THE IMPACT OF STRATEGIC FACILITY PLANNING ON THE COMPETITIVE ADVANTAGE OF LABORATORY CONSTRUCTION FIRMS: THE MEDIATING ROLE OF OPERATIONAL EFFICIENCY AND THE MODERATING EFFECT OF TECHNOLOGICAL

Chunxin Wang [1]
Hui Guo [2*]

[1 2] Innovation College, North Chiangmai University
[*] **Corresponding Author, E-mail:** David.guohui@northcm.ac.th

Abstract: This research investigates the impact of Strategic Facility Planning (SFP) on the Competitive Advantage (CA) of laboratory construction companies through the mediating role of Operational Efficiency (OE) as well as the moderating role of Technological Complexity (TC). For many laboratory constructions projects, the effective planning of facilities is now even more critical than ever to remain competitive in the market as the projects grow in complexity. Qualitative in nature, quantitative design data were collected from 317 industry experts through a questionnaire. Partial Least Square–Structural Equation Modeling (PLS-SEM) was utilized to assess the direct, indirect, and moderated relationships among variables.

The results show a strong positive direct effect of SFP on CA ($\beta = 0.517$, $p < 0.001$). The results presented initiative demonstrate that OE partially mediates this relationship ($\beta = 0.276$, $p = 0.004$), confirming the necessity of operational improvements to gain competitive benefits of facility planning. In addition, TC moderates the relationship between SFP and CA, and the effect is significant at high levels of technological complexity ($\beta = 0.647$, $p < 0.001$) compared with low complexity ($\beta = 0.385$, $p = 0.041$). Therefore, these results highlight that companies should benefit from holistic facility planning, efficiency-optimizing processes, and the use of state-of-the-art technologies in their competitive edge.

The study offers practical recommendations for industry stakeholders and advocates that laboratory construction organizations improve their operational performance and sustain their competitive advantage through an emphasis on improving design optimization, sustainability integration, technology readiness, and risk management. Limitations include the cross-sectional nature of the sample and regional focus, creating opportunities for further longitudinal studies and broader geographic investigations.

Keywords: Strategic Facility Planning, Competitive Advantage, Operational Efficiency, Technological

Complexity, Laboratory Construction, Structural Equation Modeling

Introduction

In the globalized economy of today, the increasing complexity of laboratory construction projects has generated substantial interest in the exploration of how efforts surrounding strategic planning can improve firm competitiveness. Technological advancements, growing sustainability expectations, and performance excellence now characterize the construction "market" landscape, including the special infrastructure & operational compliance challenged space of laboratory facilities. This is leading researchers and industry practitioners to conduct their investigations to explore how effective planning strategies, efficient resource management, and technology integration can make an influence on the performance of organizations. In light of these challenges and opportunities, it is necessary to explore how strategic facility planning translates into competitive positioning for laboratory construction firms. This study aims to fill this gap by investigating the direct and indirect relationships of SFP on CA with OE as a mediator and TC as a moderator.

Research Context and Motivation

Laboratory construction firms are under pressure to keep up with these developments around the world, and in the context of the construction industry, where the change is rapid, environmental pollution and technology advancement are at the top, sustainability and operational efficiency are in real demand. Laboratories are at the heart of R&D in multiple industries, and ensuring strategic design, construction, and operational processes has become ever more critical. Laboratory projects incorporate a broad array of challenges, from specialized infrastructure needs to complex technologies, making an organizational alignment of facility planning and organizational objectives essential. This context points to Strategic Facility Planning (SFP) as an essential strategic tool for improving the competitive standing of plant-processing firms within this subsector.

With high technological complexity and strict operational standards, laboratory construction projects require a firm to adopt futuristic planning methods. Plans for facilities and objectives for operations should be aligned, the lack of which leads to inefficiency, wasteful spending and poor client-experience. For both academics and practitioners, a crucial issue is how SFP contributes to competitive advantage in firms. This study investigates how SFP influences Competitive Advantage (CA) via Operational Efficiency (OE) as a mediator and Technological Complexity (TC) as a moderator.

Background and Motivation for Research

High-performance, technology-integrated, and sustainable facilities have become the norm for clients who in turn exert greater influence on the ability of laboratory construction firms to deliver in modern construction. Strategic Facility Planning (SFP) is a powerful process that allows firms to efficiently allocate resources, optimize processes, and remain competitive. Considering that laboratories are specialized settings, they need careful consideration of safety standards, functionality, spatial functionality, and rapidly advancing technology. These key pillars of designing forward, integrating with sustainability, being technically prepared and managing project risk are all part of the success of a facility that delivers against evolving science and industry needs.

The building blocks of a lab are SFP, but few laboratory constructions firms have managed to gain a sustained competitive advantage (CA) with the use of SFP. At the same time, lab projects are growing in complexity, with many needing advanced technology integration and cross-disciplinary collaboration. Earlier studies have studied the effect of how planning of a facility has a broad level of benefits in construction, but the exact impact of SFP and its impact on the competitiveness of projects, especially in laboratory construction, has remained obscure. In addition, the mediating function of Operational Efficiency (OE) and the moderating impact of Technological Complexity (TC) in this relationship have not been thoroughly investigated.

Problem Statement

As automation, artificial intelligence (AI), and the Internet of Things (IoT) have been integrated, laboratory construction projects are becoming more and more complicated. Such technological trends compel a strategy of facility planning that fulfills present operational needs as well as anticipates the demands of future technologies. Nonetheless, limited studies have been conducted in understanding how the SFP gets materialized into real competitive advantages for laboratory construction companies.

The precise role that SFP plays in boosting a firm's competitive position through improved OE is not well understood. Furthermore, the heterogeneous degrees of technological complexity across projects may either reinforce or counteract such a relationship. Filling in this gap is important for laboratory construction businesses that want to enhance project results, maximize resource use, and maintain market competitiveness.

Research Objectives

The purpose of this study is to examine the effect of Strategic Facility Planning on the Competitive Advantage of laboratory construction companies, taking into account the mediating effect of Operational Efficiency and moderating effect of Technological Complexity. This research aims to guide the answer to the following questions:

– The Impact of Strategic Facility Planning on Competitive Advantage of Laboratory Building Firms

– How does Operational Efficiency play an intermediary role in the relationship between SFP and CA?

In what way Technological Complexity mediates the relationship between SFP and CA?

This study adds to academic literature and formative practice. Practically, it enhances the empirical understanding of the impact of strategic planning processes on firm performance in specialized sectors such as laboratory construction by extending existing literature. The study offers a holistic framework for examining the interaction between SFP, OE, and CA by harmonizing the Resource-Based View (RBV), Dynamic Capabilities Theory, and Competitive Advantage Theory.

Practically, the findings will provide laboratory construction companies with practical knowledge on how utilising strategic facility planning can influence the operational processes at a laboratory and secure a competitive advantage. The results could be considered by firms for building/improving their planning strategy, making investment in appropriate technological solutions, and enhancing their project management practices. This study may also assist regulators and policymakers in creating policies for laboratory infrastructure development based on the data presented.

Literature Review

Theoretical Foundations

Understanding the relationship of SFP, OE, CA, and TC requires a robust theoretical foundation. The research is theoretical and is based on the Resource-Based View (RBV) theory, Dynamic Capabilities Theory, and Competitive Advantage Theory.

Resource-Based View (RBV)

According to the RBV, the firm is able to maintain a competitive advantage over its competitors through the possession of competitive resources, and the acquisition of these resources should be rare, inimitable and non-substitutable (VRIN). SFP is used as a strategic resource which improves the operational capabilities of enterprises and determines the sustainability competitiveness of laboratory construction enterprises. By optimizing design, applying materials sustainably, and managing project risk, firms can better leverage their internal resources to gain an advantage over their rivals.

Theory of Dynamic Capabilities

According to the Dynamic Capabilities Theory, a firm should have the capacity to combine, establish, manage, and reorganize internal and external competences to adapt to the fast-evolving environments. Firms engaged in laboratory construction projects must change in response to technology and client demand. Consequently, effective SFP in an SFP microfoundational context allows firms to build high-order dynamic capabilities including rapid response to technology innovations and efficient resource reallocation, which in turn enhances OE and CA.

Theory of Competitive Advantage

These approaches highlight the strategies firms can employ to gain superior performance in the market, such as cost leadership, differentiation, and market focus. Strategic facility planning in laboratory construction can create value and result in cost savings, greater client satisfaction and increased innovation capability. All of these influence an even better competitive advantage to the whole industry.

Serial Capacities and Service Control — Part 1: Service Process.

Strategic Facility Planning (SFP) is an integrated process that ensures the organizational strategies drive facility planning and ultimately enhance the organizational ownership performance as well as its marketplace performance. Laboratory construction firms at the SFP level, include multiple dimensions:

Design Optimization: Improving lab space optimization, safety and functionality.

Sustainable Practices: Utilising environmentally friendly building material, energy-efficient systems, and minimizing waste.

READY FOR TECH: Preparing for advanced tech integration.

Managing Project Risk: Plan for any risks such as the threat of budget overrun, non-compliance with regulations, and schedule slippage.

Previous studies show that a good SFP contributes towards operational excellence and customer satisfaction. Nevertheless, the direct relationship between SFP and being competitive in building laboratory remains largely unexamined.

Operational Efficiency and Competitive Edge

Operational Efficiency (OE) identifies the potential of the use of resources to complete the projects on time, within budget, and the expected quality metrics. Therefore, OE can be enhanced in laboratory construction through:

On-time Project Execution: Minimizing the delays and completing projects on time

Space & Energy Utilization: Reducing operational costs through effective layouts and energy usage.

Supply Chain Optimization: Improving procurement and logistics processes for better resource management.

Regulatory Compliance: Meeting regulatory requirements, safety standards, and industry regulations.

Improved OE usually leads to CA in that it allows firms to provide effective services while simultaneously facilitating innovation capabilities and customer satisfaction. But the mediation of this relationship by OE needs to be empirically assessed.

The Moderating Effect of Technological Complexity

TC Tecnologícal Complexity Technological Complexity: TC refers to the integration of new technologies in laboratory build projects. Promoting TC can facilitate the effectiveness of SFP for competitive outcomes. High TC projects may require:

Digital lab architectures: Use of AI, IoTs and automation in lab environments

Specialized Infrastructure Requirements: Construction of high-precision cleanrooms and controlled environments.

Cross-Domain Collaboration: Getting different sciences and engineering fields to work together for integrated technologies.

Emerging Technology: Keeping up with Next-Gen laboratory design innovations

High TC helps to enhance project value and differentiation, but it also means potential risks and complexity. Therefore, it is important to understand TC moderation of the SFP-CA relationship for the efficacious strategic planning.

Hypotheses Development

Informed by the underlying theory and literature, the following hypotheses are proposed:

H1: There is a positive effect of Strategic Facility Planning on Competitive Advantage in laboratory construction firms.

H2: The relationship between Strategic Facilities Planning and Competitive Advantage is mediated by Operational Efficiency.

H3: Technological Complexity moderates the relationship between Strategic Facility Planning and Competitive Advantage, such that the relationship is stronger when Technological Complexity is high.

The current chapter has offered a theoretical overview and literature review of SFP, OE, CA, and TC. It has identified gaps in the research and formulated hypotheses that will guide the empirical analysis. Chapter two will explain the research approach, the methods for data collection, measurement tools, and analytical methods.

Methodology

Research Design

This study utilizes a quantitative research method to investigate the relationships of Strategic Facility Planning (SFP), Operational Efficiency (OE), Competitive Advantage (CA), and Technological Complexity (TC) in laboratory construction companies. A survey-based data collection method was adopted, aimed towards industry personnel, and Structural Equation Modeling (SEM) was used to analyze the relationships among variables, as it provides for the examination of complex relationships, while testing mediation and moderation effects at once.

The direct and indirect effects those pathways direct the study would test the proposed hypotheses. Technology Complexity was analyzed as a moderator by creating interaction terms in SEM analysis. Data analyses were performed in SPSS 27 and AMOS 24.

Population and Sampling Method

Target Population

The target audience includes professionals working on laboratory construction projects, such as:

Decision makers who lead strategic decision-making.

Project managers who work on any construction operations.

Facility planners in charge of design and operational planning

Sampling Method

The key objective of stratified random sampling is to mitigate sampling bias and achieve a representative sample regarding several strata like firm size, industry, and location, among others. Stratification criteria were as follows:

Firm Size: Small enterprise, medium enterprise, and large enterprise.

– Industry specialization: Biotech, chemical, medical and academic laboratories.

The market is segmented based on Geographic Region as Asia-Pacific, Europe, North America and other regions.

Determining Sample Size

We aimed for a minimum sample size of 300 respondents at the outset, which was deemed sufficient to be applied for SEM analysis with adequate power. In total, there were 317 valid responses, which satisfies the minimum number of responses required, thus ensuring the analysis is robust. This is consistent with the generally provided rule of thumb of 10 respondents per item in the survey instrument.

Survey instrument and Measurement scales

The survey questionnaire developed was comprised of five sections that represented the key constructs. All items were measured on a five-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). A pilot test was performed in order to improve the reliability of the instrument involving 30 subjects, with a pre-test Cronbach's Alpha between 0.84–0.90, demonstrating good internal consistency.

Independent Variable (IV) – Strategic Facility Planning (SFP)

Using 12 items in four dimensions, SFP was measured by:

Design Optimization: Showing how your designs address factors like space utilization, safety features, and functionality (e.g., "Our laboratory designs maximize space efficiency").

Sustainability Integration: Eco-friendly materials, energy-efficient systems (e.g., "Sustainable building practices are at the heart of our projects").

Technology Readiness: Preparedness for technology upgrades (i.e., "Our facilities are ready for technological improvements").

Roject Risk Management: Strategies to mitigate the risk (e.g., "Risk management is integrated with our planning process")

Operational Efficiency (OE) – Mediating Variable (MV)

OE was assessed by 10 items related to:

Project Implementation: Projects executed on-time.

Space & Energy Utilization: Operational resource efficiency.

Streamlined procurement processes: Supply chain optimization

Compliance: Similarity to safety standards.

Technological complexity (TC) – Moderating variable (ModV)

TC was assessed using 8 items related to:

Digital System Integration: AI, IoT & automation

Specialized infrastructure requirements: controlled environments complexity

Wait, that was the news summary before one of the first four paragraphs of the story. How dare I call it "the news summary" when this is "the Sunday news summary"? It's just one of several news summary summaries (though, to be fair, it's not a news summary summary summary since it declares itself a news summary summary), interspersed with additional news summary needs.

Implementation of Next Gen Technology:Rate of technology adoption.

Dependent Variable (DV)3.3.4 CA − Competitive Advantage

CA was measured by 9 items covering:

Market Positioning:Success in attracting high-profile clients.

Cost Leadership: Advantages of operational cost.

Innovation Capability:Providing future solutions.

Customer Satisfaction: Retention and loyalty of clients.

Data Collection Procedure

Data collection was performed using an online survey sent in August-October 2024 by email and professional networks. Ethical protocols such as informed consent, confidentiality of data and voluntary participation, were taken during the process of the study. The response rate of the study was 90.57%, with the 350 distributed questionnaires being replied 317 valid (occasional) responses. Respondents were assured that the data would be used only for research purposes.

Data Analysis Techniques

Descriptive Statistics

Demographic information and construct measures were summarized by descriptive statistics (means and standard deviations). Average scores ranged from 3.42 to 4.18, suggesting that respondents generally took a positive view of SFP, OE, TC and CA.

Tests of Reliability and Validity

Reliability: All constructs had Cronbach's Alpha values of at least 0.85 and all final values were in the range of 0.853 to 0.912 (see Chapter 4 for full results).

Validity:Confirmatory factor analysis (CFA) results indicated good model fit (CFI = 0.957, TLI = 0.948, RMSEA = 0.044, and SRMR = 0.036).

Structural Equation Modeling (SEM)

To test direct, indirect, and moderated relationships, SEM was applied. The hypothesized model showed good fit indices (see Chapter 4):

Table 1: Structural Equation Modeling (SEM) Results and Model Fit Indices

CFI	0.952
TLI	0.940
RMSEA	0.046
SRMR	0.039

Moderation and Mediation analysis

Mediation: A simple mediation analysis was conducted with bootstrapping methods (5,000 resamples) where the significant indirect effect was confirmed (β = 0.276, p = 0.004).

− Moderation: TC's moderating effect was explored using interaction terms, revealing that the strong positive influence of SFP on CA was significantly augmented at higher levels of TC than at lower levels (high TC β = 0.647, low TC β = 0.385).

Ethical Considerations

Informed consent: Participants were instructed about the purpose of the study and gave consent. Confidentiality: All data was made anonymous and stored securely. Participants in this study engaged in this study voluntarily, and were at liberty to withdraw from study at any point without incurring penalties. In the study apresentou neste capitulo, a metologia de pesquisa foi apresentada, como o desenho de acordo, caracteristicas da amostra, instrumentos de mensuração e as tecnicas de analize de dados. 317 valid responses were finally collected by the data collection process guaranteeing valid and reliable results introduced in Chapter 4. The strong model fit indices and high internal consistency values confirm the robustness of the research design and measurement approach.

Results

Description of the Sample and Descriptive Statistics

A total of 317 valid responses were received from laboratory contraction companies in diverse regions and industries. demographic profile of respondents and characteristics of the firm (Table 2).

Respondent Demographics

Positions: Executives (24.92%), Project Managers (40.38%), Facility Planners (34.70%). Professionals Experience: Less than 5 years (19.87%), 5–10 years (44.79%), Over 10 years (35.34%). Geography: Asia-Pacific (39.75%), Europe (30.60%), North America (19.87%), Other regions (9.78%)

Firm Characteristics

Size of Firms: Small (29.97%), Medium (44.79%), Large (25.24%). Industry Specialization: Biotechnology (34.70%), Chemical (24.60%), Medical (20.19%), Academic (20.51%); Level of technological integration: low 15.46%; medium 54.89% and high 29.65%.

Table 2: Summary of Respondent and Firm Characteristics

Characteristic	Category	Frequency	Percentage
Position	Executive	79	24.92%
	Project Manager	128	40.38%
	Facility Planner	110	34.70%
Firm Size	Small	95	29.97%
	Medium	142	44.79%
	Large	80	25.24%
Technological Integration	Low	49	15.46%
	Medium	174	54.89%
	High	94	29.65%

Source: original data

Reliability and Validity Analysis

Reliability Tests

Cronbach's Alpha was used to assess the internal consistency of measurement scales. All constructs exceeded the 0.70 threshold, indicating satisfactory reliability.

Table 3: Reliability Analysis of Measurement Scales (Cronbach's Alpha Values)

Construct	Cronbach's Alpha
Strategic Facility Planning (SFP)	0.884
Operational Efficiency (OE)	0.876
Technological Complexity (TC)	0.853
Competitive Advantage (CA)	0.912

Confirmatory Factor Analysis (CFA)

CFA was conducted to validate the measurement model. Fit indices indicate an acceptable model fit:

Table 4: Confirmatory Factor Analysis (CFA) Results and Model Fit Indices

CFI	0.957
TLI	0.948
RMSEA	0.044
SRMR	0.036

These results confirm the constructs' convergent and discriminant validity.

Hypothesis Testing and Structural Equation Modeling (SEM)

Direct Effects

The SEM analysis revealed significant relationships between key constructs:

- H1 (SFP → CA):$\beta = 0.517$, $p < 0.001$ (Supported)
- H2 (SFP → OE): $\beta = 0.604$, $p < 0.001$ (Supported)
- OE → CA: $\beta = 0.458$, $p < 0.001$ (Supported)

These results indicate that SFP has a direct positive effect on both OE and CA.

Mediation Analysis (H2)

Hence, Operational Efficiency plays a key role as a mediator between SFP and CA. The indirect effect was $\beta = 0.276$, $p = 0.004$, indicating that improved OE is a critical mechanism whereby SFP improves CA.

Moderation analysis (H3)

The relationship between SFP and CA is moderated by Technological Complexity.

− High TC Level:$\beta = 0.647$, $p < 0.001$

− Low TC Level:$\beta = 0.385$, $p = 0.041$

These results suggest that the SFP to CA effect is more pronounced at high TC.

Model Fit Evaluation

The structural model fits the data very well:

Table 5: Evaluation of Structural Model Fit Statistics

CFI	0.952
TLI	0.940
RMSEA	0.046
SRMR	0.039

These indices indicate that the proposed model is a good fit for the data.

Summary of Findings

Strategic Facility Planning (SFP) directly influences Competitive Advantage (CA) ($\beta = 0.517$).

Operational Efficiency (OE) also partially mediates the SFP-CA relationship (indirect effect $\beta = 0.276$), indicating the significance of effective resource use and project implementation in achieving goals.

Technological Complexity (TC) further enhances the association of SFP with CA than without TC, as exhibited by the relatively larger impact of SFP on CA under situations with high TC (β=0.647).

Overall model fit indices show strong fit (CFI = 0.952, RMSEA = 0.046), providing support for the hypothesized relationships.

The following chapter will elaborate on the practical implications of these findings as well as offer recommendations for industry practice and details about research limitations and proposed future research.

Discussion

Discussion of Findings

The present study investigates the influence of Strategic Facilities Planning (SFP) on the Competitive Advantage (CA) of lab construction companies with Operational Efficiency (OE) as a mediating variable and Technological Complexity (TC) as a moderating variable. Utilizing data collected from 317 respondents and analyzed through Structural Equation Modeling (SEM), our findings yield biennial insights into the relationships among these variables.

Strategic Facility Planning / Competitive Advantage

It indicates that SFP is strongly positively associated with CA ($\beta = 0.517$, $p < 0.001$), which supports H1. These findings indicate that organizations with integrated facility planning function—encompassing design optimization, sustainability, technology readiness, and risk management—can improve their market positioning, cost leadership, innovative capacity, and customer satisfaction. Such finding mirrors the Resource-Based View (RBV) which emphasizes that competitive advantages are sustainable only when reflections on planning processes exist at the very least (for years to come) and the way internal resources are properly structured, indicating the relevance of this study as is a well-established area of research26.

The Mediating Role of Operational Efficiency

Performance of Operational Efficiency mediated** the relationship between SFP and CA (indirect effect $\beta = 0.276$, $p = 0.004$), indicating H2 was supported. This means that SFP does not only have a direct positive effect on CA, but it also has an indirect positive impact on that through performance improvements in OE. Core competencies are effective resource utilization, on-time project completion, and supply chain management, helping gain competitive positioning. Such findings align with Dynamic Capabilities Theory whereby adaptive operational processes enhance strategic planning's impact on firm performance.

Technological Complexity as a Moderating Variable

The moderating analysis shows that Technological Complexity has a significant moderating effect on the relationship between SFP and CA (High TC $\beta = 0647$, $p < 0.001$; Low TC $\beta = 0.385$, $p = 0.041$), providing support for H3. Projects of higher technological complexity are more dependent on a solid facility planning, with companies must implement advanced technologies, manage assets technospecialized and promote the work and learning in interdisciplinarity. This demonstrates that technology readiness is a significant factor for successful incorporation of SFP under challenging project conditions.

Practical Implications

The study's results provide a number of actionable recommendations for laboratory construction companies:

Improve Comprehensive Facility Planning

Firms need to capitalize on holistic SFP processes, with consideration for design optimization, sustainability and technology integration. Adopting Building Information Modeling (BIM) and project green building standards can improve project outcomes.

Operational Efficiency

The focus should be on operational processes like efficient procurement, compliance, and workforce management. Advancing OE not just polishes project delivery but increases competitiveness as a whole as well.

Favor the Integration of Technology in Complex Works

Moreover, organizations participating in projects with elevated technology complexity need to invest in enabling technology (e.g., AI-powered project management platforms, IoT-supported monitoring frameworks) to harness the full potential of SFP.

Create flexible capabilities

Facilities for employee training, adoption of flexible project management techniques and continuous upgrades in technology will allow firms to stay agile and grow with market and technology changes as they happen.

Research Limitations

Although this study offers valuable insights, it is not without limitations:

-None were collected from the pathogen and geographical scope is narrow, eg, only collected from the region of America.

-Cross-Sectional Design: The study is cross-sectional which limits our ability to infer causality.

Self-Reported Data: Participants may have provided socially desirable responses despite efforts to further anonymity; responses may have common method bias

– Inconsistencies in Technology Definition: Depending on respondents' technological literacy, the complexity of technology may differ.

Related Work

This one can be the basis for other studies in the future to:

Geographic Scope: Including data from diverse areas for broader generalization

Longitudinal Studies: Observe causal relationships over the span of several years.

Qualitative Methods: You can also use qualitative methods such as conducting interviews or case studies to dig deeper into the underlying factors.

Investigating other moderators: For instance, looking at organizational culture, leadership styles, or regulatory environments.

Conclusion

An Examination of How Strategic Facility planning Affects Competitive advantage in Journal of facilities management, with mediating role of Operational efficiency, and moderating effect of Technological complexity in construction of Laboratories. Results show that holistic facility planning significantly helps in competitive positioning not only directly but also indirectly through effective operational processes. Additionally, the complexity and sophistication of technology are a magnifier of where SFP works, elucidating the technology readiness aspect of complex projects.

Analyzing the impact of these trends on the market will highlight whether laboratory construction companies should work towards establishing a strong plan, enhancing operational prowess and investing in new technology to maintain a competitive advantage in an increasingly complex business landscape.

References

Bansal, P., & DesJardine, M. R. (2014). Business sustainability: It is about time. *Strategic Organization, 12*(1), 70–78. https://doi.org/10.1177/1476127013520265

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99–120. https://doi.org/10.1177/014920639101700108

Bowen, P. A., Edwards, P. J., & Cattell, K. (2012). Corruption in the construction industry: A review. *Building Research & Information, 40*(5), 673–686. https://doi.org/10.1080/09613218.2012.703930

Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of Building Information Modelling (BIM). *International Journal of Project Management, 31*(7), 971–980. https://doi.org/10.1016/j.ijproman.2012.12.001

Bryman, A., & Bell, E. (2015). *Business research methods* (4th ed.). Oxford University Press.

Chinowsky, P., Diekmann, J., & O'Brien, J. (2011). Project organizations as complex adaptive systems. *Journal of Construction Engineering and Management, 137*(5), 404–413. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000291

Cleland, D. I., & Ireland, L. R. (2007). *Project management: Strategic design and implementation* (5th ed.). McGraw-Hill.

Dainty, A., Green, S., & Bagilhole, B. (2007). *People and culture in construction: A reader*. Routledge.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*(1), 39–50.

https://doi.org/10.2307/3151312

Gann, D. M., & Salter, A. J. (2000). Innovation in project-based, service-enhanced firms: The construction of complex products and systems. *Research Policy, 29*(7–8), 955–972. https://doi.org/10.1016/S0048-7333(00)00114-9

Ghosh, S., & Olsen, D. (2009). Environmental sustainability and construction. *Journal of Construction Engineering and Management, 135*(10), 1045–1053. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000076

Gido, J., & Clements, J. P. (2017). *Successful project management* (7th ed.). Cengage Learning.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.

Hallowell, M. R., & Gambatese, J. A. (2009). Construction safety risk modeling and simulation. *Construction Management and Economics, 27*(9), 969–981. https://doi.org/10.1080/01446190903280751

Han, S. H., Kim, D. Y., Kim, H., & Jang, W. S. (2008). A web-based integrated system for international project risk management. *Automation in Construction, 17*(3), 342–356. https://doi.org/10.1016/j.autcon.2007.05.010

Hartmann, A., & Caerteling, J. (2010). Subcontractor procurement in construction: The interplay of price and trust. *Supply Chain Management, 15*(5), 354–362. https://doi.org/10.1108/13598541011068266

Hitt, M. A., Ireland, R. D., & Hoskisson, R. E. (2017). *Strategic management: Competitiveness and globalization* (12th ed.). Cengage Learning.

Jang, W., & Lee, J. (2019). The effect of technology readiness on innovation capability. *Technological Forecasting and Social Change, 143*, 279–290. https://doi.org/10.1016/j.techfore.2019.02.020

Kaplan, R. S., & Norton, D. P. (1996). Using the balanced scorecard as a strategic management system. *Harvard Business Review, 74*(1), 75–85.

Kerzner, H. (2013). *Project management: A systems approach to planning, scheduling, and controlling* (11th ed.). Wiley.

Kline, R. B. (2015). *Principles and practice of structural equation modeling* (4th ed.). Guilford Press.

Leach, L. P. (2014). *Critical chain project management* (3rd ed.). Artech House.

Li, Y., Liu, Y., & Liu, H. (2020). Resource orchestration for innovation: The role of organizational capabilities. *Journal of Business Research, 112*, 191–204. https://doi.org/10.1016/j.jbusres.2019.10.051

Love, P. E. D., Edwards, D. J., & Irani, Z. (2012). Moving beyond optimism bias and strategic misrepresentation: An explanation for social infrastructure project cost overruns. *IEEE Transactions on Engineering Management, 59*(4), 560–571.

https://doi.org/10.1109/TEM.2012.2193858

Love, P. E. D., Edwards, D. J., & Smith, J. (2016). Rework causation: Emergent theoretical insights and implications for practice. *Construction Management and Economics, 34*(7–8), 441–452. https://doi.org/10.1080/01446193.2016.1185072

Luo, H., Gong, Y., & Zhang, X. (2019). Influence of green innovation on project performance: The moderating role of project complexity. *Journal of Cleaner Production, 233*, 404–414. https://doi.org/10.1016/j.jclepro.2019.06.048

Müller, R., & Turner, J. R. (2007). The influence of project managers on project success criteria and project success. *International Journal of Project Management, 25*(1), 59–70. https://doi.org/10.1016/j.ijproman.2006.02.015

Ofori, G. (2015). *Nature of the construction industry, its needs and its development: A review of four decades of research*. Routledge.

Porter, M. E. (1985). *Competitive advantage: Creating and sustaining superior performance*. Free Press.

Scott, W. R. (2013). *Institutions and organizations: Ideas, interests, and identities* (4th ed.). Sage Publications.

Senge, P. M. (2006). *The fifth discipline: The art and practice of the learning organization*. Doubleday.

Sweis, G., Sweis, R., Hammad, A. A., & Shboul, A. (2008). Delays in construction projects: The case of Jordan. *International Journal of Project Management, 26*(6), 665–674. https://doi.org/10.1016/j.ijproman.2007.09.009

Tabachnick, B. G., & Fidell, L. S. (2018). *Using multivariate statistics* (7th ed.). Pearson.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509–533. https://doi.org/10.1002/smj.4250180702

Turner, J. R. (2009). *The handbook of project-based management* (3rd ed.). McGraw-Hill.

Wang, J., Liu, J., & Zou, P. X. W. (2016). Risk evaluation in mega projects: A decision support framework. *Journal of Civil Engineering and Management, 22*(5), 673–682. https://doi.org/10.3846/13923730.2014.914082

Winch, G. (2010). *Managing construction projects* (2nd ed.). Wiley-Blackwell.

Yin, R. K. (2017). *Case study research and applications: Design and methods* (6th ed.). Sage Publications.

Zhang, L., & Fan, X. (2013). Sustainability practices in construction project management. *International Journal of Project Management, 31*(2), 276–284. https://doi.org/10.1016/j.ijproman.2012.06.003

Zou, P. X. W., Zhang, G., & Wang, J. (2007). Understanding the key risks in construction projects in China. *International Journal of Project Management, 25*(6), 601–614. https://doi.org/10.1016/j.ijproman.2007.03.001