

Efficient Knowledge Management Accelerates Enterprise Digital Transformation: Arup Case Study Postprint

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Abstract

[Objective/Significance] In recent years, technological advancement has continuously transformed the design and delivery methods in architecture and planning, models of industry collaboration, and the pathways through which they deliver well-being to humanity, communities, and the environment. Nowadays, disruptive technologies (such as 5G, cloud computing, Internet of Things, big data analytics, and artificial intelligence) are redefining how enterprises manage projects and operational efficiency. Knowledge management systems must also evolve with technological progress to adapt to the new digital era environment, while efficient knowledge management systems are also key elements in accelerating enterprise digital transformation. [Method/Process] By introducing how Arup's new knowledge management system in the digital environment accelerates the company's digital transformation, it illustrates that efficient knowledge management is an important factor in driving enterprise change management. [Results/Conclusions] In this new digital era, knowledge management will be substantially different, and a new modern knowledge management system is both a prerequisite and a key driving force for promoting digital transformation across the entire organization. Knowledge management systems should gradually evolve with technological advancement, becoming more effective and more diversified, to respond to different era changes and strategies, promote corporate reform, and deliver increasingly superior technologies and services to clients.

Full Text

Editorial Note

To deeply explore and centrally report outstanding knowledge management practices in various organizations, and to promote the dissemination of best practices in knowledge management, we have organized this "Knowledge Management

Practice Special Issue.” This special issue includes five case studies: experience sharing from the international engineering consultancy Arup and China Asset Management Company, which have won the “Most Admired Knowledge Enterprise” (MAKE) award multiple times; research on the knowledge engineering system of China State Shipbuilding Corporation; the Illinois Firefighter Line of Duty Death Digital Image Collection Database (IFLODD); and the construction of Tongji University’s institutional repository. These cases cover diverse types of knowledge management work and can provide valuable learning and research materials for readers. We also welcome submissions to our regular column “Best Practices.”

Efficient Knowledge Management Accelerates Enterprise Digital Transformation — A Case Study of Arup

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Abstract

[Purpose/Significance] In recent years, technological advances have continuously transformed how buildings and planning are designed and delivered, how industries collaborate, and how they create benefits for people, communities, and the environment. Today, disruptive technologies such as 5G, cloud computing, the Internet of Things, big data analytics, and artificial intelligence are redefining how enterprises manage projects and operational efficiency. Knowledge management systems must also evolve with technological progress to adapt to the new digital era environment, while efficient knowledge management systems are key elements in accelerating enterprise digital transformation. **[Methods/Process]** By introducing how Arup’s new knowledge management system in the digital environment accelerates the company’s digital transformation, this paper illustrates that efficient knowledge management is an important factor in promoting enterprise change management. **[Result/Conclusion]** In this new digital age, knowledge management will be fundamentally different, and a new modern knowledge management system is both a prerequisite and a key driver for the digital transformation of the entire organization. Knowledge management systems should gradually evolve with technological progress, becoming more effective and diversified to meet the changes and strategies of different eras, promote corporate reform, and provide clients with more excellent technologies and services.

Keywords: digital transformation, knowledge management, digital revolution

1. Enterprise Overview

Founded in 1946, Arup provides core creative strength for numerous renowned projects worldwide, spanning all fields and industries of the built environment, with projects in over 140 countries. The company's designers, engineers, architects, planners, consultants, and technical specialists work with clients to create high-quality, impactful innovative projects: from the Sydney Opera House to the Bird's Nest and Water Cube, from London's King's Cross Station redevelopment to the Hong Kong-Zhuhai-Macao Bridge, from the world's first zero-carbon community BedZED to China's first C40 Climate Positive project Shougang Park. These outstanding projects have earned Arup an acclaimed reputation in the industry.

Arup's "people-centered" corporate culture encourages employees to think independently, be creative, and continuously learn. The company integrates innovation and technical excellence into the design process and constantly explores new technologies to provide optimal engineering solutions for challenging and complex technical problems. Sustainability is at the core of Arup's design philosophy, guided by the vision of "shaping a better world." In Fortune magazine's inaugural 2015 list of "50 Companies That Can Change the World" [1], Arup was the only company from the construction engineering industry recognized for its positive impact on the built environment. Simultaneously, Arup won the "Operating Model Master Award" at the 2020 Digital Transformation Awards [2] held by International Data Corporation (IDC) in Hong Kong, which recognized Arup's excellence in improving business responsiveness and efficiency through digitally connected products, services, assets, people, and customers. Arup's success stems from gathering industry elites from around the world, enabling cross-regional and cross-disciplinary collaboration to provide clients with comprehensive "integrated design" services spanning design, engineering, planning, and various specialized technologies. This is inextricably linked to Arup's mature knowledge management system.

2. Arup's Knowledge Management System Drives Enterprise Digital Transformation

As a global engineering consultancy and urban advisory organization, cross-technical and cross-regional knowledge sharing is particularly important. Founder Sir Ove Arup noted in the 1940s that even experienced engineers struggle to master and familiarize themselves with technologies from different engineering fields, understand how to practice "integrated design," and share knowledge across the organization. Recognizing the importance of knowledge management, Arup has implemented a "knowledge management" program for many years, treating it as an important method to optimize collaboration. Arup formally established its first knowledge management strategy in 2001, and today, its knowledge management system has reached maturity. Knowledge harvesting, storage, and sharing have been embedded in daily operations and

corporate culture, forming a knowledge cycle that effectively and continuously develops Arup's collective wisdom. Arup's knowledge management strategy and practices have been widely recognized by numerous independent research institutions and third-party organizations, winning the MAKE Awards (Most Admired Knowledge Enterprise) for consecutive years.

2.1 Knowledge Management Strategy

Arup's knowledge management is led by the Knowledge Management Group established at Arup University Global Headquarters. The group primarily develops strategies and provides support based on business objectives, measures and evaluates knowledge management approaches and implementation, and is assisted by regional knowledge specialists and multiple technical practice communities to form a global network. This network helps promote knowledge management methods and practices across regions and business units, creating a positive sharing environment where knowledge sharing can thrive. The management group also collects feedback and makes appropriate adjustments to ensure its knowledge strategy is optimized according to business needs.

The primary goal of Arup's knowledge management strategy [3] is to ensure that Arup becomes an efficient, knowledge-based best-practice organization, focusing on more effectively acquiring and sharing experiences or best practices within the company and with strategic partners (training and learning, knowledge and information management). Simultaneously, it maintains technological advantages by predicting new knowledge needs (forward-looking insights) and its development (innovation, research, and technology development), forming a knowledge cycle system, as shown in Figure 1 [Figure 1: see original paper].

2.2 Digital Transformation Plan

In 2017, Arup set an ambitious goal to become a leader among engineering consultancies in data and digital technology-driven business through a digital transformation plan. To drive this plan, Arup invested substantial resources and adopted a combined top-down and bottom-up approach. Arup uses a "push" and "pull" strategy to achieve significant progress in a short time. The "push" embeds digital technology into daily work to improve efficiency and design quality, thereby enhancing the competitiveness of various services. The "pull" meets client needs to develop high-value digital services. This trend will be further developed through the widespread application of different digital technologies.

For the digital transformation plan, Arup established four goals for knowledge management: Enable employees to understand new digital technology trends and help them learn and acquire new knowledge; Encourage employees to apply new knowledge, methods, and technologies in daily work; Support employees in integrating digital technology with professional domain knowledge to develop new services and products; Assist employees in actively influencing clients and the entire industry.

2.3 Knowledge Management — The Engine of Digital Transformation

For Arup, the knowledge management system is like a car's engine that propels the company toward its desired strategic direction. The more efficient the engine, the faster and more sustainably the company can reach its goals. If employees are immersed in a continuous learning environment, they more readily accept new concepts and understand the importance of upgrading skills to adapt to a rapidly changing world. If they are accustomed to actively acquiring and sharing knowledge, they are more likely to learn from others' experiences and apply them to their daily work. If they remain curious about future trends and actively engage in research and development, they are more likely to use emerging technologies for innovation.

2.4 Right Timing

Major changes have already occurred in other industries regarding digital transformation. For example, FinTech has long been applied in the financial industry, and manufacturing has advocated for Industry 4.0. However, the construction industry has developed relatively slowly until now. The conservative approach in construction is understandable because decisions made in current construction projects will have lasting and far-reaching impacts on their management and operation for decades to come. For instance, a bridge built today has a design life of at least 120 years, requiring detailed and long-term consideration.

The construction industry is at an important turning point where significant change is inevitable. Meanwhile, the COVID-19 pandemic has dramatically changed how people live, work, and play, as well as how buildings and infrastructure are designed, built, and operated. Many daily operations have been forced to undergo digital transformation, prompting the entire industry to reconsider and examine how digital technology can make the built environment safer, healthier, and more resilient. Arup possesses certain technological advantages and a mature knowledge management system. If it can act quickly and follow development trends, it can seize more opportunities and capture significant business prospects.

3. Implementation in the East Asia Region

3.1 Arup's East Asia Region Plan

To better understand the current status and development direction of digital applications, Arup organized a digital transformation thematic study and invited experienced external consultants for high-level investigation and research. In 2017, Arup launched a digital transformation plan that clarified four important goals and action plans: Data-driven business; Process automation; Innovative products; Value-added services.

Arup adopts a push-pull strategy to drive digital transformation. The push refers to the internal need to move toward digitally-led design (including work-

flow automation) and transform into data-driven business development. The pull refers to the need to meet client demands to develop high-value digital services. As previously mentioned, the entire transformation process includes four key stages: Awareness and learning; Application; Integration; Influence. First, a series of activities drives cultural change, making employees aware of the significance of digital transformation and providing them with rich learning resources and opportunities. Second, workflow automation applies digital technology to engineering projects, providing clients with higher quality and more efficient services. Third, new digital technologies are integrated with business to provide clients with better or newer solutions. Finally, through Arup's innovation ecosystem, it actively influences clients and the entire construction industry.

To support this process, Arup established a leadership team called the "Digital Think Tank," which reports to the regional board on direction, policies, and progress, approves investments, mobilizes resources, assigns tasks, and monitors progress related to digital transformation. Led by the East Asia Regional Chairman, the East Asia Chief Operating Officer is also a key member of the team.

Arup also created the "Digital Rock Band," a group of employees passionate about digital transformation who help accelerate digital change, promote the application of digital technology and knowledge, and build a relevant culture to support the Think Tank's promotion efforts. Members organize activities to stimulate employee interest, connect Arup with the external ecosystem, promote idea exchange and sharing, disseminate information, and ensure Arup's digital transformation progress reaches every corner of the company.

The "Digital Den" is Arup's digital technology knowledge and exchange center, where digital technology enthusiasts can gather for knowledge and information exchange, technology demonstration, and sharing, allowing employees to experience emerging technologies and explore more possibilities for digital service products.

3.2 Cultural Change

Like many change initiatives, successfully transforming corporate culture is crucial for achieving sustainable desired outcomes. From the beginning, Arup focused on people, helping employees understand what digital transformation means for business and clients, and providing them with necessary learning resources and opportunities.

3.2.1 Digital Space To attract employees, Arup established a comfortable Digital Den that provides a pleasant environment for chatting and brainstorming, thereby stimulating many creative ideas. Arup's unique Digital Den has three major functions: Gathering employees passionate about change, who share ideas and build a sense of belonging and communities of practice; Allow-

ing employees to experience the latest innovative digital technologies; Inducing exploration of more digital possibilities.

Arup's Digital Den not only provides a gathering point but also continuously hosts relevant training, sharing, and networking activities to drive cultural change. For example, a lecture series called JustDen is held weekly after work hours in the Digital Den, providing snacks and beer, and inviting employees from technology companies or Arup to introduce the latest digital technologies related to planning, design, construction, and operation, and discuss their potential applications. Additionally, a monthly lecture series called Trans4rum invites senior executives from major companies to share their experiences in digital transformation, helping employees understand how other companies prepare for digital transformation and learn valuable lessons from their experiences.

3.2.3 Digital Acceleration Change Workshop Arup has over 40 skills networks (also called technical practice communities) in its knowledge management system, covering various specialties, each led by skills network leaders from five regions. To accelerate digital change, in 2018, each skills network held a two-day "Digital Acceleration Change Workshop" to discuss digital transformation, explore opportunities, and establish technical development plans for their specialty aimed at automation and data-driven business. Workshop outcomes included development roadmaps and action plans to simplify workflows, develop automation tools, and explore integrating the latest digital skills into current service areas.

3.2.4 Innovation Lab The Innovation Lab is a carefully designed training program (see Figure 5 [Figure 5: see original paper]) that has been regularly conducted globally since 2018. Each event gathers employees from 70 different teams who are enthusiastic about driving change to discuss user experience design, cultural change, design thinking, venture capital processes, emerging technologies, automation principles, potential new digital services and products, and sales techniques. Trained employees become change ambassadors within their teams. Arup also collaborates with cutting-edge experts and scholars in specific fields to share their latest research findings and innovative processes in the Innovation Lab.

3.2.5 Training Programs Arup's training strategy is based on the 70:20:10 concept, where 70% of learning comes from on-the-job training, 20% from informal training mainly driven by different skills network activities, and 10% from formal training.

(1) Master's Programs. Arup collaborates with world-class universities to develop one-year internal master's programs on relevant technologies. After completing these programs, employees actively help drive relevant business development or technology applications in their respective regions and offices. These courses include several digital technology-themed programs, such as the "Data

Analytics in the Built Environment” master’s program with the University of Southampton and the “Machine Learning and Artificial Intelligence Applied to the Built Environment” master’s program with King’s College London.

(2) Digital Technology Basic Training Series. As a fundamental step in digital transformation, basic digital technology training is crucial for achieving goals. During the transformation, the company needs to continuously improve the skill levels of design and engineering personnel in automation and data-driven design, and more importantly, strengthen awareness among new graduates and help them learn relevant digital skills early in their careers. Therefore, at Arup, the digital technology basic training series is mandatory for recent graduates, who can also choose other optional and recommended courses. They can enroll in and complete required and elective courses at their own pace on the online learning platform.

(3) Micro-courses and Short Videos. Micro-courses are short, highly focused learning modules based on single topics or questions. They are a quick and simple method for sharing knowledge throughout the company. These courses are hosted on Arup’s integrated learning platform and accessible to employees worldwide anytime. A large number of micro-courses related to digital technology have greatly promoted digital transformation. The integrated learning platform can also track employees’ learning progress, enabling skills network leaders to conveniently analyze which courses employees have accessed and related feedback and suggestions. Additionally, lecture series organized by Arup, such as the JustDen series and skills network knowledge sharing, are recorded, edited, and stored on the internal video sharing platform (MediaSpace) for global employees. To date, Arup has accumulated a large number of digital technology-related lecture videos, providing rich learning materials for employees.

(4) LinkedIn Learning. LinkedIn Learning is an online education platform providing numerous video modules taught by industry experts, covering digital, business, creative, and technical topics, as well as personal development courses for improving soft skills. Through partnership with LinkedIn Learning, Arup employees can access thousands of learning resources, most of which are related to digital skills, and can search for them directly through the internal integrated learning platform.

(5) Formal Training. Arup has developed many formal training courses focused on practical applications. For example, the one-day AR/VR/MR bootcamp (see Figure 6 [Figure 6: see original paper]) covers basic introductions, potential application scenarios, differences between VR/AR/MR, and creating VR applications based on participants’ own professional models.

3.3 Workflow Automation

When data becomes the core of all projects and work, automation and data application become valuable. Automation can simplify repetitive work, ensuring

accuracy and consistency, allowing employees to spend more time focusing on complex technical problems, exploring optimal solutions, and delivering high-quality results for clients—this has always been Arup’s goal. Arup has made tremendous efforts to build a Common Data Environment. To accelerate automation, Arup has formulated a series of important initiatives.

3.3.1 Workflow Library The first part of automation is identifying and standardizing common workflows. To this end, Arup’s various skills networks and business teams held multiple workshops to excavate and optimize key workflows within the enterprise, mapping data-based information flow combined with workflow diagrams, and optimizing each step in the process (see Figure 7 [Figure 7: see original paper]). Simultaneously, a central repository called the Workflow Library was created on the intranet to store and share all standardized workflows across the company.

3.3.2 Automation Implementation Plan The Automation Implementation Plan is Arup’s strategy for turning plans into action, adopting a top-down approach. Each team must select at least one workflow for improvement and automation, completing it within a fiscal year. Each team is responsible for its own automation progress, while the East Asia Headquarters Digital Design Team provides necessary methodologies, technologies, and platforms for assistance. After completing each automation implementation plan, the implementation team creates corresponding micro-courses on the intranet for technical sharing.

3.3.3 Secondment Program Since engineering teams need to handle client projects daily, completing automation implementation plans on schedule becomes extremely challenging. Therefore, Arup established a secondment program where employees responsible for plan implementation can apply for temporary secondment to the headquarters digital design team for a period of time, completing the plan under their guidance. After completing the program and returning to their teams, secondees serve as “automation ambassadors” to promote the implementation of new automated workflows and provide support.

3.3.4 Tool Library Workflow automation often generates related digital tools. All automation tools from around the world are stored in a shared Tool Library for more effective sharing. All employees can post feedback and suggestions on these tools to obtain optimal application solutions and make further improvements. Additionally, Arup has developed an internal platform to monitor the usage of different tools and regularly provides reports on tool application.

3.3.5 Automation Bootcamp The Automation Bootcamp provides employees with learning opportunities to practice automation tools under expert guidance and encourages them to apply them in daily work. These experienced

internal experts guide approximately 12 employees each time, explaining in detail how to effectively program and solve real project problems. The bootcamp is designed as a series of two-hour courses and has trained hundreds of employees to date.

3.4 New Digital Services and Products

In the new digital era, adopting digital technology to provide new, high-quality services or products is crucial for maintaining market competitiveness. In recent years, Arup has been committed to combining professional domain knowledge with the latest digital technologies to provide clients with better or newer solutions while enhancing the company's ability to create value and effectively transform the built environment.

3.4.1 Creative Workshop By holding multiple small-scale innovation workshops on digital technology, Arup gathers employees passionate about innovation to explore solutions for industry pain points and derive new services. Through interactive workshops, employees can propose their own insights and follow up on subsequent R&D progress and results. Through these activities, employees can train themselves in methods and techniques for promoting digital products and learn how to communicate their messages clearly. For this purpose, Arup established an innovation working group to systematically screen these creative ideas and provide guidance throughout the development process.

3.4.2 Research As an industry leader, Arup is committed to providing new ideas and excellent solutions through research to help clients realize innovative ideas. Every year, Arup allocates substantial funds for research aimed at actively pursuing future business opportunities by identifying client and enterprise needs. Arup views research and innovation capabilities (knowledge creation) as filling the gap between current best practices and future business needs and expectations, maintaining its industry-leading position.

To promote digital transformation, since 2017, the East Asia region has allocated more than half of its annual research budget to support digital-related research, from automation to developing new digital products and services. The focus encourages proof-of-concept or minimum viable product (MVP) development projects. Through a series of research efforts, Arup has developed many new solutions, including an intelligent management platform for buildings. Arup's design team and digital acceleration center team work closely to develop a digital platform that integrates information from Building Information Models (BIM) and other asset management data, then uses artificial intelligence to optimize management. The development purpose is not only to provide a platform but also to collect and analyze client data to provide better data-driven consulting services.

3.4.3 Digital Acceleration Hub (DAH) Established by the Digital Think Tank in 2018, the Digital Acceleration Hub is a team composed of professional software developers and digital service experts. Unlike other Arup employees, the Digital Acceleration Hub team works in a co-working space in Shenzhen's Nanshan District, aiming to fully utilize the surrounding resources of Shenzhen's high-tech industrial development zone, which hosts many Chinese tech giants and innovative startups.

The Digital Acceleration Hub has three main purposes: Assist with automation implementation plans and develop digital design tools to improve work efficiency; Provide clients with digital technologies such as GIS platforms, IoT, AR/VR, drones, AI/ML, etc.; Enter Shenzhen's rich digital ecosystem to explore potential technologies and opportunities beneficial to Arup's skills and business.

Digital Acceleration Hub experts work closely with Arup's internal professional employees to understand workflows and help them achieve automation to improve efficiency and accuracy, helping employees solve complex software development problems so they can focus on design. The Digital Acceleration Hub also builds digital tools and platforms to provide clients with other value-added services, such as IoT platforms for building operations and AR/VR tools for design visualization (see Figure 8 [Figure 8: see original paper]).

3.4.4 Foresight Arup's foresight department focuses on identifying and analyzing trends affecting the future of the built environment. This includes understanding the main drivers of change, possible paths to the future, and impacts on specific businesses, projects, and business environments. The aim is to translate foreseeable trends into actionable insights to support strategy, design, and innovation processes. Arup's foresight team has published numerous reports and held multiple seminars with clients and partners on digital transformation trends, having a significant impact on the industry and maintaining a leading position (see Figure 9 [Figure 9: see original paper]). This also helps other companies better position themselves and collaborate with Arup to develop new products.

3.5 Innovation Ecosystem

Arup adopts a systematic approach to promote innovation. In addition to internal R&D, it encourages employees to innovate and invest within the corporate framework and collaborates with external partners such as technology companies, universities, and local startups for joint innovation. This approach enables Arup to use external knowledge to inspire innovative ideas and develop breakthrough solutions for clients (see Figure 10 [Figure 10: see original paper]).

Arup connects with technology providers through various channels, such as the JustDen lecture series, Digital Building Exhibition, external research partnership networks, and various external activities to interact with high-tech com-

panies in different regions. Many technology companies have been invited to participate in Arup's activities to promote cooperation or expand the ecosystem. In today's competitive environment, accelerating the promotion of innovative solutions to the market is crucial, and co-creation with partners is key.

4. Summary

As previously mentioned, Arup's digital transformation goals are to become a pioneer in data-driven business, automate work processes and workflows, develop innovative products and solutions, and provide value-added services to clients. These goals will ultimately translate into improved corporate operational efficiency, client and employee satisfaction, business performance, competitiveness, and market influence.

Efficient knowledge management plays a critical role in the rapid and demanding digital transformation process. Digital transformation provides an excellent opportunity to verify the importance of good knowledge management in organizations. This case study aims to provide reference for knowledge-centric enterprises, explaining the importance of establishing and practicing efficient knowledge management. Change is constant, and the ability to quickly adapt to and thrive in a changing environment can enhance corporate competitiveness and lead the company to become an industry leader.

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Note: Figure translations are in progress. See original paper for figures.

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