VERTIV WHITE PAPER

Rethinking Modern Data Center Design and Construction Trends

The consistently growing workload requirements and energy consumption brought by accelerated computing supporting AI, data analytics, and high-performance computing (HPC) continue to dominate the industry news.

Regulations and upcoming mandates on generative AI and edge data centers' environmental impact have put companies in a wait-and-see mode. To top it all off, there's the constant need to plan and prepare mitigation steps for black swan events, supply chain shortages and delays, and a growing skills gap and fatigue in managing and maintaining an evolvingly complex infrastructure.

This survey from Data Center Dynamics (DCD) entitled "**Data Center Construction Trends**," investigates the perspectives and opinions of data center professionals worldwide regarding data center construction and potential areas for improvement.

The next section of the report summarizes the respondents' experience and perspectives on the different concerns pertaining to data center construction: supply chain inefficiencies and rising costs, project and design management, and widening skills and workforce gap. We also include strategies, professional insights, best practices, and available technologies in the market to ease some of the difficulties cited.

Current Pain Points

Looking at the respondents' concerns, we consolidated the top three issues data center professionals currently face. While overall sentiment on data center construction is favorable, noticeable areas for improvement are highlighted.

1. Data Center Construction Delays

Getting the data center up and running as quickly as possible is the most crucial objective in its construction. However, the difficulties brought by the pandemic and other geopolitical events challenged suppliers in keeping up with the increased demand and caused delays in construction. Trade restrictions and logistics woes compounded these disruptions. While construction delays are common, the accumulated extent of delays and being behind targets by three to six months can significantly affect organizations.

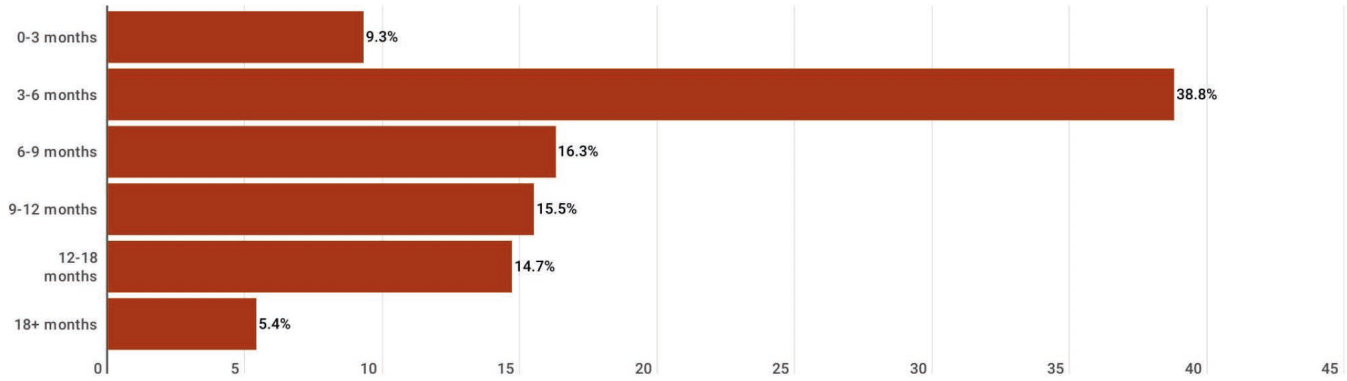

***Figure 1.** Data center respondents' longest construction delays in the past 12 months (Graph screenshots taken from DCD survey sponsored by Vertiv).*

This has also caused an increase in price points for specific parts and systems, resulting in additional costs on accumulated overtime construction and operational delays.

To "demolish-and-rebuild" or "refurbish-and-retrofit" a data center?

A persistent question is whether closing and building a new data center would be more practical than refurbishing an existing one, considering the planning and costs involved. Among all factors considered, a pertinent concern is whether the original cooling and power infrastructure matches newer equipment specification requirements and vice versa.

In the next section, "Insights and Strategies", we include the considerations and experiences of different teams in collaborating with clients to find the most applicable data center implementations vis-à-vis their immediate needs and their short, medium, and long-term objectives for their respective facilities.

2. Insufficient Power Planning

While the speediest construction and operation of the data center is the most important goal, so is planning for its detailed functions, projects, and recovery for unforeseen events – internal and external alike. We found it interesting that among the three drivers for site selection of data center construction, the top three factors many of the respondents considered all pertain to power: availability, cost, and access. This implies the critical role energy plays even beyond the construction, but more so during operations and maintenance of an optimal data center.

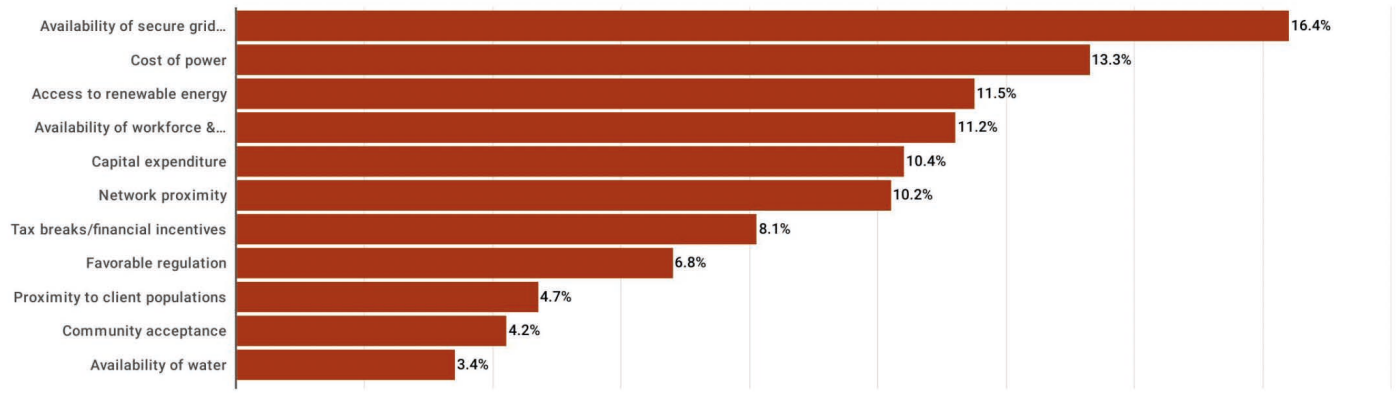

Figure 2. *Identifying the three most important factors driving data center construction site selection: ranked in the top five were availability of secure grid power (16.4%), cost of power (13.3%), access to renewable energy (11.5%), availability of workforce and skills (11.2%), and capital expenditure (10.4%).*

The importance that organizations put on consistent energy delivery is further reinforced by the respondents' emphasis on energy efficiency and sustainability. The capability to consistently monitor and evaluate the energy use of machinery individually and as a system increases the data center team's resilience for operational continuity, especially against external conditions. To this end, data center professionals recognize that an efficient and consistent delivery and source of energy can not only optimize the equipment's functions and operations, it can also protect equipment to maximize its lifecycle, lower total cost of ownership (TCO), and get return on investment (ROI) the soonest. Moreover, this allows the organization to respond to environmental, social, and governance (ESG) requirements for responsible operations, compliance, and oversight.

Another notable consideration that the respondents identified is the integration of newer developments in construction such as modular construction techniques and AI for faster, real-time design and management. Many of the respondents looked to offsite modular construction techniques (20.5%), the use of AI in design and build management (17.4%), and automated real-time visualization of projects in progress (12.2%) as the top three most promising innovations for data center construction. This openness to newer and innovative trends suggests that data center professionals are willing to push for other methods outside the traditional notions of data center construction. This also points to technology receptiveness that can make planning, designing, constructing, and managing the entire process more efficient, simplified, and economical. The general attitudes pose an optimistic view of how these developments can improve data center construction in the long run.

3. Skills and Workforce Shortage

In addition to exhaustion and fatigue among data center professionals and the IT industry in recent years, there is a growing skills gap in the construction domain. While other aspects of the data center construction were surprisingly less pronounced in terms of shortage, the disparity in numbers might suggest an imbalance in recruitment opportunities, training, and skills development available internally and externally.

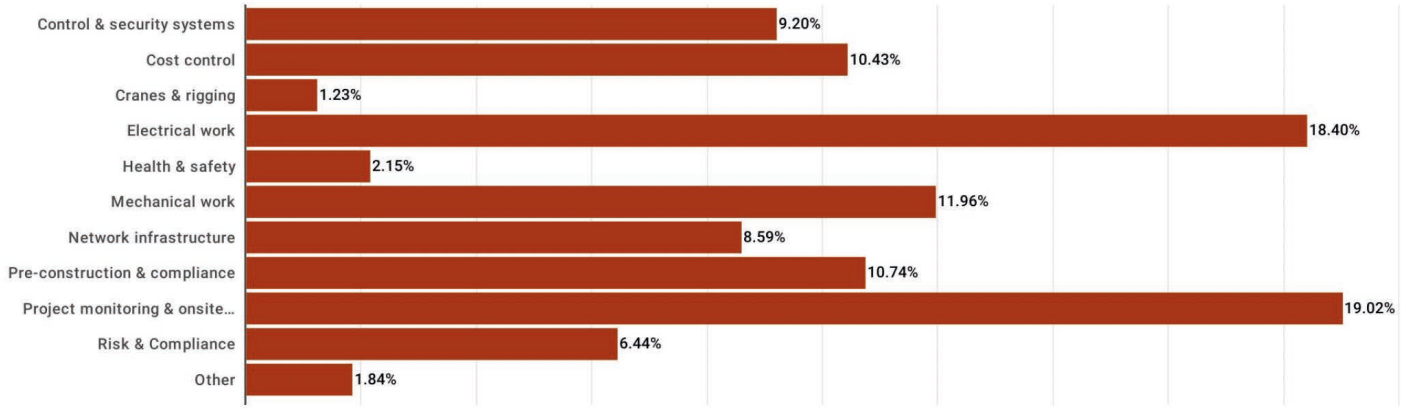

Figure 3. *Areas in the data center where skills shortages are most felt: Project monitoring and onsite management (19.02%), electrical work (18.40%), mechanical work (11.96%), pre-construction and compliance (10.74%), and cost control (10.43%) rank as top five.*

From another angle, the ranking pronounced skills shortage can also be due to the continuous changes and developments in the technology and techniques used in planning for and during data center construction. Considering the changing tools and requirements for the construction vis-à-vis the anticipated goals of the organizations in terms of current needs and growth, the available skills and workforce might need periodic and simultaneous upskilling and knowledge bridging.

In the next section, we combine the survey report's analyst recommendations with our own insights and best practices that respond to the respective pain points of organizations for data center construction. We also include strategies that decision-makers and data center professionals can consider in planning, implementing, designing, and adapting according to their needs.

Insights and Strategies

As data centers respond to the demands for information and AI use, the data center can also adopt the latest available technologies in the market to respond to the evolving needs for data center construction, skill upgrades, and infrastructure maintenance.

Supply Chain and Power Management System (PMS) Resilience

An important realization in the post-pandemic world is how fragile and interdependent the supply chain can be. Business closures or missing components, regardless of origin, can cause a chain of delays that add up to the companies' capital and operational expenditures (CapEx and OpEx). Relying on single-supplier providers can lead to problems with business and operational continuity. This is particularly evident when components, entire systems, construction consultants, and emergency assistance cannot reach the site.

One strategy to prevent this vulnerability is having local suppliers for modular solutions to maximize time, cost, and energy efficiency benefits. The modules' portability makes them ideal for rapid deployment of data processing systems whenever and wherever they are required, and the modules can be built or sourced separately and assembled onsite. Building redundancies into the supply chain, such as having multiple utility providers and procurement sources, minimizes the risk of operational disruptions and financial loss.

The modular approach also means the facility can be scaled accordingly to meet changing demands within a tight timeline while consuming less energy compared to traditional modes of construction. On the flip side, the modular approach can also be used to gradually expand power consumption and scale the data center, which allows managers and engineers to manage and match their budgets and space accordingly. With multiple and customizable design models and diverse component suppliers following advanced technology applications that are easily replicated, organizations can build and manage a robust data center supply chain able to withstand predictable and unforeseen circumstances.

Regular Auditing and Mapping for Risk and Cost Management

Data center professionals should regularly audit their equipment inventory to monitor and evaluate systems' individual and collective conditions and lifecycles. With AI and machine learning integration, extensive data collection, and the accessibility provided by simplified remote and onsite monitoring platforms, engineers and managers can:

- Better prioritize and allocate their attention and tasks.
- Ensure the entire infrastructure runs efficiently.
- Make more precise analyses for data center facility projections in the short- and long-term concerning the business, customer, and demand increase.

Furthermore, a regular audit allows the authorized team to have a comprehensive and networked map identifying the following:

1. Equipment inventory
2. Components
3. Related projects
4. Vendor lists
5. Workforce
6. Utilities

This map is vital for risk and cost management – in identifying and comparing the actual and potential areas of CapEx and OpEx pits, vulnerabilities, growth, competitive pricing opportunities, new techniques and technology integrations, tax breaks, regulation-affected areas of concern, vendor diversification, and cost savings, among other contingency planning and documentation facets.

This comes into play when deciding between building a new data center or retrofitting an existing one. Companies' sustainability, management, economic, and growth goals are matched consistently, with some factors and examples considered being:

- Identifying the swing source install as the starting point.
- Current power availability limitations vis-à-vis speed for expansion.
- Multi-tenant data centers (MTDCs) with standard designs.
- Goals of outweighing the efficiency gains of newer facilities following the IT cycle.

"Bring Your Own Power" (BYOP) with Modern Microgrids

Gone are the days when data centers relied on grid power alone to sustain operations and uptime. With increasing utility prices, energy fluctuations, and frequent outages, many data centers are turning to innovative modern microgrids. These hybrid energy ecosystems – basically composed of but not limited to a battery energy storage system (BESS), a hydrogen fuel cell, and a variety of distributed energy resources (DERs) such as solar PVs and wind turbines – are self-sufficient energy systems installed in a specific facility or locale that is "always on".

By combining multiple power sources in a streamlined storage, distribution, and contingency system, these robust facilities provide alternative power solutions to compensate for less reliable grid power. Also known as "bring your own power" (BYOP), integrated energy management systems (EMS) ensure continuous and consistent power supply while anticipating uncertainties like natural disasters, managing costs, and recognizing future needs while protecting the environment.

Recruitment, Training, and Development

Decision-makers can also use AI and big data to facilitate task automation and upskilling for their personnel. Skilled data center personnel can explore new upskilling opportunities while using their existing knowledge and skills as valuable baselines. These can be used to learn and handle new equipment, train new personnel, and bridge the skills gap for modern, intelligent systems responding to new mandates. As a result, they can constructively compare their traditional knowledge with the newer innovations for data center technologies and development vis-à-vis the organization's overall objectives.

Meanwhile, newer systems integrating AI and machine learning are now available in the market to automate tasks such as temperature and energy consumption adjustments, monitoring, and data collection for baseline setting and comparison for anomalous behavior alerts. The collected data can be used for designing, planning, constructing, and maintaining possible data center expansions in relation to the organization's current and projected usage and applications.

Internal De-siloing and Syncing with External Partnerships and Programs

Data center managers and personnel can work in sync to continuously review their current inventory of equipment and skills needed. This strategy allows the team – together with the rest of the company's supply chain partners, IT, and security teams – to continuously update themselves on the trends and implement upgrades that work best. From planning and designing the data center to monitoring and evaluating systems once it is up and running, AI use and integration can be a learning venue for budding and experienced data center professionals.

Moreover, educational and recruitment partnership programs with the supply chain and educational institutions ensure that decision-makers are up to speed with training, employment, and the latest technology the company can leverage for research and integration into their current systems. Partnerships can also advance the organization's objectives via technology and efficiency research in their respective sectors as authority and industry leaders pioneering solutions in the market.

Prefabricated Modular Solutions and Continuous Training

Prefabricated modular (PFM) solutions are beginning to compete with the traditional onsite stick builds in terms of:

- Assembly efficiency and low-risk, high-value implementations for dynamic organizations with both foreseeable and unexpected growth incorporated in the design
- Tighter integration across systems, processes, and management due to its agility, optimized performance, and high-customization form factors from whitespace to power to cooling

Post-construction of the data center, supply chain partners should be able to provide end-to-end project services, including ample training for the authorized data center personnel on the operation specifications of the new facility.

A data center construction partner's expertise should have a wide range of support and service programs customized to the client's needs, from

1. Site project launch
2. Monitoring
3. Management
4. Electrical
5. Preventive maintenance
6. Remote monitoring
7. Emergency response
8. Site assistance

A complete lifecycle approach with a global reach in the supply chain ensures the partner has a robust supply chain and training for country-specific and international know-how on compliance and assistance.

Sustainability and Financial Forecasting

Anticipation and demand for what AI and generative AI can further bring to the table show no signs of slowing down, and so do the demands and costs for power and data. Alongside this anticipation is the mainstream awareness that data centers and companies need to show responsible environmental stewardship and use of resources. In some cases, customers go to the extent of patronizing companies able to demonstrate ESG compliance while remaining consistent with their delivery of quality products and services.

Constructively taking the challenge enables organizations to pivot in business practices and get more innovative and intentional for product and service development. Integrating more sources of power leads to consistency, reliability, and sustainability. Studies show that this approach improves financial performance and prepares businesses for windfalls. Investing in energy-efficient technologies and methods while simultaneously making strategic decisions on data center infrastructure requires foresight in planning and allocating resources over time.

Strategies: Review previous projects and adopt applicable modern solutions

Financial forecasting and budgeting would require a deep dive into the business' historical performance and spending on project construction costs to plan and make sufficient gains. In reviewing and auditing past critical infrastructure construction financials, efficiencies, and outcomes, organizations can find patterns and repeated problem areas for accurate budget and financial allocation with:

- Invested facilities
- Site selections
- Scalable storage solutions
- Thermal and power management techniques
- Advanced analytics tools

Adopting these tools and platforms can reinforce design and management assistance to streamline and discover areas for long-term and anticipated efficiencies and growth.

Data center professionals and decision-makers can also use newer, more innovative build techniques and technologies, such as AI, to:

- Plan and design mission-critical facilities
- Manage construction details
- Automate tasks
- Monitor operations
- Prepare for components' end-of-life (EOL) and replacement

In determining the strategies and tools needed to supplement plans for sustainable critical infrastructure such as data centers, several organizations provide guides and consultative services to align compliance, objectives, implementations, and forecasts vis-à-vis risk and sustainability management and governance.

Conclusion

From planning and design to construction and operationalization, the data center's efficiencies, growth, demands, and workforce require alignment on multiple fronts to ensure sustainability, continuity, protection, and safety. Integrating modern, renewable, and intelligent technologies with traditional knowledge and skills from conceptualization and design can serve as the baseline proactive approach to plan for and invest in mission-critical equipment and frameworks. The advancements, growth, and demands that generative AI and its supporting technologies have turned a corner. This development includes the heightened awareness that learning, upskilling, and adapting are the only ways to ensure continuity – regardless of the industry.

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