few clicks, they will connect with a digital lender and local manufacturers and procure a home for themselves at a fraction of the cost of buying it from a developer. Increasingly, governments will realize they no longer need to be dependent on speculators and debt, and begin to license affordable serviced land directly to citizens and communities as an economic platform. The effect will be to unlock a "long tail" housing industry worth trillions of dollars: the "citizen sector". Rami was glad to know his project proposal was approved by the government.

Safe and secure

Jointly strengthening resilience



Pillar impact

Extreme weather events, according to the World Economic Forum's *Global Risks Report 2017*, are considered the biggest global risks. The top five risks list in 2017 also includes major natural disasters, large-scale involuntary migration, large scale terrorist attacks and massive incident of data fraud and theft. All these risks, whether natural or human-made, have severe implications on the built environment and the way it would need to be designed and operated. By 2050, climate change-related risks will be predominant if we are not able to take effective action. The outlook and long-term trend for other safety and security-related risks in the built and virtual environment most likely will look similar.

Target vision

Since the early 21st century, the impact and frequency of natural disasters have been increasing. These disasters cause human tragedy and damage as well as disrupt infrastructure systems, energy systems, communication systems, financial systems and other critical systems. The growing disruptions caused by natural and human driven disasters need to be addressed.

The construction sector envisions a four-step approach to keep society safe and secure:

1. Using state-of-the-art techniques, the robustness of construction and built environment will be optimized to prevent failing when under stress;
2. To reduce vulnerability and propagating damage, the interconnectedness of the construction processes and products will be limited where needed;
3. The sector acknowledges that all systems can fail and considers redundant modus operandi to curtail long-term damage; and
4. By considering ways to bounce back quickly if systems fail, the construction sector needs to ensure quick recovery of society after a disastrous event.

The vision in essence accepts that there will always be "residual risk" and disruptions will happen. However, the vision strengthens resilience to enable society to prosper despite these challenges.

Implementation process

What do governments need to do to achieve the vision?

Infrastructure conditions, vulnerabilities, interconnectedness and associated interdependencies need to be discussed and evaluated across all levels of government. Governments need to develop disaster prevention and recovery plans. Priorities need to be set, including feedback mechanisms to evaluate fulfilment of those priorities. Requirements for

fall-back functionality in case disruption takes place need to be developed. This ensures societal and economic damages are minimized and recovery is quick. Regulatory frameworks should be established by governments to ensure autonomous fall-back functionality and self-healing mechanisms when systems are disrupted. This framework could cover housing, utilities, ports, airport and linear transportation infrastructure. Disaster resilience plans for natural and cybersecurity hazards by national and local governments, in consultation with stakeholders, are essential in order to reflect the needs and priorities that underlie the fulfilment of the vision.

What do industry associations need to do to achieve the vision?

The industry needs to take the lead to align financial interests and incentives of the insurance, construction and utility sector. Insurance and re-insurance companies have an interest in the quick recovery of the build environment and its utility services. Cross-sector arrangements have to be put in place to stimulate resilience and improve performance. Industry associations should take the lead to determine where sector-wide modular systems are beneficial for both the industry and society; such systems can enhance quick and low-cost recovery. Private-private collaborations with other industries need to be stimulated for infrastructure projects, particularly in the introduction of innovations. Industry associations need to develop smart and agile standards for modular systems in housing and infrastructure sector where clear advantages in terms of resilience are seen. These standards should be adopted on the condition that the recovery and cost improvements are evident and that these allow for broad competition to ensure continuous improvement of modular elements within these standards.

What do private/public companies need to do to achieve the vision?

Companies should develop best solutions fitting the governmental and industry-wide ambitions as shown above. When contracted, they need to be able to adapt to changing circumstances and adopt improvements and innovations where appropriate. They have to be keen to align incentives across the entire construction value chain. The financial and re-insurance sectors have a key role to play in the achievement of this vision, as they are not only key experts in risk management and risk transfer, but are also important investors. They can influence the design of infrastructure and incentivize the implementation of risk mitigation strategies by applying risk-based premiums, and as investors, request additional resilience requirements in the design of the infrastructure projects they finance. Research and consultancy organizations can be helpful in developing plans and policies for government to improve safety and security, reduce outstanding risks and improve resilience. This branch can also help to develop modular systems to improve quick and low-cost recovery after disasters, and to develop autonomous-mode systems which ensure fall-back functionality and self-healing mechanisms when interconnected systems are disrupted.

Envisioning the future

Flora and Jorge prepare for the hurricane approaching their island. Fortunately, their small modular home is much sturdier than the house they lost in the devastating 2017 hurricane season. Jorge works at the modular home elements production site and knows there are plenty of elements in stock for replacements. Even better, no skilled labour is needed to replace those elements, so repairs will be quick and cheap. Flora switches off the power supply from the grid to test the stand-alone power supply through the solar panel and battery. Like most houses in their low-income neighbourhood, they are fully connected to smart grids for electricity, water and data. But as building codes require, each house or group of houses needs to have a fall-back autonomous mode to ensure the well-being of the inhabitants in case of disasters.

Although Flora and Jorge are concerned about the approaching hurricane, their worries are incomparable to those of the hurricane season three decades ago when they lost their home. Since then they have seen how beach and reef restoration offers much better protection against waves, and how an emergency port facility proved its value when the regular facilities were blocked by damaged ships and sunken yachts. If everything fails, at least they can get off the island quickly afterwards as the airport personnel is trained and equipped to restore air traffic as soon as the winds die down.

Long term

Mastering and optimizing full lifecycle solutions



Pillar impact

Effective asset investment decision-making and sustainable results in business performance require companies to take a lifecycle approach, addressing not only infrastructure assets but also the supporting resources, processes, data and enabling technologies that are critical to success. When the cost of a project is estimated only for design and construction, the long-term costs associated with maintenance, operation, and the decommissioning or reuse of a project are often overlooked. Looking primarily at engineering and construction, initial costs leads to short-sighted decisions. [A case study by McKinsey & Company](#) highlights the benefits reaped by a major transportation-asset operator and developer that embraced a lifecycle approach in 2011. Lifecycle infrastructure risk management was far reaching in this case across the organization; it involved people processes, management practices, governance, approval processes and day-to-day behavioural norms at every level.

Target vision

The infrastructure and urban development industry needs to deliver affordable and flexible lifecycle optimized solutions that support repurposing and recapitalization to drive long-term asset and community value. It is a demonstrated need and, while current adoption is limited, the approach will be more feasible in the future for a number of reasons. For example, the industry will face fewer uncertainties and will become more competitive and transparent, increasing

its added value to society by employing fewer resources more effectively. In addition, sustainability and resilience will become mainstream industry requirements. Automation will also play an important role in reducing the risk, increasing efficiency and competitiveness, increasing transparency, and improving communications with the public. Moving upstream, new construction materials will decrease cost and many will be biological and biodegradable. Construction will be automated and will be computer-driven, an extension of design, based on robotics and growing use of bio-materials. Planners, designers and engineers will offer important advisory services to owners on how to solve problems in an integrated way. By doing the right project, the costs will be reduced and planners, designers and engineers will become important orchestrators of the process. Moreover, the public will demand it due to increased awareness.

Implementation process

What do governments need to do to achieve the vision?

Decisions based on the lifecycle performance of an asset make economic sense and add value to the users and society at large. However, lifecycle performance is not widely used today because it is incompatible with today's economic principles, which focus on the short term, and often lifecycle costing is not congruent with the business objectives of a project's owner. For the lifecycle approach to become mainstream, policy leadership by governments is needed, as are changes in the construction industry, financial markets and mindset when it comes to sustainability.

Governments also need to legislate and enforce compliance with lifecycle performance for government projects. A critical role is to facilitate financing from the private sector for public projects run by a government. Governments would need to ease regulations for public-private partnerships and establish rewards and penalties for lifecycle performance in the private sector, especially in use of resources, i.e. like the carbon tax. The key would be to communicate the benefits of lifecycle considerations to the public and support automation that leads to transparency and to a reduction of risks.

What do industry associations need to do to achieve the vision?

Industry associations need to take the lead to change the approach of their members from moving away from prescriptive contracts to output-based performance contracts. Industry associations would need to prepare the appropriate legislation as well as actively lobby with the government to implement the required changes. Industry associations would also need to prepare best practices and develop ways to quantify the benefits of lifecycle optimized solutions. The change in mindset would not take place without associations educating their members through established channels.

What do private/public companies need to do to achieve the vision?

Working with lifecycle optimized solutions, private/public companies need to focus on reducing risk, redundancy and cost, and, most importantly, increase quality and value to society. At the same time, both government and the private sector will need to address cybercrime in a highly interconnected automated industry.

Envisioning the future

Anna, a government employee, tried to convince her boss that it would make more sense to construct a proposed building in-house, instead of giving the job to a developer who would build and lease back to the government. Anna's arguments focused on the value of lifecycle optimized solutions, which only a long-term owner can pursue. She argued that the developer would flip the building for a sizeable profit and had no interest in its long-term performance. Her boss, however, said that the government had no money to finance the project and her project was in competition with hundreds of other projects nationwide for a limited pool of funds.

Anna wanted to construct a building that was energy and water efficient, with proper lighting and acoustics, providing an optimal working environment for government employees. She knew that only an organization with a long-term perspective could deliver such a project, and that it was suitable for lifecycle optimized solutions since the government would pay both the upfront cost and the operating costs over a long time period. The adoption of sustainability rating and the effective use of automation, using integrated building information modelling (BIM), would allow Anna to accurately predict the construction costs, the operating expenses and the comfort levels.

Government projects have mandatory Leadership in Energy and Environmental Design (LEED) and BIM requirements and their lifecycle optimization is always followed by post-occupancy evaluation. Before a government-financed project is authorized to proceed, it also requires a detailed financial study of the applicable alternatives: renovation, relocation, new construction, leasing, lease construction. However, there is one significant limitation to the process: the available capital is limited and the government is not allowed by law to get private financing.

Understanding the constraint, Anna decided to pursue an alternative route. She started considering how she could write the contract with the private developer who would build the building and lease back to the government, the only available option to meet the demand for a new building. She was wondering how the contract would secure lifecycle optimization for her project. The alternative proposal worked. She was also successful in instituting change so future project managers would be able to have the means available to benefit from lifecycle optimization.

Tangential to this success, Anna was also happy to read in the press that a state had decided to refurbish a bridge in danger of collapse. The news reported that the bridge replacement had been priced at \$250 million and would cause major disruptions to traffic. However, the engineers offered the state to use an innovating technical approach and repair the structural links at a cost of under \$4 million and an increase of the bridge's life expectancy to 40 more years.

Responsive and responsible

Transitioning to systemic leadership and long-term thinking



Pillar impact

The rapidly changing nature of today's economy – characterized by a new wave of disruptive growth driven by innovation, tech-centred processes and automation – offers promise, but requires collaborative, long-term oriented leadership to ensure that all of society's stakeholders benefit from this new growth. To address this challenge, the World Economic Forum's International Business Council launched the [Compact for Responsive and Responsible Leadership](#) in January 2017. The compact recognizes that corporations and investors are powerful actors in society, and through leadership, long-term thinking and investor-corporate dialogue they can improve the state of the world. There is emerging consensus on the need for a new compact for corporations, their chief executive officers and boards of directors, as well as leading investors and asset managers, to create a corporate governance framework with a focus on the long-term sustainability of corporations and the long-term goals of society.

Target vision

Leaders have to be responsive and responsible; they must understand that we are living in a world marked by uncertainty, volatility and deep transformational changes. Many people are living in precarious situations and searching for identity and meaning in a fast-changing world. They want to regain their sense of purpose. More than ever, leadership means taking responsibility. It requires courage and commitment to listen and honestly explain the breadth

and complexity of issues, to proactively generate solutions and to take action based on core values. The reality is that the future offers humankind many opportunities for healthier, greener, more fulfilled and peaceful lives. By exercising responsive and responsible leadership, we can make this possibility our reality.

Implementation process

What do governments need to do to achieve the vision?

Globally, institutions are experiencing a trust crisis. Last year, Edelman's trust barometer highlighted that populations across the world had less trust in elites than ever before, with the standing of governments being particularly hard hit. Distrust increased after the financial crisis and has intensified with later events: revelations of the Panama papers, hacking scandals and political speculation with the general public's understanding of facts.

For governments, but also corporations and investors, taking a strong stance against corruption is essential to responsive and responsible leadership. We therefore encourage consideration of frameworks such as the World Economic Forum's [Partnering Against Corruption Initiative \(PACI\)](#). Corporate tax is a vital source of government revenue across the globe. It is especially vital in developing countries, and therefore government have a particular responsibility to end global tax avoidance.

What do industry associations need to do to achieve the vision?

Industry associations can help set the corporate standards on social responsibility. They can lead by example and set high standards for a corporation, including with respect to human rights, and the integration of relevant sustainability and environmental, social and governance, and corporate social responsibility, which is key to achieving strategic and operational planning, and ultimately, long-term value. Industry associations can collect leading practices for corporations so that society is best served by businesses that have aligned their goals to serve the long-term goals of society. The UN SDGs offer a useful roadmap for such alignment. Associations should come up with guidelines to ensure that short-term financial gains should not distract from the corporate and societal goals of long-term economic prosperity and social welfare. There is also a need for a compact that recalibrates the relationship between public corporations and their major investors, and conceives of corporate governance as a collaboration among corporations, shareholders and other stakeholders working together to achieve long-term value and resist short-termism. Industry associations can promote alternative dispute resolutions frameworks so that disagreement between stakeholders is best resolved in a transparent and respectful manner, de-escalating conflictual stances wherever possible.

What do private/public companies need to do to achieve the vision?

The industry needs more [systemic leaders](#) that understand this interconnectivity and that are visionary, innovative, agile and adaptable at promoting inclusive development, equitable growth, as well as credible ethical behaviour. Business leaders have to walk the talk and establish the appropriate “tone at the top” to actively cultivate a corporate culture that gives high priority to ethical standards, principles of fair dealing, professionalism, integrity, full compliance with legal requirements, ethically sound strategic goals and long-term sustainable value creation. Industry leaders have to clearly communicate their long-term focus. They have to describe a joint vision of their corporation’s strategy, make the case for long-term investments where needed and describe capital allocation priorities in this context. Executives have to articulate the link between strategy and compensation design, and explain the talent diversity mix of the board and executive leadership team. Finally, they have to explain how the practices and culture support independent oversight and transparency.

Envisioning the future

Abebi worked in a construction firm in Nigeria as a supply chain handler where she became adept at helping routing trucks to a construction site in Lagos; she became a certified virtual reality truck driver. After the birth of her first child, she was able to continue working from home. She also pursued remotely a degree that combined urban development studies, landscaping, anthropology, civil engineering and communications. Abebi rapidly rose in her company and supervised the international growth of her

firm. At one point, a government official from a developing country hinted to her that she would need to undertake unethical methods to secure a public mega-project win. She immediately asked her bid team to pull out of the process, and reported the incident to an impartial and confidential multistakeholder ethics department that took action, leading to relieving the public official of his duties and restoring the procurement process with Abebi’s firm’s participation after two months of investigation.

Abebi’s exemplary ethical behaviour caught her senior executive’s attention, which led to her promotion to global chief financial and ethics officer. In this role, she built a system linking salary compensation to success in engaging multiple stakeholders and achieving or exceeding their requirements among other criteria. Today, Abebi spends part of her time mentoring other young leaders in the organization, instilling in them the same sense of integrity and ethics that led her to a top management position. She has also co-developed a new leadership development programme for her firm to foster job growth among employees.

Abebi’s story shows that self-policing is now more prevalent in the value chain at the initial industry ethical transformation stage. Companies no longer fear raising their concerns to ethics bodies, which in turn increases trust between the different value chain constituents and diminishes unethical behaviour in the industry in the long term.

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