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Agile Transformation on Capital Substation Projects

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Abstract

The Agile transformation of 132/11 kV Capital Substation Projects has significantly improved efficiency, cost-effectiveness, and sustainability in infrastructure development. By leveraging Lean and Agile methodologies, including Scrum frameworks, process streamlining, and extensive workforce training, project delivery timelines were reduced by 30%, cutting construction duration from 30 to 21 months. This transformation resulted in AED 1.8M in cost savings per substation, amounting to AED 27M annually, alongside an 84% improvement in first-time drawing approvals. Additionally, the integration of precast construction methods reduced 3,165 tons of CO_2 emissions across 15 substations, reinforcing Agile's role in sustainable project management. The benchmarking of these innovations against other government authority CFR process further highlights Agile's scalability and industry relevance. These findings demonstrate that Agile is not only a project management methodology but a transformative approach that enhances speed, cost-efficiency, governance, and sustainability in capital infrastructure projects.

Keywords: Agile project management, Lean transformation, substation projects, infrastructure efficiency, sustainability.

INTRODUCTION

Infrastructure development plays a pivotal role in supporting economic expansion, with substations being critical components of power transmission and distribution networks. In Dubai, where rapid urbanization aligns with ambitious projects like Dubai Urban Plan 2040, the timely delivery of 132/11 kV substations is essential for meeting growing energy demands. However, traditional project management methodologies often struggle with inefficiencies, including prolonged approval processes, stakeholder misalignment, and rigid execution frameworks. These problems have led to cost overruns, late completion, and reduced degrees of flexibility, prompting a transition towards more cost-effective and flexible solutions in capital substation projects.

This research investigates using Agile methodologies in Power Utility capital substation projects to improve efficiency, reduce construction time, and lower costs. Agile philosophy is conducive to collaborative, incremental processes that offer faster decision-making and adaptable project execution. The study is focused on how Agile combined with Lean principles has attained a 30% reduction in project timeline, realizing massive cost savings of AED 1.8M per substation and a massive increase in first-time drawing approvals. The transformation also aligns with Dubai Urban Plan 2040, UAE Centennial 2071, and the

Sustainable Development Goals (SDGs 9 & 12), emphasizing sustainable infrastructure and efficient utilization of resources. The findings offer a roadmap for implementing Agile and Lean in capital-intensive infrastructure projects in the future, with new utility industry governance standards being established.

LITERATURE REVIEW

Traditional Project Management in Infrastructure

Traditional approaches like the Waterfall model have been the standard for decades in infrastructure projects. The waterfall approach is based on a linear process—planning, design, procurement, construction, and commissioning—and is characterized by sequential activities with clearly defined responsibility (Edison *et al.,* 2021; Chukwunweike & Aro, 2024). PMBOK accommodates common practices in risk management, governance, and process groups, which can be readily embraced in capital projects (Njau *et al.,* 2023). However, such rigid models will lead to cost overruns and delay according to their prescribed structure (Kashikar *et al.,* 2016). Restricted feedback through iterative looping limits the stakeholders' participation, while extensive documentation and time-consuming review phases hamper responsiveness and imagination (Kuttruff, 2023; Bricker *et al.,* 2022).

Agile & Lean in Construction

Agile and Lean methodologies transcend traditional boundaries through incremental development, co-creation with stakeholders, and effectiveness (Celestin *et al.,* 2024). Agile frameworks like Scrum include sprints, stand-ups, and immediate issue resolution, reducing project timelines by 25-30% and improving risk management (Edison *et al.,* 2021; Khan *et al.,* 2017). Lean focuses on eliminating waste and efficiency using Kaizen, Just-In-Time (JIT) delivery, and value stream mapping (Maraqa *et al.,* 2023). The Crossrail Project in London and the Hassyan Clean Coal Project in Dubai successfully implemented Lean practices, reducing material waste and improving execution timelines (Debre, 2021; Power Technology, 2023).

Agile in Energy & Utilities

The energy and utilities sector increasingly adopts Agile to adapt to regulatory changes, technological advancements, and market shifts (Dubai Electricity and Water Authority, 2023). Kairos Power applies Agile in nuclear reactor development using rapid prototyping, iterative testing, and stakeholder engagement, reducing risks and accelerating innovation cycles (Barnes, 2024). Agile also enhances smart grid and renewable energy projects. The Mohammed bin Rashid Al Maktoum Solar Park in Dubai applies Agile governance to improve deployment efficiency (Obaideen *et al.,* 2021). Utilities use Agile-based incremental deployment in smart grids to refine and scale innovations while minimizing system inefficiencies (Pacific Gas and Electric Company, 2023).

Municipal Infrastructure & Governance

Agile methodologies strengthen municipal infrastructure project regulatory approvals. The Call for Review (CFR) procedure is a clear indication of Agile-driven governance with lowered approval duration as per cross-functional coordination (Khan *et al.,* 2017). Stakeholder-led incremental documentation and decision-making in Agile-based regulatory frameworks shorten the time to approval for high-cost capital projects. Such frameworks improve adaptability without diminishing compliance, thereby being applicable in municipal government (Dubai Electricity and Water Authority, 2023).

Hybrid Approaches & Emerging Technologies

Restrictive aspects against Agile deployment are hierarchical configurations and resistance to distributed decision-making (Celestin *et al.,* 2024; Chukwunweike & Aro, 2024). Hybrid models like the Scaled Agile Framework (SAFe) integrate the flexibility of Agile with framework-type governance, which provides capital project regulatory compliance (Saradara *et al.,* 2023; Power & Wendorff, 2022). Emerging technologies like AI and digital twins enhance Agile infrastructure. AI-driven predictive analytics optimize resource planning, and digital twins enable real-time scenario testing, improving decision-making accuracy and speed (Njau *et al.,* 2023; Dubai Electricity and Water Authority, 2023).

METHODOLOGY

Agile Transformation Process

The power utility capital substation projects were revolutionized via an Agile transformation on a systemic roadmap from Q2 2020 to Q4 2024, involving the integration of Lean and Agile Thinking principles to enable best-in-class project implementation. Figure 1 below encapsulates the systemic step-by-step strategy, starting from process capture and current-state mapping, pilot implementation at the pilot substation, and culminating in full implementation on all capital projects. The pilot project approach was essential in testing Agile methodologies in a controlled environment before deploying them at a larger scale.

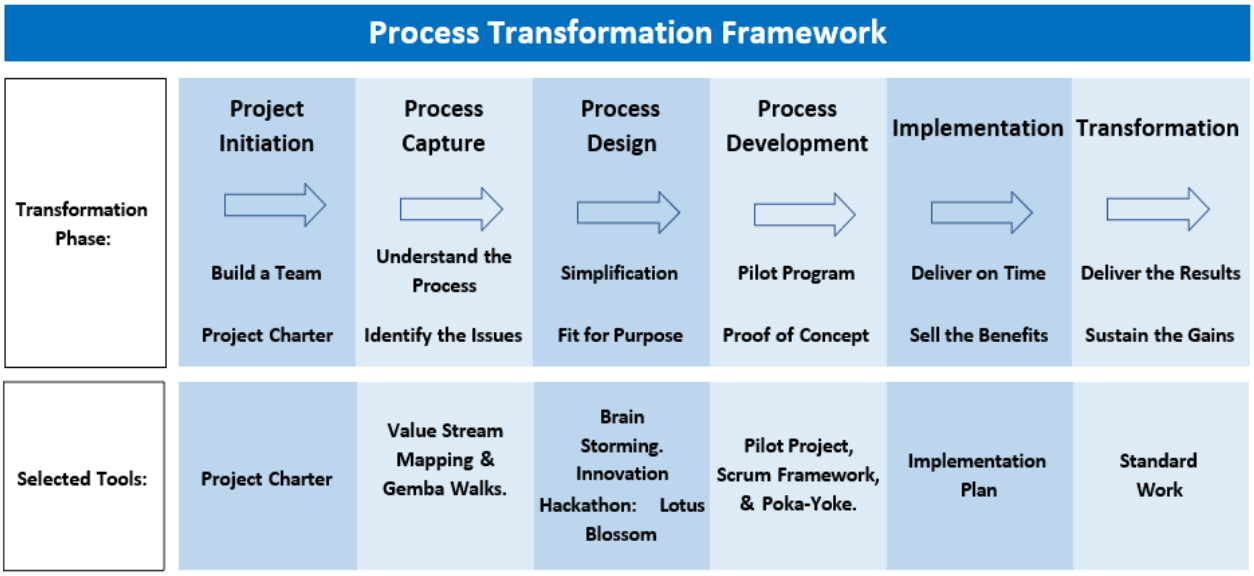

Figure 1: Process Transformation Framework

Process Improvements

Key process improvements were made to drawing approvals, project governance, and execution workflows. The Bulk Submission and Call for Review (CFR) Process was introduced to streamline approvals, significantly reducing delays by 91%. The new system allowed for faster, structured approval cycles, eliminating the need for multiple resubmissions.

A critical organizational restructuring was implemented, where Scrum teams were formed, and stationed engineers took on the role of Scrum Masters. This ensured real-time issue resolution, cross-functional collaboration, and decentralized decision-making. Furthermore, the Minimum Design Detail Drawings concept was introduced, significantly reducing redundant reviews and saving 2.9 months per substation. Figure 2 below demonstrates the major Agile steps of implementation where Lean principles are introduced in every stage of the project.

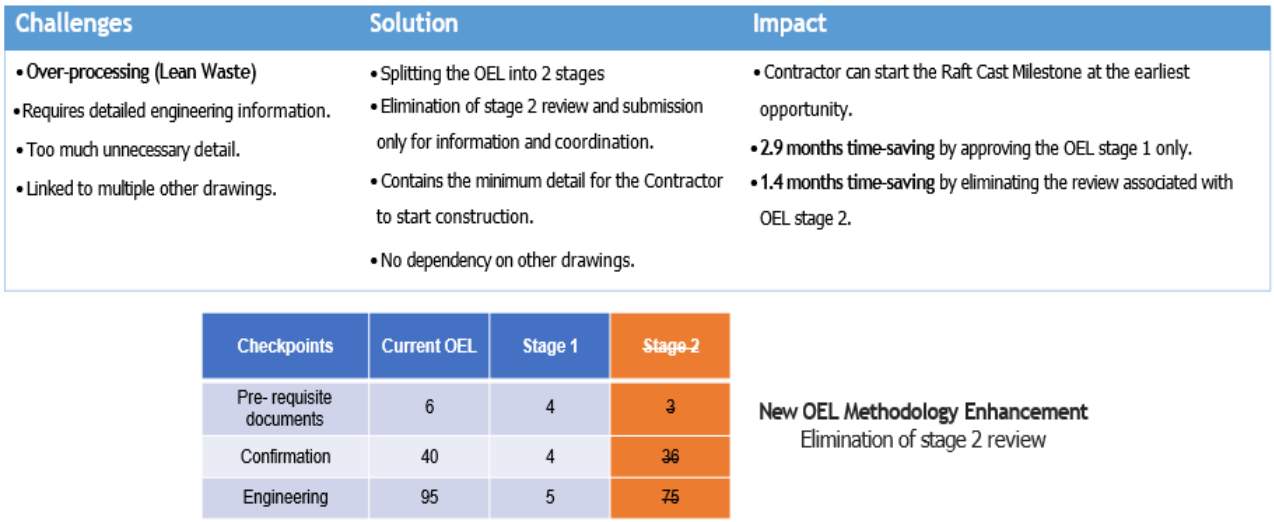

Figure 2: Minimum Design Detail Process for OEL Drawing

Stakeholder Engagement

Stakeholders' active participation was imperative to Agile transformation's success, particularly with large project contractors such as Siemens, Mitsubishi, L&T, and EEE. Contractors were integrated into Agile processes, participating in Sprint Planning, Reviews, and Retrospective Meetings to ensure consistent compliance with Agile values. Internally, the governance structure was fortified by stationed engineers appointed for the role of Scrum Masters, allowing for daily stand-up meetings and Agile backlog management. Weekly reporting frameworks also provided leadership oversight, and monthly governance reviews provided an

overview of Agile adoption success and areas for improved optimization.

Data Collection & Benchmarking

Data collection focused on key performance indicators (KPIs) such as approval cycle time, project delivery time, and governance efficacy in evaluating Agile performance. The High-Level Plan—Key Milestones (Table 1 below) provides a timeline-based breakdown of Agile deployment, indicating significant activities and expected project milestones.

Table 1: High-Level Plan – Key Milestones

High-Level Plan			
	Key Milestones	**Start Date**	**Target End Date**
Milestone 1	Initiative Initiation	01-Apr-20	30-Apr-20
Milestone 2	Process capture	25-Apr-20	25-Jun-20
Milestone 3	Process Design	14-Jun-20	14-Aug-20
Milestone 4	Process Development	26-Jul-20	13-Mar-21
Milestone 5	Implementation	24-Feb-21	30-Jan-23
Milestone 6	Transformation	01-May-22	31-Dec-23

RESULTS

Timeline & Cost Efficiency

The Agile makeover of the Power Utility's capital substation projects delivered a 30% shorter construction time for substations, lowering the average project duration from 30 months to 21 months. This success testifies to the strength of iterative processes, instant issue-solving, and coordination with stakeholders in gargantuan infrastructure projects. Compared to traditional models suffering from long approval waits and informatically scheduling, Agile's flexible approach allowed quick adjustments, avoiding bottlenecks and speeding up execution (Figure 3).

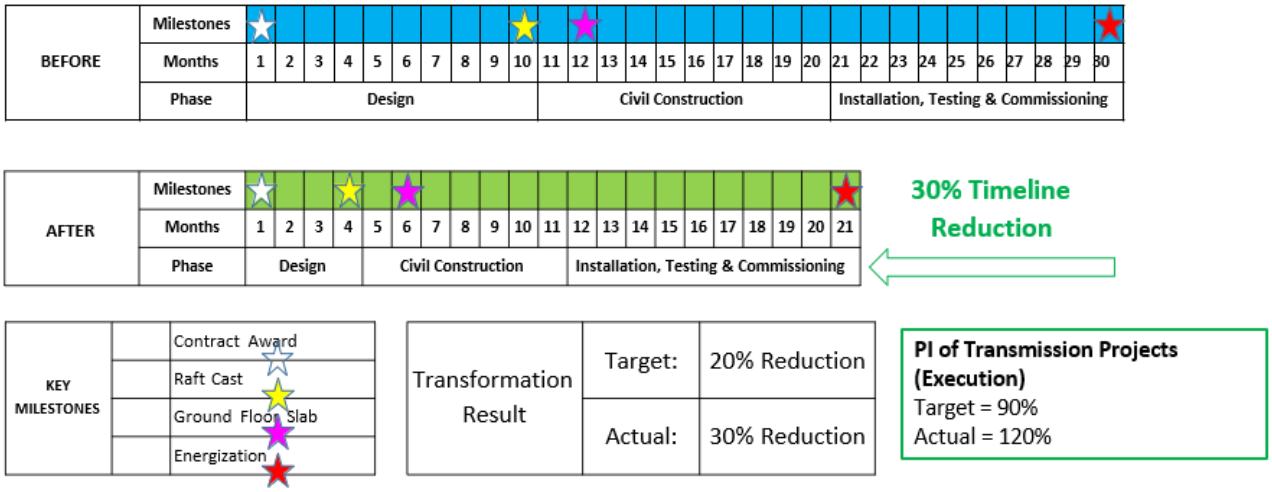

Figure 3: Reduction of the Build Timeline

The cost implications of this transformation are also significant, with an overall annual cost saving of AED 27 million, averaging AED 1.8 million per substation. These are the outcomes of early procurement efforts, risk mitigation through iterative governance, and reduced material wastage. The cost efficiencies further validate that Agile is not merely a scheduling tool but a financial optimization mechanism in capital-intensive projects (Figure 4). The strategic integration of Lean procurement principles alongside Agile has reinforced value-driven project execution, ensuring that cost savings do not compromise output quality.

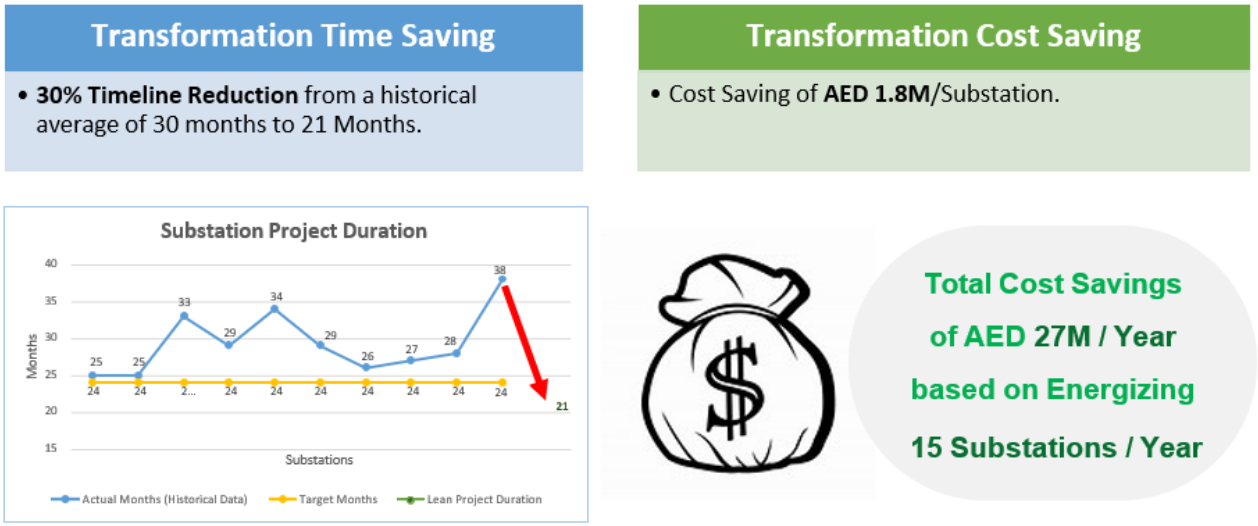

Figure 4: Total Cost Savings of AED 27M / Year

Process Optimization

The 84% increase in first-time approval of design drawings highlights the direct impact of Agile's iterative submission model. Traditional approval workflows, reliant on linear, batch-style submissions, often lead to extensive revisions, causing delays. Project teams reduced turnaround times by shifting towards a progressive review cycle with real-time feedback loops while maintaining compliance standards. This change underscores the necessity of integrating Agile governance into regulated environments, proving that compliance and agility are not mutually exclusive (Figure 5).

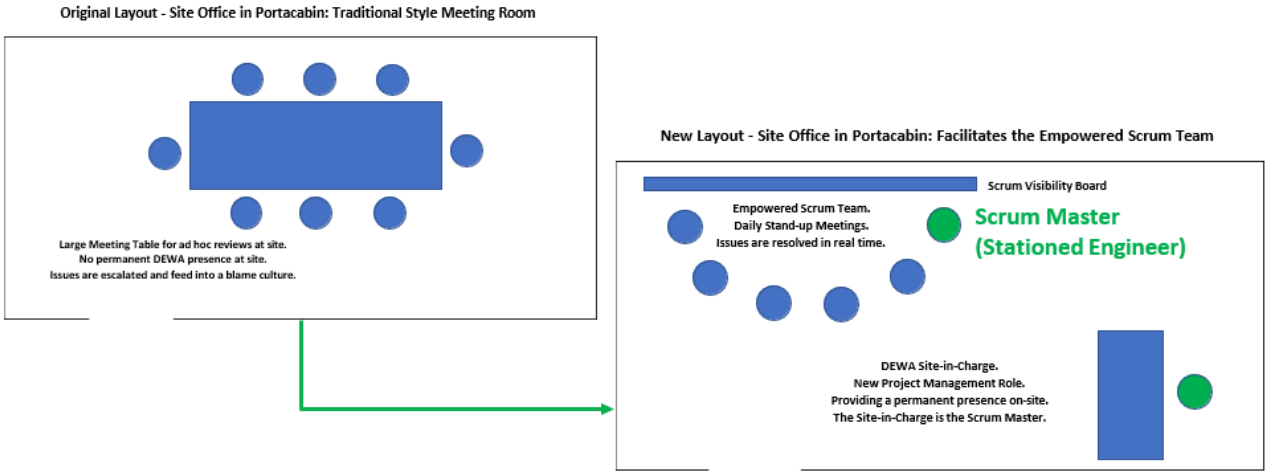

Figure 5: Comparison of Agile vs. Traditional Substation Delivery

Further, the 40% reduction in raft casting time reflects the benefits of early risk identification, pre-emptive resource allocation, and enhanced coordination among cross-functional teams. A critical takeaway from this outcome is that physical execution phases of infrastructure projects can benefit as much from Agile as administrative processes. This improvement challenges the misconception that Agile only applies to digital or service-based industries, reinforcing its adaptability in heavy engineering and construction.

Sustainability & Environmental Impact

The 3,165-ton reduction in CO_2 emissions across 15 substations exemplifies how Agile-driven efficiencies translate into measurable environmental benefits. These reductions stem from optimized construction workflows, waste minimization, and strategic material sourcing, reinforcing Agile's role in sustainable project management. The results indicate that Lean-Agile synergies can be an effective sustainability enabler, aligning project execution with global carbon reduction commitments (Figure 6).

No.	Strategy	Impact
1	Circular Economy Policy 2021-2031	Optimum utilization of DEWA and contractor resources to provide electricity.
2	UAE CENTENNIAL 2071	Upskilled DEWA staff using Lean and Agile thinking.
3	DUBAI URBAN PLAN 2040	Power provided in line with Dubai's urban development plan.
4	SGDs 9: Industry, Innovation, and Infrastructure 12: Ensure sustainable consumption and production patterns	Infrastructure Projects (Power Substation) delivery timeline reduced by 30%. Iintroduction of precast into the substation which had : - **Economy:** Cost saving of 520*1250 =650,000.00 AED cost savings. - **Environmental:** CO2 emission reduction of 211 tons. - **Social:** Reduction of associated noises of civil works for 2-months early completion. Amount of carbon dioxide emission saving per substation = 520*0.36*1.13 = 211 tons Number of substation executed using precast (till end of 2023) = 15 Total amount of carbon dioxide emission saving= 3165 tons

Figure 6: Amount of carbon dioxide emission saving per substation

Beyond emissions, the decrease in noise pollution and environmental footprint validates the secondary benefits of accelerated project execution. By reducing on-site activity duration, Agile reduces community disruption, improves occupational safety, and reduces indirect environmental harm. These findings strengthen the case for integrating Agile into urban infrastructure development, where minimizing environmental and social disruption is as critical as cost and time efficiency.

Quality Enhancement

The refined governance model under Agile has led to faster, data-driven decision-making, significantly reducing rework and misalignment among stakeholders. Traditional governance structures often create hierarchical decision-making silos, which hinder project adaptability. In contrast, Agile's decentralized governance structure empowers cross-functional decision-making, ensuring real-time resolution of critical project constraints. This improvement is evident in the comparison of planned versus actual project durations (Figure 6).

Capital Substations - Lean & Agile Roll-Out Plan 2023

	Lean & Agile Ideas	Substation Code - Milestone Start											
1	New OBS Structure	SS 1, 2, 3	SS 4, 5, 6	SS 7, 8, 9	SS 10, 11, 12	SS 13, 14, 15							
2	OEL Simplification		SS 1, 2, 3	SS 4, 5, 6	SS 7, 8, 9	SS 10, 11, 12	SS 13, 14, 15						
3	Bulk Drawings			SS 1, 2, 3	SS 4, 5, 6	SS 7, 8, 9	SS 10, 11, 12	SS 13, 14, 15					
4	Drawings CFR Process			SS 1, 2, 3	SS 4, 5, 6	SS 7, 8, 9	SS 10, 11, 12	SS 13, 14, 15					
5	Station Engineer at Site				SS 1, 2, 3	SS 4, 5, 6	SS 7, 8, 9	SS 10, 11, 12	SS 13, 14, 15				
6	Scrum Framework				SS 1, 2, 3	SS 4, 5, 6	SS 7, 8, 9	SS 10, 11, 12	SS 13, 14, 15				
7	Issue Resolution Process	SS 1, 2, 3	SS 4, 5, 6	SS 7, 8, 9	SS 10, 11, 12	SS 13, 14, 15							
8	Raft Cast					SS 1, 2, 3	SS 4, 5, 6	SS 7, 8, 9	SS 10, 11, 12	SS 13, 14, 15			
9	ITC Ideas												SS A
	Roll-Out Timeline:	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23	Aug-23	Sep-23	Oct-23	Nov-23	Dec-23

Note	SS: Substation

Figure 7: Transformation Cost Saving & Timeline Reduction

The reduction in rework rates reflects the value of proactive issue identification within Agile frameworks. The earlier visibility into project constraints made it possible for teams to undertake corrective actions before execution, leading to fewer cost overruns and higher quality assurance. This confirms that Agile, when applied to capital projects, is a control mechanism in the preventative sense and not just an execution accelerator.

DISCUSSION

Agile-driven substation projects fared better than Waterfall-controlled projects by settling issues faster, stakeholder cooperation, and adaptability, reducing slowdowns in design and faster approvals. Unlike Waterfall's one-way, linear processes, Agile's spiral process decreased slowdowns caused by dependencies. Using Scrum teams and installed engineers as Scrum Masters facilitated real-time observation, skirting around the impediments. The use of non-hierarchical governance compared to decentralized operation boosted flexibility as well as optimization. Early stakeholder engagement, structured training, and multiple collaborations ensured teams aligned with Agile principles, reducing resistance. Standalone teams accelerated decision-making by not relying on slow top-down approvals. Challenges like training deficits and stakeholder resistance were avoided through Lean Black Belt and Agile Scrum training, providing mass capability. Benchmarking in global infrastructure projects confirmed Agile's viability beyond substations, achieving success in power grids, solar and wind energy, and urban infrastructure. This modification made Agile a disciplined yet adaptable methodology, offering cost reduction, schedule reduction, and better project governance.

CONCLUSION

The power utility's capital substation projects Agile transformation has successfully showcased its virtues of reducing project lead times, optimizing costs, and sustainability. Having reduced substation construction time by 30% and AED 27M in cost each year, Agile has been witnessed firsthand as an immensely successful alternative to traditional project management practices. Further, the integration of Lean has promoted sustainability activities that have shown radical CO_2 emission reductions as well as minimizing the environmental impact. The broader industry ramifications show that Agile is a future-proof approach to managing capital infrastructure projects, allowing for flexibility, efficiency, and improved stakeholder collaboration. However, to leverage the full potential of Agile, the industry must evolve through digital transformation by integrating AI, IoT, and predictive analytics with Agile to further refine project prediction and risk assessment. Future research needs to make Agile practices automatic to make implementation even further and explore scalability to distribution and generation projects to enable enormous adoption within the power industry.

REFERENCES

- Barnes, A. (2024, February 16). *France's EDF returns to profit as nuclear power generation rebounds.* Euronews. https://www.euronews.com/business/2024/02/16/frances-edf-returns-to-profit-as-nuclear-power-generation-rebounds
- Bricker, S., Terrington, R., Burke, H., Dobbs, M., Arnhardt, R., Kearsey, T., & Thorpe, S. (2022). Urban geoscience report: the value of geoscience data, information and knowledge for transport and linear infrastructure projects. https://nora.nerc.ac.uk/id/eprint/533117
- Celestin, M., Sujatha, S., Kumar, A. D., & Vasuki, M. (2024). The Rise of Agile Methodologies in Managing Complex Business Projects: Enhancing Efficiency, Collaboration, and Adaptability. *Indo-American Journal of Multidisciplinary Research and Review*, *8*(2), 69-77. https://doi.org/10.5281/zenodo.13871832
- Chukwunweike, J., & Aro, O. (2024). Implementing agile management practices in the era of digital transformation. *World Journal of Advanced Research and Reviews*, *24*(1).
- Debre, I. (2021, January 16). *Expo 2020 unveils key pavilion in Dubai as pandemic surges.* AP News. https://apnews.com/article/dubai-united-arab-emirates-middle-east-coronavirus-pandemic-environment-fdebe5173157dcce159b151854e7d51c
- Dubai Electricity and Water Authority. (2023, June). *DEWA commissioned.* Dubai Electricity and Water Authority. https://www.dewa.gov.ae/en/about-us/media-publications/latest-news/2023/06/dewa-commissioned
- Edison, H., Wang, X., & Conboy, K. (2021). Comparing methods for large-scale agile software development: A systematic literature review. *IEEE Transactions on Software Engineering*, *48*(8), 2709–2731. https://doi.org/10.1109/TSE.2021.3069039
- Kashikar, A., Mehta, D., Motichandani, B., & Dasika, D. (2016). A case study on agile and lean project management in construction industry. *IOSR J. Mech. Civ. Eng*, *13*(4), 31-39. https://doi.org/10.9790/1684-1304013139
- Khan, M. S., Woo, M., Nam, K., & Chathoth, P. K. (2017). Smart city and smart tourism: A case of Dubai. *Sustainability*, *9*(12), 2279. https://doi.org/10.3390/su9122279
- Kuttruff, O. (2023, November 16). *Agile methods: The definition of business agility and how to put it into practice.* Workpath. https://www.workpath.com/en/magazine/agility-definition
- Maraqa, M. J., Sacks, R., & Spatari, S. (2023). Strategies for reducing construction waste using lean principles. *Resources, Conservation and Recycling Advances*, *19*(200180), 2023. https://doi.org/10.1016/j.rcradv.2023.200180
- Njau, D. N., D'amour, O. J., Mwicha, J. M., Mucheke, J., Kiio, P. M., & Awino, J. O. (2023). *Agile Project Management*. IPR Journals and Book Publishers.
- Obaideen, K., AlMallahi, M. N., Alami, A. H., Ramadan, M., Abdelkareem, M. A., Shehata, N., &

Olabi, A. G. (2021). On the contribution of solar energy to sustainable developments goals: Case study on Mohammed bin Rashid Al Maktoum Solar Park. *International Journal of Thermofluids*, *12*, 100123. http://dx.doi.org/10.1016/j.ijft.2021.100123

- Pacific Gas and Electric Company. (2023, October 5). *PSPS post-event report: 09-20-2023*. Pacific Gas and Electric Company. https://www.pge.com/assets/pge/docs/outages-and-safety/outage-preparedness-and-support/09-20-PSPS-Post-Event-Report-20231005.pdf
- Power Technology. (2023, June 21). *Hassyan clean coal project, Dubai.* Power Technology. https://www.power-technology.com/projects/hassyan-clean-coal-project-dubai/
- Power, N. S., & Wendorff, P. (2022). Politics in Software Development. https://doi.org/10.1007/978-1-4842-7380-7
- Saradara, S. M., Khalfan, M. M. A., Rauf, A., & Qureshi, R. (2023). On the path towards sustainable construction—the case of the United Arab Emirates: a review. *Sustainability*, *15*(19), 14652. http://dx.doi.org/10.3390/su151914652