ABSTRACT

Title of Dissertation: CROSS-INDUSTRY ADOPTION AND SUSTAINABILITY PRACTICES IN FACILITY MANAGEMENT

Jeff D. Chi, Doctor of Philosophy, 2022

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Propelled by new technology, modern management methodologies, and sustainability movement, the facility industry has become one of the fastest growing business sectors. This dissertation conducts research on facility market growth, cross-industry learning and innovative method adoption, and sustainable facility practices.

Multiple research methodologies are employed to examine six propositions. Mixed use of case studies, surveys, interviews, qualitative comparative analysis (QCA), and Grounded Theory with *Pre-Post* comparisons are applied to study target propositions from multiple angles, draw strengths from one methodology to offset the weaknesses of another, and deliver balanced analyses and arguments.

The demands for modern facility management methods, preconditions for new practice adoptions, and risk control in project execution are discussed in reference to case studies. Importance of government involvement and the critical role of corporate policy plays in converting government efforts into results are confirmed with survey responses from industry practitioners and backed by case studies. Current challenges encountered in sustainable facility practices are discussed and the causes of these issues are investigated. Besides survey and case studies, interviews and special topic content research are conducted to explore potential solutions. The collective outcome of the research has established case-based reasoning to support each of six propositions on the determinants of project success.

CROSS-INDUSTRY ADOPTION AND SUSTAINABILITY PRACTICES IN FACILITY MANAGEMENT

by

Jeff D. Chi

Dissertation submitted to the Faculty of the Graduate School of the
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Dedication

To my wife Jane,

my son Nathan, and my daughter Nina

Acknowledgement

I would like to express my sincere appreciation to the advisory committee members for guiding me in the dissertation preparation, professors who taught me the extremely valuable prerequisite courses, and the department faculty who diligently provided administrative support to all graduate students.

A special gratitude goes to my advisor Dr. Gregory Baecher for his intellectually generous help throughout the pursuit of my doctoral degree. Without his advice and encouragement, it would be impossible for me to achieve this major milestone in life.

The debt I owe to my family for four and half years of love, inspiration, understanding, and tolerance far exceeds my powers of description.

Finally, I would like to say to my late father: “Dad, I hope I have made you smiling and proud.”

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1. Introduction

1.1. General Introduction

Building and maintaining shelters are ancient practices as old as human history and facility management techniques have evolved throughout generations. In the past two decades, the facility management market has enjoyed an enormous growth with an annual increase rate of 7%. In 2019, the global facility management market reached $1.3 trillion while the United State market reached $352 billion (Markets and Markets Research LLC 2019). Advanced technology, innovative management concepts, and the sustainability movement revitalized this traditional industry into one of the most prosperous business arenas. The service scope of facility management expanded far beyond keeping floors clean and machines well-oiled.

Despite its long history and enormous market size, facility management has been disproportionally underserved by both academia and industry professional associations. It was not until the mid-1980's that facility management was recognized as a professional brand of its own, more organizations began realizing the important role that the facility management plays in their business pursuits, more facility managers started moving up from basement boiler rooms to corporate board rooms, and more schools recognized facility management as a separate academic discipline.

Today's facility executives are the organization's castle keepers who safeguard corporate assets with a strong stewardship and ensure a high level of lifecycle performance. Facility managers need to acquire new skills and adopt innovative methods to meet the increasing demands and challenges. This dissertation examines cross-industry learning and risk management in project planning and execution.

Sustainability has become a formidable business enabler to the facility management industry. Due to decades of uncontrolled industrialization, the global environmental resources have been overly spent at an alarming level. Commercial facilities are accountable for nearly 50% of the total global energy and water consumption and 40% of greenhouse gas emission. Sustainable facility growth not only helps organizations to reduce operation costs, improve corporate image, but also significantly improve the global environment and make this planet a better place for everyone to live. This dissertation conducts research analyses on government environmental regulations and incentives, corporate sustainability practice policies, and challenges encountered in sustainability practices.

1.2. Research Limitations and Assumptions

- Due to space restrictions, exclude residential or heavy industrial projects.
- Focusing on general management methods, not technical or procedural details.
- *Facility Management* and *Asset Management* are used interchangeably.
- The average economic life of facilities is 50 years.

Figure 1.1 provides a graphic reference of the dissertation research structure with detailed breaks downs.

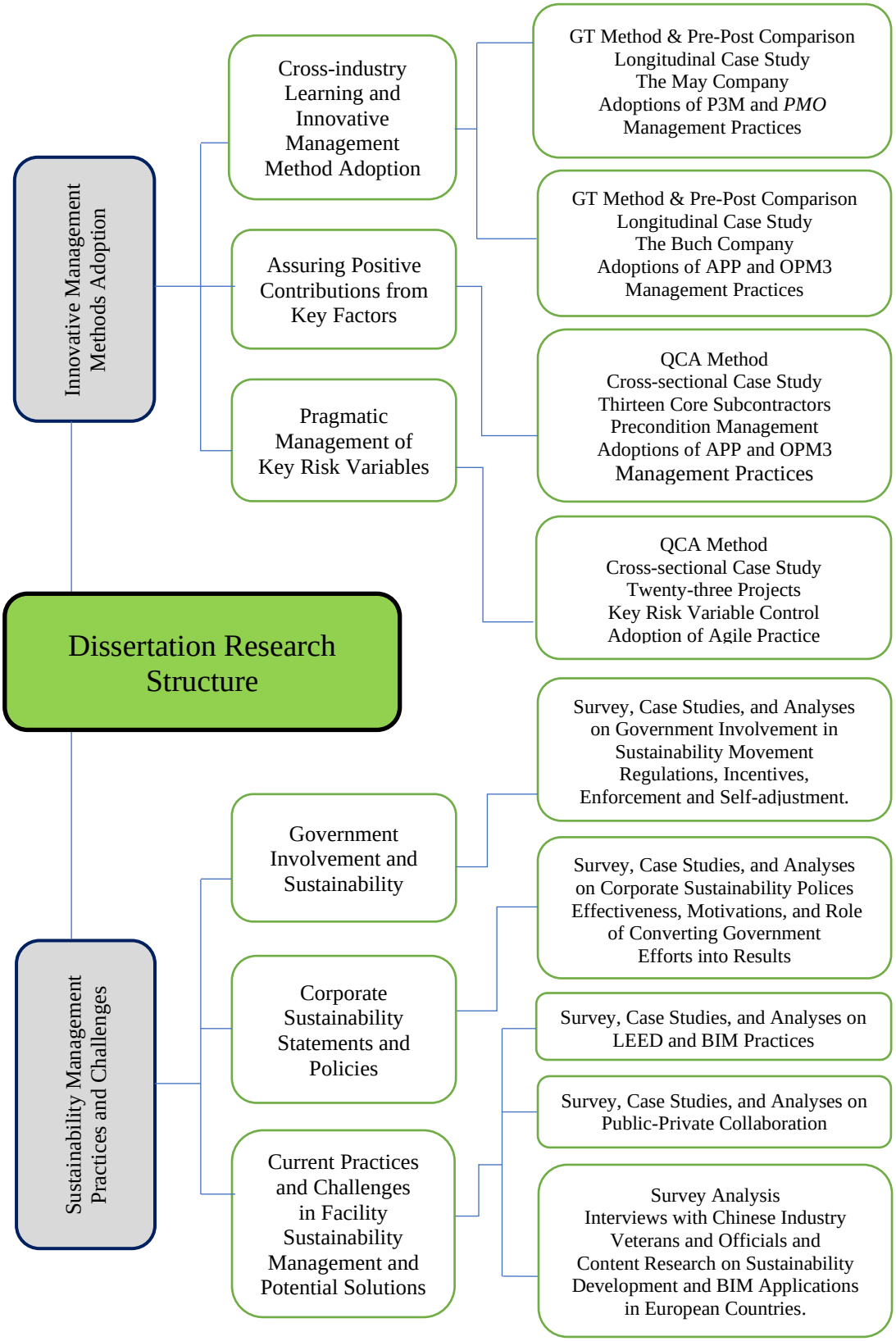

Figure 1.1 - Dissertation Research Structure

2. Literature Review

This chapter conducts a broad survey on the facility management industry and various modern project management methodologies that will be used in later sections to support the dissertation propositions. In general, regarding facility management, books and articles in school libraries and achieves are largely irrelevant and outdated while professional research published by industry associations is often overlapping, contradicting, and technique and procedure focused. Website research and industry association publications are the main sources of this literature research.

2.1. Facility Management Market

The facility management market has experienced phenomenal growth in the past decades in terms of dollar amount and service scope. The global market is estimated to reach $1.9 trillion in 2024, with a 15% AAR; and the US market $465 billion (Business Wire 2019). Technology advancement and sustainability regulations propelled the demand for innovative solution services drove business surges that this “traditional” industry had never seen before. The new solution services include asset optimization, system automation, cyber security, BIM, sustainable facility management, and more. According to PR News (2019), the global new solution services market reached $32 billion in 2017, $34.5 billion in 2018, $36 billion in 2019, and is projected for $61 billion in 2024.

2.2. Facility Management Basic Concepts and Definitions

This section provides definitions, types of facility projects, characteristics of facilities, and facility management teams.

2.2.1. Definition of Facility

The Latin root of the word "*facility"* is *"facile"* which means *"to make things easier to achieve."* The basic function of a facility is to provide the necessary space and equipment in adequate conditions to allow the operation to achieve the intended goals. Facilities are organizational assets in the form of real estate properties, equipment, infrastructure, and integral systems. "A facility may refer to: an installation, contrivance, or other things which facilitates something; a place for doing something, a commercial or institutional building, such as a hotel, resort, school, office complex, sports arena, or convention center (Wikipedia 2021)."

2.2.2. Types of Facility Projects

A facility project is an endeavor to construct, maintain, or dispose fixed assets in order to support organizational operations or business strategies. By funding resource, facility projects are categorized as capital investment or expense maintenances.

Capital Investment Projects: Larger or special projects, such as asset acquisitions, new construction, or major renovations. Most capital projects are funded by an organization with a well-defined scope for one specific purpose. Typically, they involve investment analysis, feasibility studies, financial planning, professional consulting, and engineering services.

Expense Maintenance Projects: Activities that keep facilities in proper functional conditions. They are funded by budgets with projections on loosely defined scopes of work. Maintenance projects include routine building upkeep, equipment maintenance, preventive inspections, communication system repairs, emergency responses, and

groundwork, safety, security, fleet management. Typical maintenance projects do not require consulting or engineer design services.

Minor renovations that do not change the facilities intended use are often classified as maintenance projects. Major renovations that alter the facility's designed functions are capital projects. Disaster prevention and minor emergency responses are maintenance projects. Major disaster responses and remedies are special capital projects.

Each organization has its own financial strength and classification criteria. A minor project to one firm could be a major one to another. Ambiguities may leave room for arbitrary interpretations leading to counterproductive and caustic internal fights about budgeting between division and corporate. It is easy to separate capital from expense projects by dollar amount. It is common for medium size corporations to classify projects below $500K as maintenance expense, greater than $3 million as capital investments, any projects in between as either depending on the organization management styles. Figure 2.1 illustrates the decision-making flow chart that a larger corporation uses for the capital project classification process.

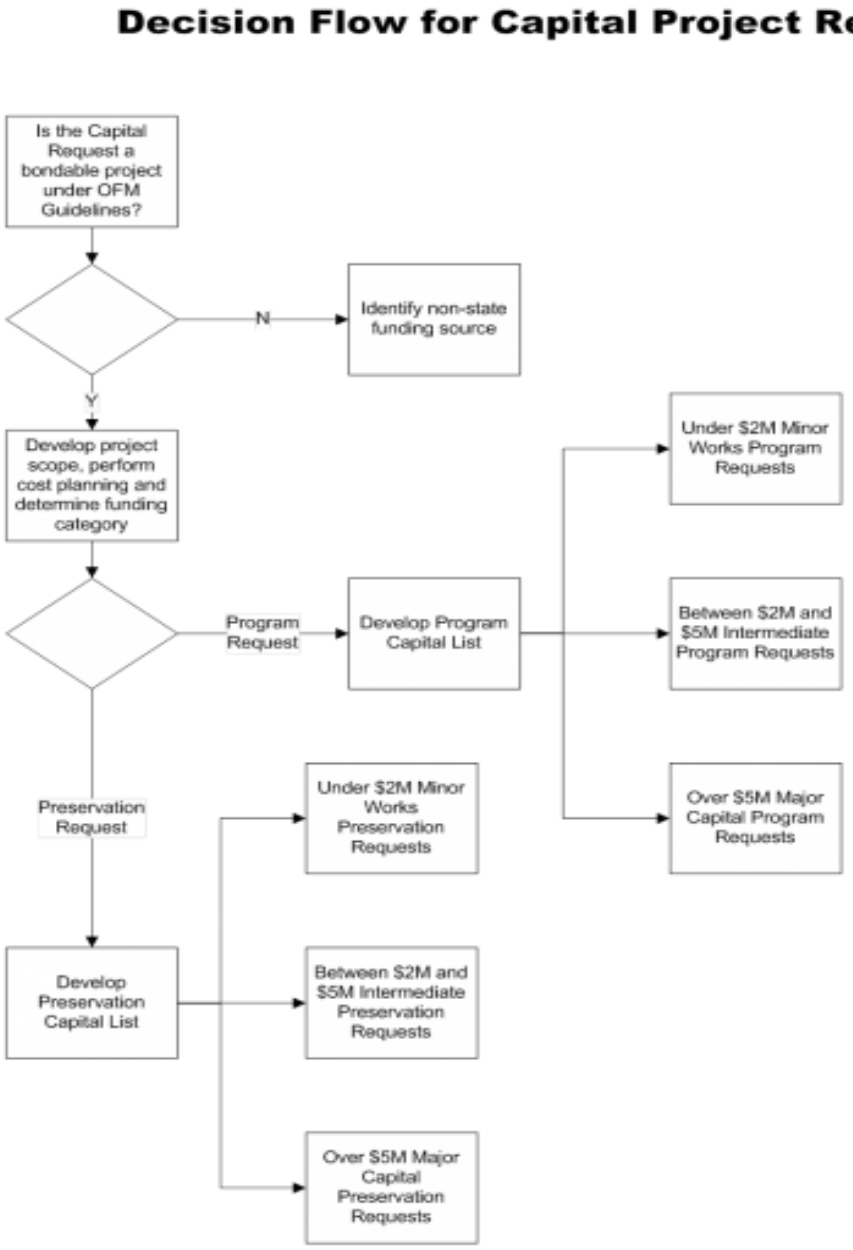

Figure 2.1 - Facility Project Request Flow Chart
(Source: Central Washington University 2021)

2.2.3. Facility Project Management

The broad definition of facility management by the International Facility Management Association (IFMA 2020) is “a profession that encompasses multiple disciplines to

ensure functionality, comfort, safety, and efficiency of the built environment by integrating people, place, process and technology." IFMA needs to expand the definition for the modern facility management has gone far beyond keeping buildings functional and comfort. Now facility management covers a full spectrum of services from asset planning to financial strategies, real estate positioning, IT infrastructures, lifecycle management, sustainable growth, and social responsibilities. Figure 2.2 is an illustration of the components of facility operating asset management.

Figure 2.2 - Asset Management Components
(Source: Pure Energy Professionals 2019)

2.2.4. Characteristics of Facility Project Management

- Facility projects usually have long lifespans counting in years or decades.
- Lifecycle includes planning, construction, maintenance, and decommission.
- Facility lifecycle performance is measured against the value it generates and contributes to the organization over its lifespan.
- Beside cost saving, quality, and schedule, function reliability is a critical KPI of facility performance.

- Relationships with service providers play a huge role in facility management daily operation. It is a worthy topic for separate research.
- The departments within the organization are facility teams' internal customers.
- Politics, power struggles, and mind-games are inevitable in facility daily operation and the human factor cannot be ignored while studying facility project management.

2.2.5. Characteristics of Facility Management Teams

Facility management teams tend to work together on the same projects for years or decades. It is not uncommon for some of them to grow sentimental attachments to the facilities of which they take care for long time and build strong comradeship with colleagues. The sense of belonging and bonds are unique in the facility industry making job satisfaction and team chemistry key factors to project success and personal well-being.

Working in a stable environment and through progressive accumulation, facility management teams often gain in-depth knowledge and intuitions about their projects and the organizational policies and norms. A mix of expertise and skills is important to build a high-performing facility management team. Compliant technical skills, compatible managerial style, and accommodating experience generate mutual respects and confidence and make a cohesive high-performing team. The dynamic industry growth demands facility management professionals to possess broad technical knowledge and much sophisticated people skills to meet the challenges that they have never experienced before.

2.3. Facility Management Profession

This section provides a brief history of the facility management profession, industry associations, academic support, and the challenges that it currently faces.

2.3.1. Facility Management as a Profession

In the 1880's, French mining engineer Henri Fayol developed the general theory of administration with 14 principles for greater economic efficiency, meanwhile American mechanical engineer Fredrick Taylor advanced the concept of scientific management with his 4 principles of management. Their works ushered the scientific management into existence. In the 1930's, Peter Drucker introduced the quantitative performance measurement theory, emphasizing on processes and results. In the ensuing decades, project management was further developed by Edward Damming's total quality control, Michael Porter's leadership and strategical management, and Abraham Maslow's behavioral management. The outstanding contributions of these brilliant management gurus have shaped the body of knowledge project management of today.

Although scientific management was born in factory production lines, the construction industry widened it into project management. In the 1960's, the construction project management established itself as a profession. However, not until the 1980's were the facility managers recognized as a professional brand of its own. In recent decades, new technology and sustainability movement sparked the growth in facility management and expanded the service dimensions beyond its traditional scope. Facility management became a separate academic discipline and an independent profession. More corporations realize the critical role facility management plays in business successes and expect their facility teams to be more sophisticated and versatile. "Organizations have lofty objectives

demanding much more from their facilities teams … and look for facility professionals who have strong business acumen and financial aptitudes and understand how the lifecycle operates (Lord and Miller 2017)."

2.3.2. Current Challenges to Facility Management Professionals

Today's facility management has grown in both complexity and scope. The range of the services expands into investment planning, assets management, IT infrastructure, and sustainability management. As facility management professionals moving up the corporate ladder and involving more in organizational business strategy planning, they are expected to have the skills and education to adequately cope with the mounting responsibility and increasing complexity. Helbling Associates, a recruiting firm specialized in facility executive placement, made a statement, "facilities management executive of today must have boardroom and leadership skills, as well as the ability to manage teams and complex capital projects at a senior level … and should also be aware of industry advances (Helbling & Associates 2021)."

One of the most pressing issues that the facility management industry faces is recruiting young talents to replace the aging workforces. The International Facility Management Association (IFMA) demographic survey of 2019 indicates that the average age of 23,000 members is 49 years old and only 7% is under 35 (IFMA 2020). It takes a new facility manager 4-8 years to acquire necessary skills to perform routine duties. Lengthy skills training makes this workforce shortage more daunting. The supply shortage is a direct result of decades of lukewarm efforts in professional development by both academe and the industry. Lack of recognition, slow career development, inadequate pay and incentives, and work stressors push young generations away.

2.3.3. Professional Associations

The International Facility Management Association (IFMA), Association for Facilities Engineering (AFM), and International Council of Shopping Centers (ICSC) are three influential facility management professional associations. The Owners and Managers Association (BOMA), British Institute of Facility Management (IBIFM), and German Facility Management Association (GEFMA) are major reputable international associations. The Restaurant Facility Management Association (RFMA), Society of College and University Planning (SCUP), Science and Technology Facilities Council (STFC), International Associations for Sports and Leisure Facilities (IASLF), and Institute of Real Estate Management (IREM) are associations focused on serving niche submarkets.

These associations have been working on promoting facility management and sponsoring conferences and seminars. Because the competition, the collaboration among the associations is less than desirable, market and trade information produced are often contradicting, and the practice standards published are redundant.

2.3.4. Academic Support for the Facility Management Industry

Considering its market size and comparing to the construction and other industries, facility management is disproportionally underserved by academia in terms of quantity and quality. Only a handful of universities in the United States offer degreed facility management programs. Not until recent years, the business booming drew academic interest and investment to assist the facility industry.

For a long time, facility management has been in the shadow of construction management. Though the two share many similarities and can cross learn from each other, facility management has its own characteristics distinct from construction and deserves to

receive special attention in academia. According to survey by Hotcoursesaboad.com in 2019, there are a total of 972 bachelor's and 275 master's degrees in construction management and only 21 bachelor's and five master's degrees in facility management offered in the US; only four doctoral degrees in facility management are offered in the world, with one in Hong Kong and three in Malaysia (Hotcoursesaboad.com, 2019). More universities realized the potential of this academic field. Georgia Tech, Michigan State University, Arizona State University, University of Indiana, Temple University, Brigham Young University, and Wentworth University are among the American schools introducing facility asset management programs (Hotcoursesaboad.com, 2019).

Establishing a new facility management program requires stable student enrollment, a well-developed curriculum, and dedicated faculty with adequate academic and industry experience. European and Asian universities are more advanced than their American counterparts in facility management research and education. European universities are currently the global leaders in facility management education and research. A total of 43 bachelor's and 23 master's degrees in facility management are currently offered in England alone. All four doctoral programs in facility management in the world are offered by Hong Kong and Malaysian universities.

2.4. Facility Lifecycle Management

The average economic life of a commercial facility is 30 years and rigorous maintenance may extend it to 50 or more. A lifecycle facility project's performance is evaluated over its lifespan from inception to decommission. Facility lifecycle management policies should be developed to guide facility planning, assessment, feasibility

study, acquisition or construction, operation maintenance, and reposition. Figure 2.3 illustrates an example of facility lifecycle management model.

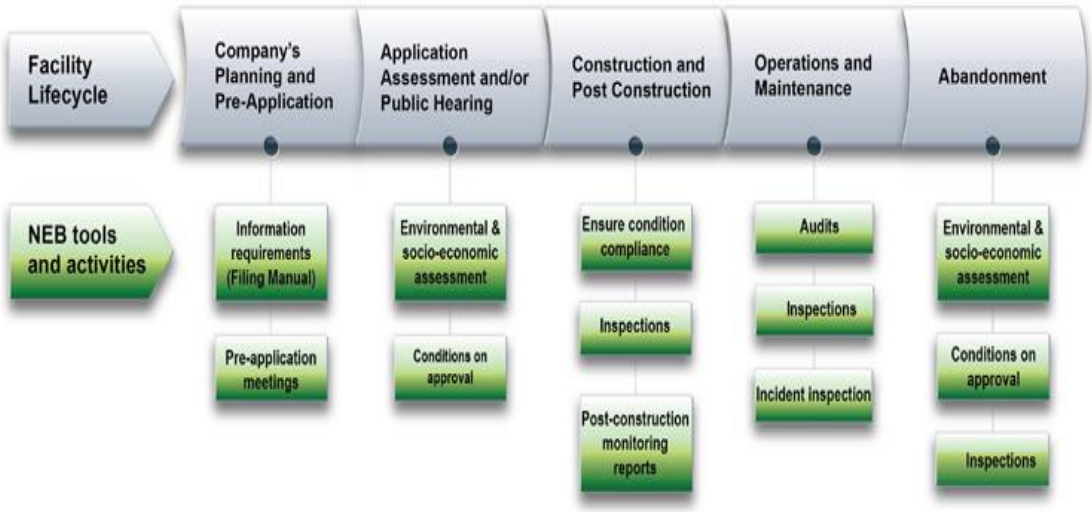

Figure 2.3 - Example of Facility Lifecycle Management Model
(Source: Pure Energy Professionals 2019)

Facility management policies should reflect corporate culture, organizational business strategies, staff competency and engagement. Figure 2.4 provides an illustration of lifecycle asset management.

Figure 2.4 - Asset Life Cycle (Source: Linard 2013)

2.4.1. In-depth Definition of Facility Lifecycle

Facility lifecycle literally refers to the entire "from-cradle-to-grave" life span of a corporate facility. In this dissertation, facility cycle also implies the associated management activities throughout the course of the facility's life. Below are several ways to define facility life with different emphasis.

- Useful Life, Functional Life, or Working Life: These terms all refer to the general estimated years that a facility can physically serve its intended functions until the functional obsolescence forces a replacement.
- Service Life: Estimated years that a facility can perform adequate service. Slightly different from useful life, service life is more a technical parameter that heavily depends on the initial design and ongoing standard maintenances.
- Design Life: The engineer's forecast of the facility life. Similar to service life. Most commercial facility have an average design life of 50 years.
- Economic Life: The years of a facility from acquisition until economic obsolescence. It is a financial parameter and often shorter than useful life or service life.
- Probable Life: A statistical estimate of facility service years based on statistical analysis.

In Figure 2.5, facility life is classified by service length: a short life is less than 15 years, a medium life is between 15-30 years, and a long life is greater than 30 years.

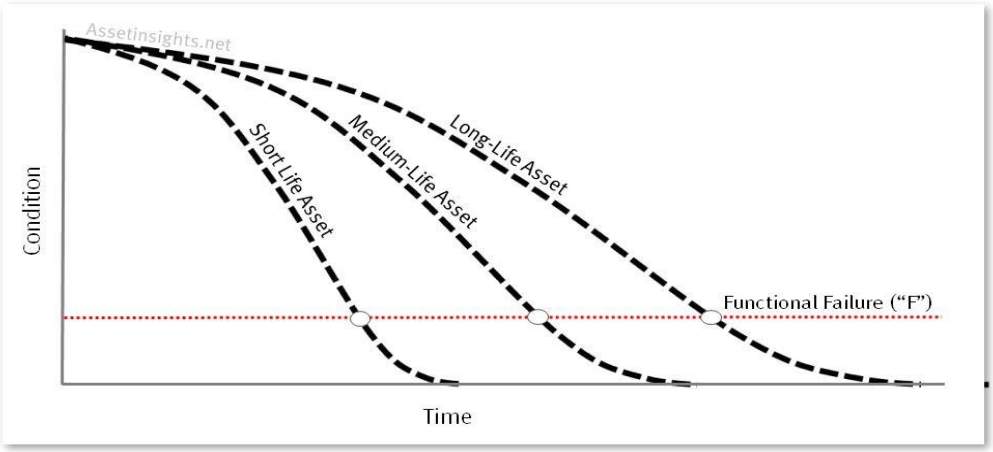

Figure 2.5 - Facility Project Life (Source: Assetinsight.net 2020)

Like a breathing creature, a facility goes through life stages from birth to tomb and the average working life of typical corporate properties is 50 years. Inevitably, physical deterioration, functional obsolescence, economic use decline, or aesthetic demand triggers the curtain call and forces the facility into decommission or replacement. Figure 2.6 illustrates the five stages of facility lifecycle and associated management and financial planning.

1. Pre-Birth (Year 0): Facilities are under financial evaluation and feasibility study for either acquisition or construction. No maintenance or capital improvement is required.
2. Childhood (1-15): Facilities are in new or gently used condition. Warranties and basic maintenance budgets usually are adequate to keep the facilities functioning well.
3. Adolescence (16-30): Short-life components start reaching to the ends of its service life and require replacements and maintenance. Extra funding beyond basic budget is needed and an adequate level of maintenances can significantly extend facility service life in this stage.

4. Adulthood (31-50): Major components gradually reach service life and start to decline. High levels of maintenance, major retrofits and partial replacement associated significant capital investments are needed to sustain the facility functions.
5. Old (50 plus): Exceptional maintenance can effectively increase facility service life. Project teams should carefully weigh the financial investment against the performance outcome of older facilities prone to the high possibility of failure.

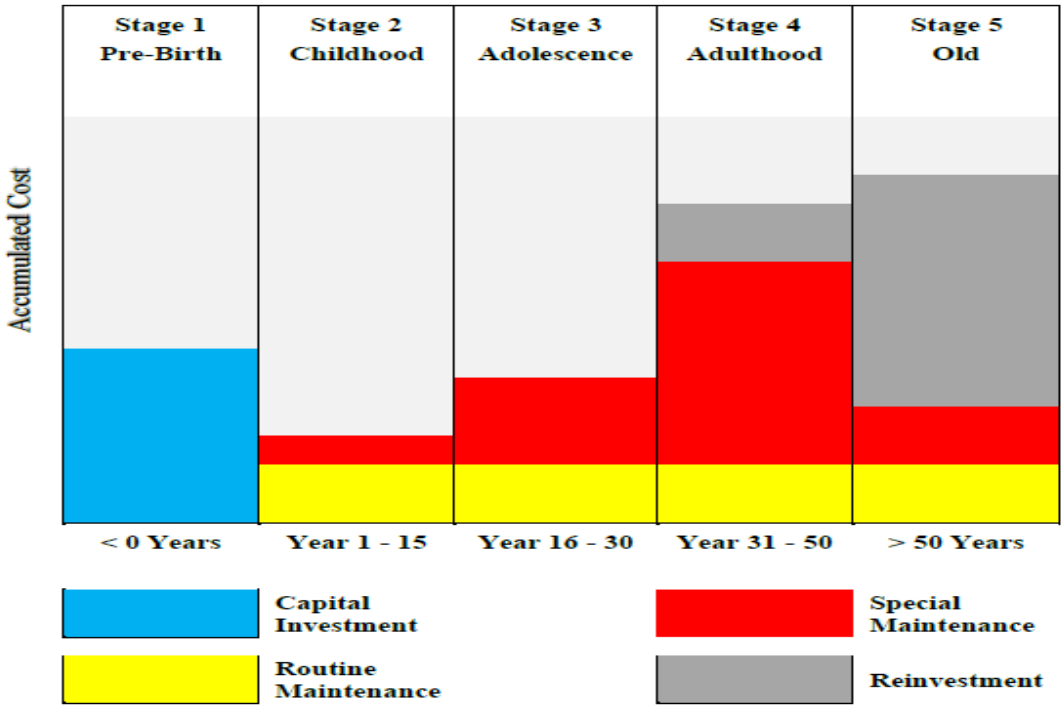

Figure 2.6 - Facility Lifecycle Stages and Financial Planning

2.4.2. Statistical View of Facility Lifecycle

The lifecycle of a facility is the median service years under the assumption of normal usage and standard care. The level of maintenance and workload may skew the probability distribution and cause the lifecycle to be either optimistic (longer) or pessimistic (shorter). Figure 2.7 provides an illustration of the lifecycle probability distribution.

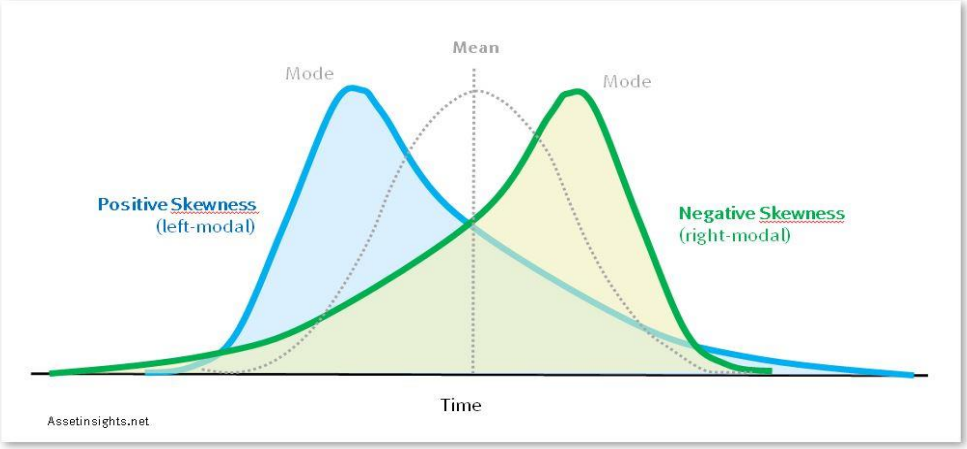

Figure 2.7 - Facility Lifecycle Deterioration Probability Distribution
(Source: Assetinsights.net, 2020)

2.5. Facility Risk and Failure Management

This section discusses types and natures of facility risks, facility functional failures, probability distributions, risk registers, and statistic modeling.

2.5.1. Facility Project Management Risks

Risks are uncertainties involving exposures to danger. Facility managers encounter risks in every lifecycle stage of properties. Typical facility project management risks are design discrepancies, creeping scope, budgeting errors, limited resources, delays, cost overruns, disputes, quality, safety, leadership, and incompetence.

2.5.2. Facility Function Failure Risks

Exposed to wear and tears, as going through the lifecycle stages, facility physical condition deteriorates and reaches to potential failures. Typical failures are technical, economic, legal, aesthetic, functional obsolescence. Figure 2.8 illustrates the correlation between facility resistance to deterioration vs. time.

Facility failures cause operation stoppage, disruption, shutdowns and financial losses and liability exposures. Classifying types of failures cab ne challenging due to hidden and overlapping conditions. The common consequences of facility failures are safety, environmental, operational, and non-operational. The severity levels are catastrophic, critical, marginal, negligible.

Some facility failures are gradual that the facility team can monitor the progress and develop preventive maintenance and replacement plans accordingly. Some are abrupt, the team have to deploy risk-based modeling to develop predictive maintenance and emergency responding plan to avoid disastrous impact to the operation.

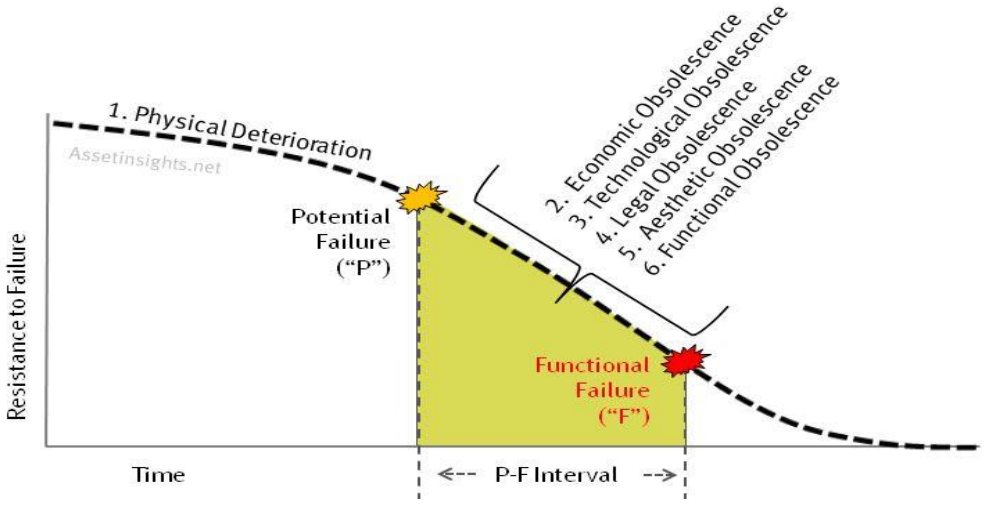

Figure 2.8 - Resistence vs Performance Failure
(Source: Assetinsight.net 2020)

2.5.3. Facility Project Risk Assessment

The Association of Project Management Body of Knowledge (APMBOK 7th Edition 2019) defines project risks as "an uncertain event or condition that, if it occurs, has

a positive or negative effect on one or more project objectives." **Error! Reference s ource not found.** provides examples of internal and external risks in facility projects.

Table 2.1 - Examples of Facility Project Internal and External Risks

Internal Risks	External Risks
Project Team Leadership competency, skills, and expertise. Interpersonal conflicts Lack of commitment and staff turnovers	Corporate Support Limited resources and unrealistic expectations Bureaucratic policies, lack of guidance and control Micromanagement or disengagement
Project Planning Lack of due diligence Poorly defined scope and budgets Unsuitable project team assignment Miscommunication	Economic Interest rate inflations Market fluctuation and inflation Vendor or subcontractor bankruptcy Project cashflows
Design Infeasible or ambiguous designs Missed critical design information Lack of coordination among disciplines	Technical Poor technical planning and investment Obsolete IT systems and cyber security Inadequate training or support
Procurement Disqualified vendors Supply shortages Long lead time or delivery delay Product quality and warranties	Capital Project Construction Cost estimate overruns Schedule delays Scope creeping Post-construction services
Contract & Legal Inappropriate contract formats Errors and omissions of critical clauses Potential claims, lawsuits, and arbitrations	Maintenance Infrastructure obsolescence and lack of pre-ventive plan System failure Safety
Environmental Contamination and pollution Clear air and water regulation LEED requirements Energy conservation	Government Policy Permits and approvals Community support Regulation and law changes OSHA enforcement
Labor and Union Difficulty recruiting experienced managers Employment disputes Tough union negotiations and strikes	Weather and Natural Disasters Inclement weather Floods Force majeures

2.6. Project Management Methods Suitable for Facility Industry to Adopt

Facility management share similar management principles with many other industries such as construction, manufacture assembly lines, supply chains, and IT. The added service dimensions of lifecycle management and sustainability movement demand facility management professionals to take innovative approaches and learn adaptive management methods from other industries. This section conducts a research on a short list of selected methodologies that facility management industry can benefit from well-planned cross-industry learning.

2.6.1. Aggregate Project Plan

The Aggregate Project Plan (*APP*) is a comprehensive and systematic project screening model that manages the project developing process. Organizations always concurrently manage multiple projects competing for limited resources. In their article (1992), *Creating Project Plans to Focus Product Development,* S. Wheelwright and K. Clark introduced the matrix of the Aggregate Project Plan to assist executives in organizing projects according to importance and urgency and grouping them into four categories: derivative, platform, breakthrough, and R&D. Figure 2.9 illustrates a modified *APP* for facility project management. The horizontal arrow indicates the impact of the projects to the organizational mission critical goals. The vertical arrow indicates project the impact on facility functions and conditions. The shape indicates project types. The size of the shape represents the resources needed.

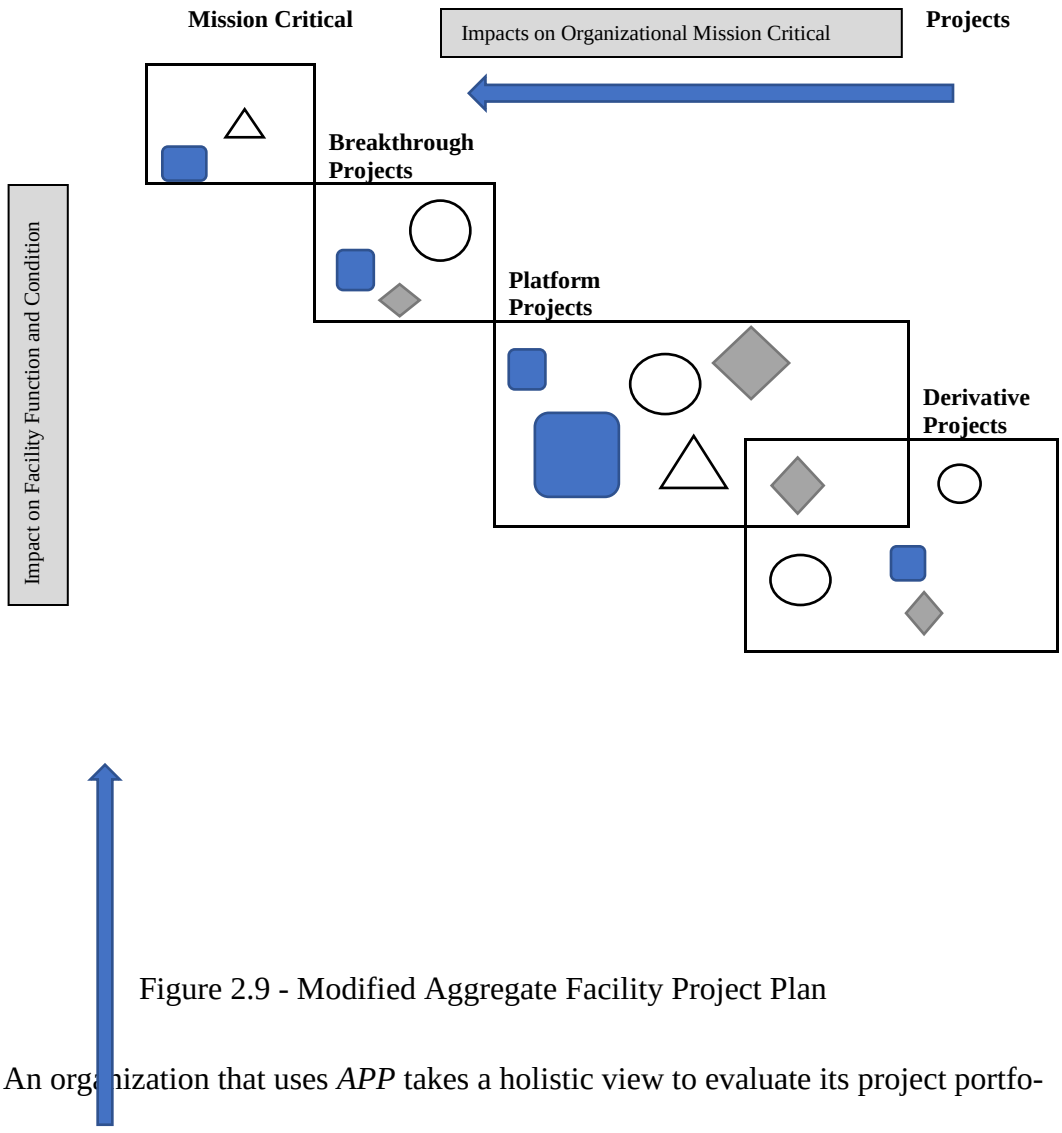

Figure 2.9 - Modified Aggregate Facility Project Plan

An organization that uses *APP* takes a holistic view to evaluate its project portfolio with a lifecycle sustainable growth prospective. Going through four *APP* filtering stages, projects are screened and categorized by scope characteristics and significance to organizational strategies for different level of management intensities and monitoring. The projects in the organizational are assessed and categorized in the following four groups:

- Derivative projects: Routine facility maintenance and operating activities that do not generate significant future offerings to the organization such as minor facility upgrades and routine maintenance.

- Platform projects: Preventive maintenance, property renovations, upgrades that have major departures and present the next generation of organizational offerings such strategic upgrades and major equipment purchases.
- Breakthrough projects: Projects have potential to disruptive technology changes that involve new technology, new management methodologies, or disruptive legal or government regulations such using GPS, drones, and robots for facility monitoring and preventive maintenance, or federal or local government new ordinances.
- Mission critical projects: Projects that can open blue skies for the future of the company that are critical to organizational survivals, marketing strategies, and sustainable success such as change the organization service lines, relocate to a different geography area, or penetrate to different a demographic market.

Each organization has its unique criteria about how to organize and manage its project portfolio, so executives need to constantly monitor the dynamics of the project's evolvement and periodically make necessary adjustments. Also, facility managers need to be aware of that *APP* was initially developed for manufacturing and product development. Adjustments are necessary to make fit to facility projects. *APP* works well with the Organizational Project Management Maturity Model (*OPM3*) in assessing corporate competency and developing business strategies.

2.6.2. Organizational Project Management Maturity Model (OPM3)

Organizational Project Management Maturity Model (*OPM3*) is a continuous self-regulated mechanism that helps the senior management to take a holistic approach to

examine project management on the organizational level. Following the *OPM3* five steps, the company evaluates the effectiveness (maturity) of how different types of projects are managed while identifying the strengths and weakness of the company. Figure 2.10 is an illustration of how the three *OPM3* integral elements (*knowledge, assessment, and improvement)* work together.

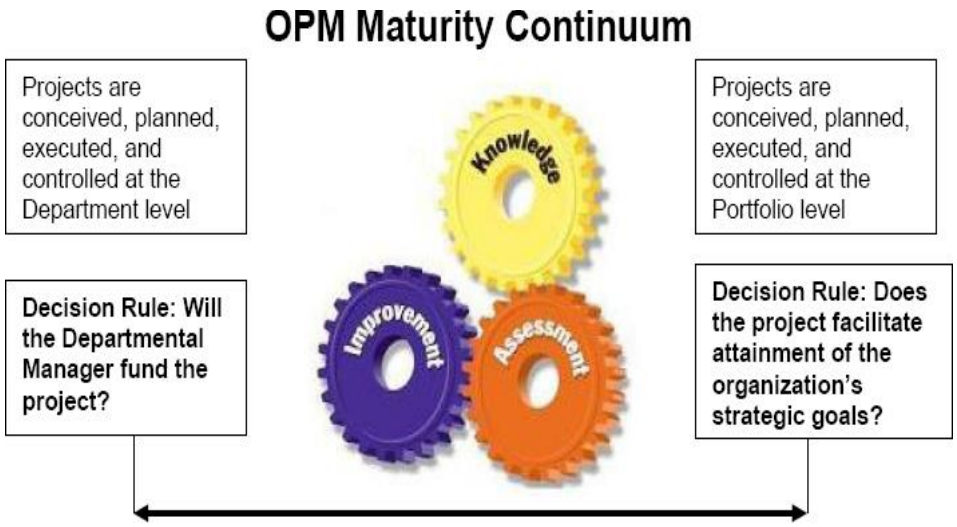

Figure 2.10 - OPM3 Continuum (Source: Project Management Institute 2006)

OPM3 is an iterative cycle with five steps: prepare assessment, assessment, implementation, improvement, and repeating the process. The five steps can be applied on individual projects, programs (groups of projects), or an organization portfolio. Going through iterations, the organizational maturity levels should progressively grow from individual project to portfolio and from standardization to control, and improvement will continually move into its next iteration as shown in Figure 2.11 (Kravsov, 2020).

Similar to *OPM3*, the Software Engineering Institute (SEI) developed the Capacity Maturity Model (CMM) in the1980's to help IT companies assess their capacities and improve product delivery. Slightly different than *OPM3*, CMM offers a framework for

continuous improvement in a of project with loosely defined scopes. The five CMM maturity levels are outlined in the Figure 2.12 below.

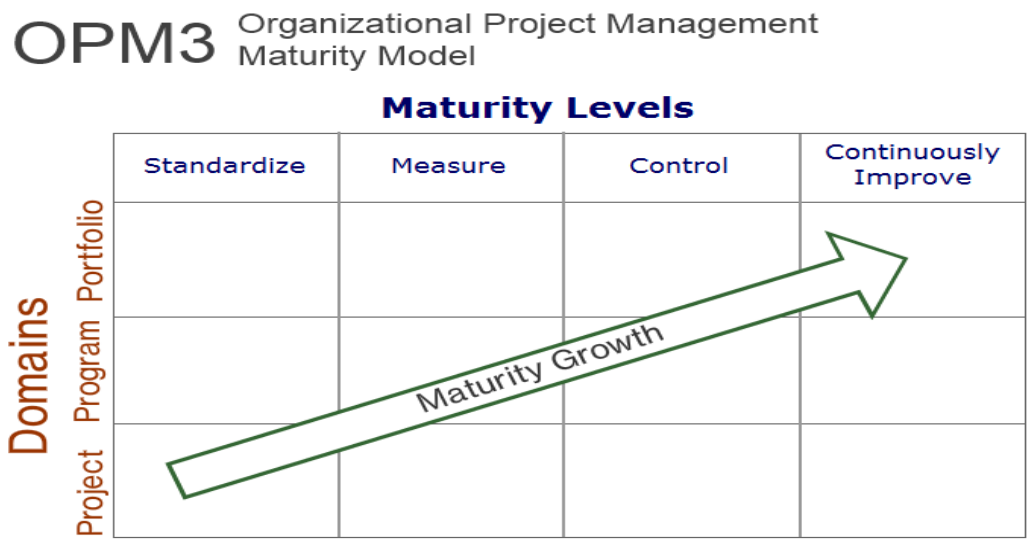

Figure 2.11 - Organizational Project Management Maturity Model (Source: Seesing 2003)

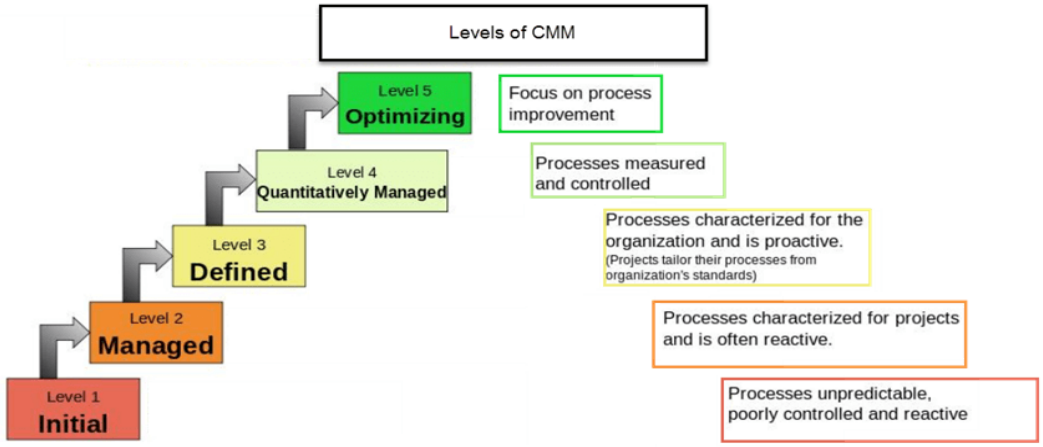

Figure 2.12 - Capability Maturity Model (Source: Guru99.com 2021)

The Modified Capacity Maturity Model (MCMM) is a combination that creatively blends the strengths of *OPM3* and CMM. Figure 2.13 provides an illustration below. An

organization can select appropriate elements from *OPM3* and CMM to create a model that fit its particular needs and characteristics. These maturity models provide structured procedures to help organizations keep a keen awareness of their strengths and weakness and continuously improve.

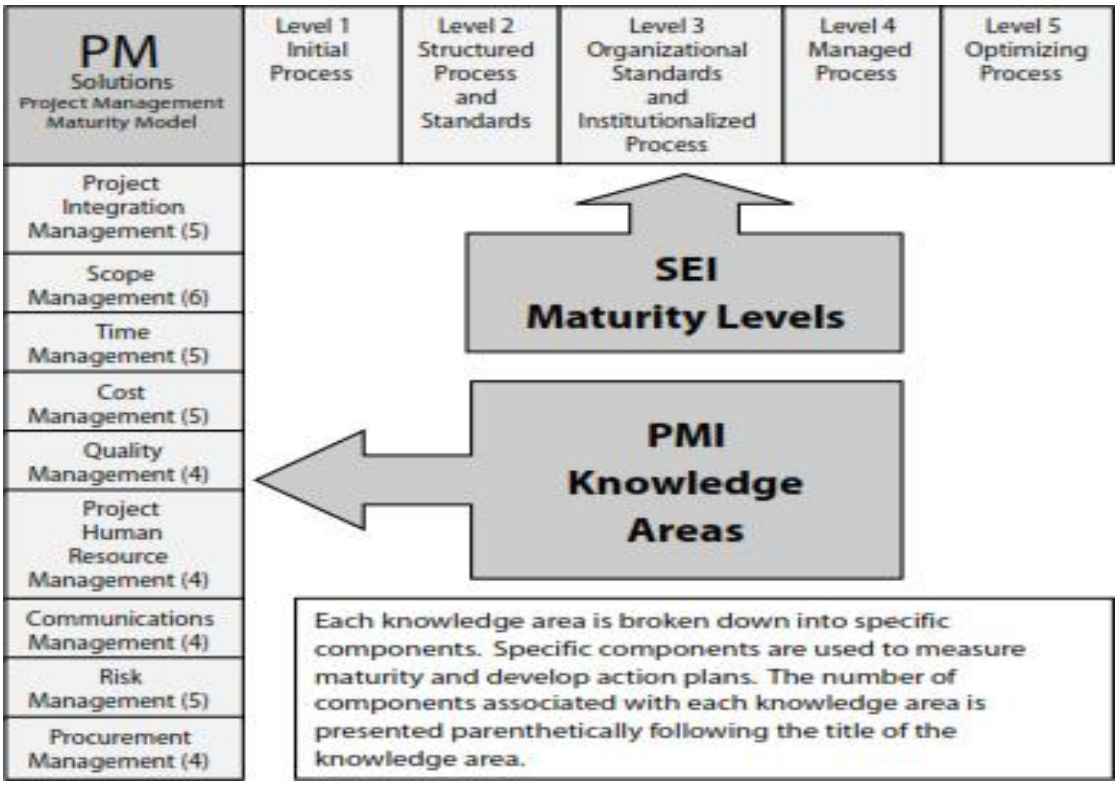

Figure 2.13 - SEI and PMI Models (Source: Pennypacker and Grant 2002)

2.6.3. Portfolio, Program, and Project Management (P3M)

Typically, an organization has a large pool of projects with varying scopes, complexity, importance, and urgency. Categorizing the projects with similar characteristics and assigning them to taskforces with proper responsibility and authority would significantly enhance project management efficiency. The Portfolio, Program, and Project Management provides structure to systematically organize projects on three-levels: organizational-

portfolio, divisional-program, and individual-project levels. Figure 2.14 is an illustration of the *P3M* management structure.

On the organizational portfolio level, facility executives view all projects in the corporate facility pool. On the program level, the projects with similar characteristics are grouped into manageable packages to generate synergy and management efficiency. On the individual project level, the specific responsibility and authorities are assigned to the tactic task forces to carry the project executions.

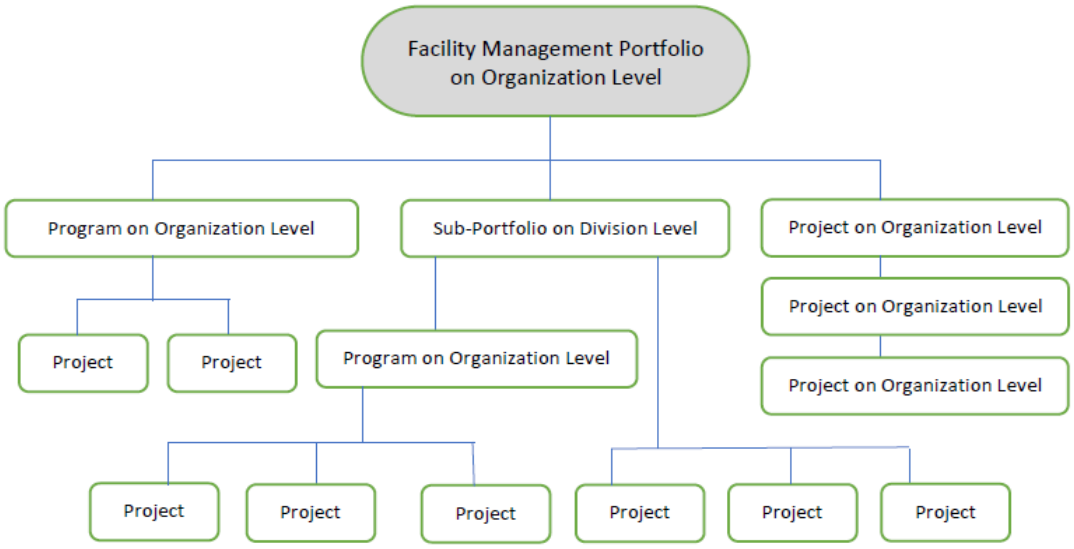

Figure 2.14 - P3M Structure

P3M and Project Management Office (*PMO*) share the similar concept and structure. Corporate senior management can develop *P3M* framework first, then assign the projects to appropriate task groups.

To provide executives a systematic approach to monitor development of the projects, key performance indexes are designed to gauge the performance of organizational

facility project portfolios. Table 2.2 shows three facility project KPIs and calculations commonly used in *P3M* portfolio monitoring and evaluation.

Table 2.2 - Commonly Used Facility Project Key Performance Indexes

Key Performance Index	Calculations
Facility Condition Index (FCI) =	*∑ Current Backlog ($) / Facility Reproduction Cost ($)*
Extended Facility Condition Index (EFCI) =	*{∑Current Backlog ($) + ∑Future Renewals ($)} / Facility Reproduction Cost ($)*
Facility Needs Index (FNI) =	*{∑Current Backlog ($) + ∑Future Renewals ($) + ∑Required Updates ($)} / Facility Reproduction Cost ($)*

2.6.4. Project Management Office (PMO)

The Project Management Institute provides a textbook-like definition "Project Management Office (*PMO*) is a *management* structure that standardizes the *project*-related governance processes and facilitates the sharing of resources, methodologies, tools, and techniques (Aziz 2014)." It is another example of PMI definitions that are good in nomenclature but vague in practice.

In essence, *PMO* is a commonsense exercise rather a new management fad. Many organizations basically use this approach without calling it *PMO*. A typical organization consists of several departments or divisions. These middle-level management groups carry out the same functions described for PMO to manage corporate facility project portfolios. If an organization already has the same management structure in place, adding redundant layers would cause bureaucracy and internal political fights. Cooch warned "as

PMO process framework widens, you should be trying to reduce the administrative burden at roughly the same rate (Cooch 2018).” Microsoft’s Share-Point Group is one of many cases of large corporations successfully implementing *PMO* in operation to promote synergy, collaboration, and efficiency.

Basically, *PMO* is the managerial structure of implementing the *P3M* and shares the same flow chart. Figure 2.15 provides an illustration.

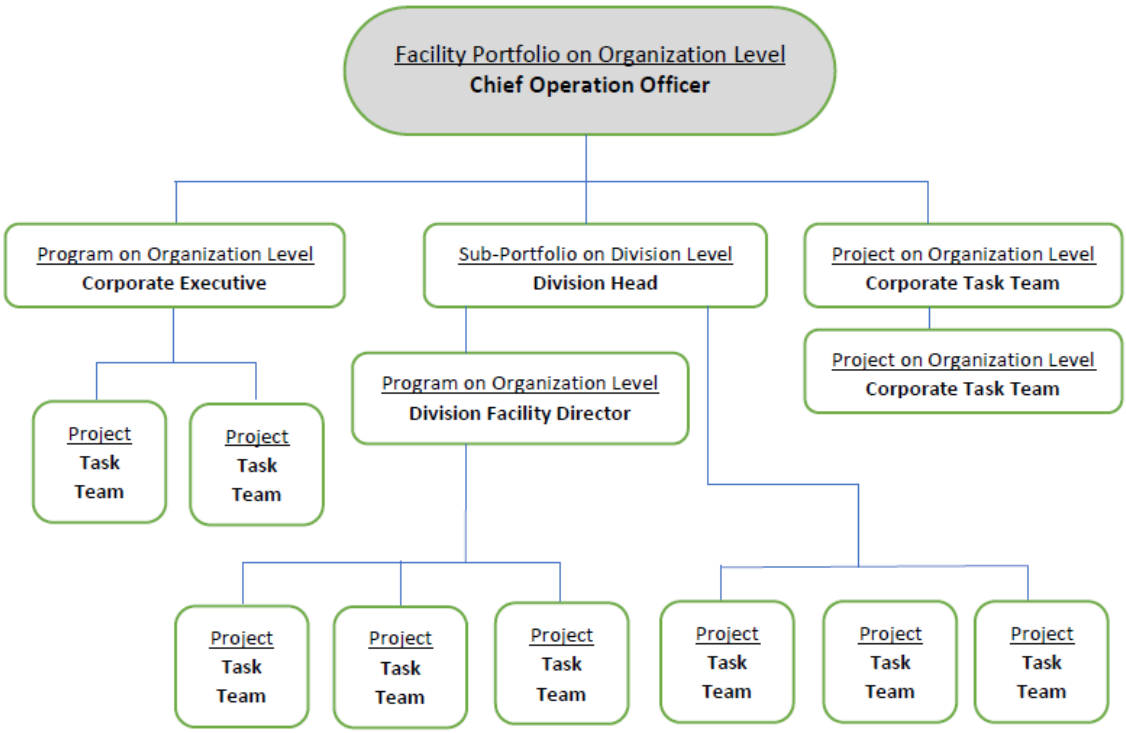

Figure 2.15 - PMO Structure

2.6.5. Combine P3M and OPM3 Methodologies for Synergy

Partnering with the British government, Axelos developed the *P3M*3 software which integrates *P3M* and *OPM3* into one system to improve project management efficiency. *P3M3* is an innovative and practical method that successfully synergizes two track-proven methodologies: the tactical portfolio management of *P3M* and the

strategical organization maturity improvement model of *OPM3*. Figure 2.16 provides an illustration of a basic concept of *P3M3* below.

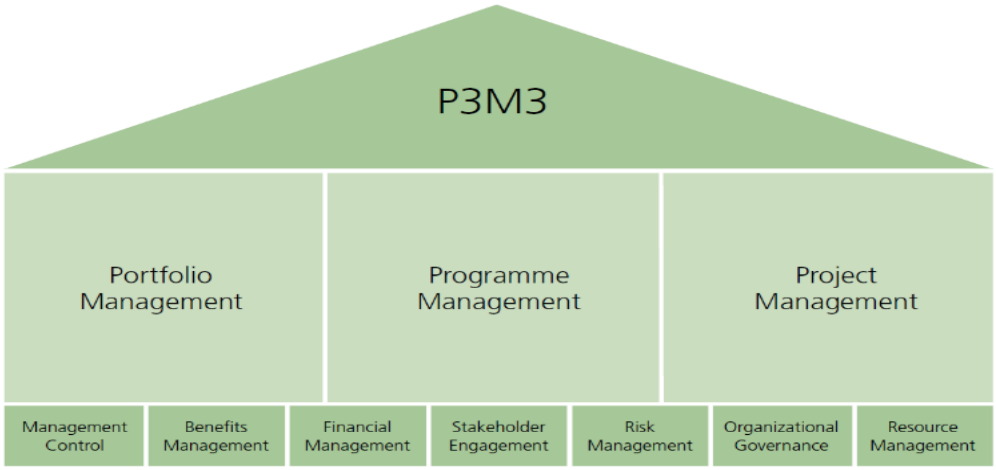

Figure 2.16 - P3M3 Structure (Source: Hedeman 2017)

P3M3 is well received by the facility management industry. It creates a two-dimensional self-assessment framework that synchronizes the organization's current competitive strengths with a snapshot of projects that are currently in the portfolio, balancing present capacity and future business potential.

2.6.6. Conventional and Adaptive Project Management

Conventional styles of project management are deterministic and predictive. In the project execution, the project team strictly follows the extensive planning that is developed upfront. Waterfall is a typical predictive project management approach that is widely used in many industries for decades. Figure 2.17 provides an illustration. Traditional management approaches have been modified in a number of ways to make them more flexible to the emerging needs of construction and facility projects. New management methods industries such as design-build, performance-based turnkeys, project

consultant at risk, and indefinite delivery and indefinite quantity (IDIQ) are well received in practice.

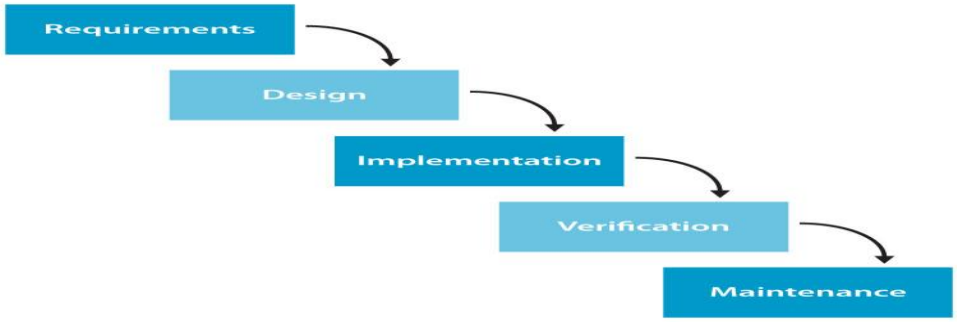

Figure 2.17 - Waterfall Project Management Approach (Source: Base360.Com 2016)

In the IT industry, software engineers constantly deal with a high volume of changes that the traditional predictive approaches do not fit to manage. To meet these emerging challenges, the IT industry developed the adaptive management approach with an iterative mechanism for incremental improvement. Figure 2.18 provides an illustration of the adaptive methodology.

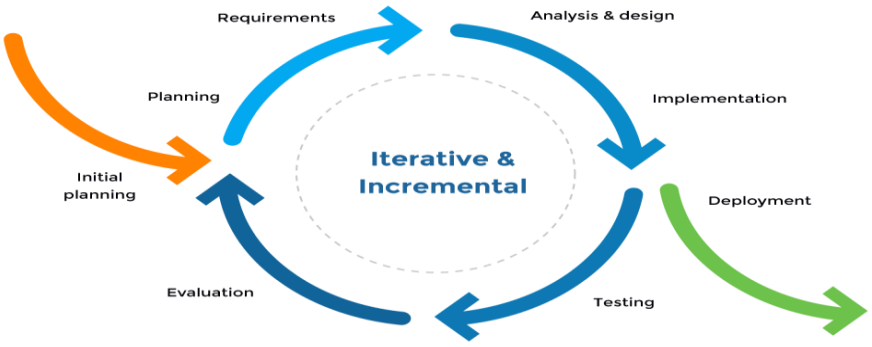

Figure 2.18 - Adaptive Methodology (Source: Kakarla, 2019)

Interactive communication and incremental improvement are two key elements in the adaptive management approach. End-users are invited to participate throughout the

project's development and provide timely feedback. Based on periodical development review within the group and users' intermittent inputs, the project team adjust the project scopes, technical methods, and delivery targets.

Traditional facility management methods are effective to manage well defined projects, but it lacks the nimbleness to handle high volume changes. The Agile management approach provides the flexibility that the software engineers need in product development and widely adopted in many industries. Following the Agile Manifesto of 2001, a number of new project management concepts were developed, namely Scrum, Kanban, and Crystal.

2.6.7. Agile Management for Facility Projects

Agile has become a buzzword in the project management sphere. In essence, the Agile management is not a methodology, but rather a style or a philosophy of project management. This adaptive approach has a conceptual structure consisting of five steps: 1) define project scopes and requirements, 2) integrate inputs and test the intermediate results, 3) invite and process feedback, 4) adjust, improve, measure the process, and 5) record, and go through the cycle again. Figure 2.19 provides an illustration of an example of Agile implementation with detailed breakdowns.

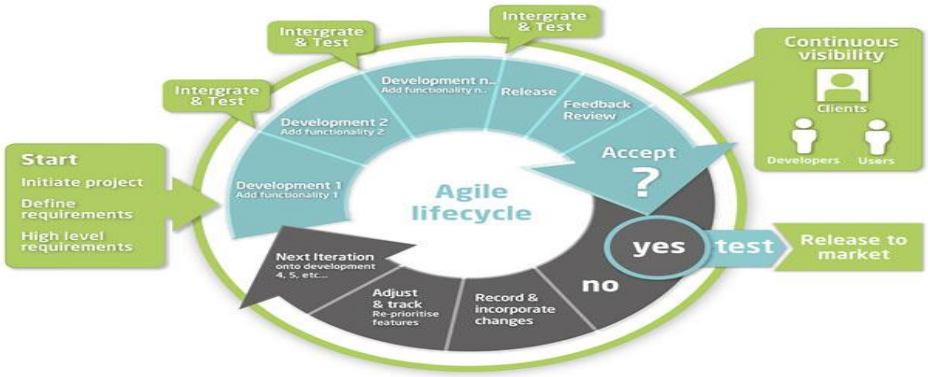

Figure 2.19 - Agile Lifecycle (Source: FAVPNC 2019)

Nimbleness is the main strength of Agile is of the keys to its success. Inevitably, flexibility comes with uncertainties and associated risk. To manage the potential risks embedded in an Agile project requires mutual trust among all parties involved. Facility management teams often stay together and work with the same group of outside service providers for years. The tightly woven network and stable relationships produce battle-tested trust and mutual understood leverages that make facility lifecycle project management a fitting candidate for effectively adopting the Agile approach.

Another key to Agile success is extensive and timely involvement from competent owners. Knowledgeable facility managers, who are the owner representatives, work on site side by side with the project team provides prompt and quality support in Agile implementation. The unique willingness and capacity of owner's involvement makes facility lifecycle project management suitable for Agile application.

Agile is popular and works well for some facility projects, though project managers should exercise caution in application. Among the four *APP* categories, Agile fits better to these projects in both the *Mission Critical* and *Breakthrough* groups, while

traditional methods are more effective for these in the *Derivative* group with routine operation and less changes.

For Agile was not originally designed for facility lifecycle projects, in order to optimize its advantages and avoid pitfalls, project teams need to make modifications based on the specific needs of their projects instead of doing Agile just for the name's sake. Figure 2.20 provided an example of modified Agile approach for facility management.

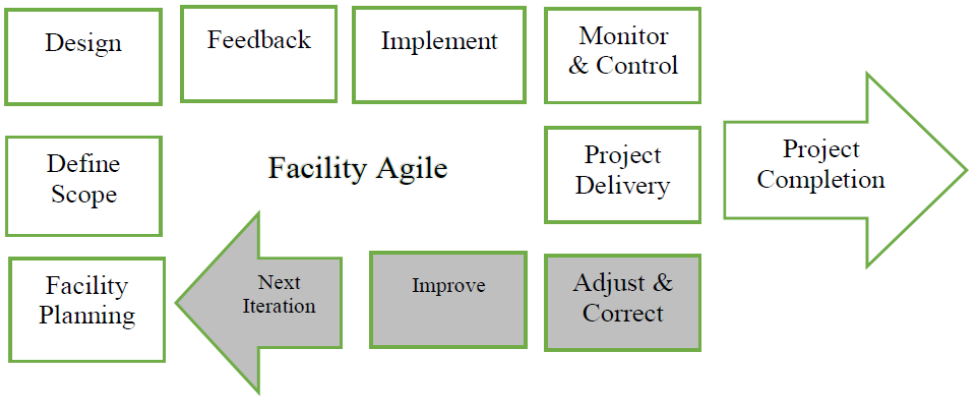

Figure 2.20 - Modified Agile Methodology for Facility Management

Successful adoptions of new management practices require in-depth understanding, creative adjustment, and prudent risk control. Agile is simple in concept, but complex in implementation. In the real project management world, facility managers operate within many rules and restrictions and face various challenges and demands. As Shapiro stated in his article *Applying Agile Methodologies in Non-Agile Contractual Scenarios*, "Agile works best in a non-Agile world when certain assumptions are met, and if those assumptions are not met the benefits of Agile are not as clear (2016)." On the same topic, Coram and Bohner added, "If the requirements for

work to be performed are part of a legal contract, an Agile method may be inappropriate since requirements are malleable (2005)."

The Achilles heels of Agile method are the liability consequences resulting from extensive owner's involvement and the ambiguity of obligations for the parties involved. In his article, *How Fragile is Your Agile?* Goulstone discussed common legal issues Agile teams often encountered in practices:

> 1) Party roles and obligations within each improvement circle and decision power on procedure and agenda, 2) Satisfaction of obligations, levels of acceptance, responsibilities for compliance of obligations, and liabilities for incompliance, 3) determination of fairness of schedule and compensation for services, 4) Mechanism to resolve disputes, and 5) Legal consequences to any party that unilaterally terminates the Agile partnership (2020).

At the core of the Agile method is an acknowledgement of the role of trust. The emphasis on fair business dealing and presumed obligations makes Agile vulnerable to trust risks. In today's overly legalized business world, trust and transparency are rare commodities. Applying Agile to the appropriate project types, carefully designed risk control plans, and pre-aggreged dispute solving mechanisms are paramount to Agile execution in practice. In events where disputes arise and situations get out of control, mismanaged risks lead to legal complications among the parties. Wards commented on Agile relationship in *Eight Do's and Don'ts of Agile Contact*,

> If the relationship breaks down, it is likely that a party's satisfaction of the trust obligations would be legally measured only by the obligation of good faith and fair dealing if specific cooperation obligations are not spelled out. The contract

provisions in Agile may look more like a relationship than a traditional contract disputes provision (2019).

2.6.8. Mixed Use of Agile with Conventional Methodologies

Agile is effective on loosely defined project and conventional waterfall are efficient on the rigid ones. But in practice, most projects fall in between. Savvy managers mix the use of both methodologies to optimize the outcome. They tend to use Agile on unfamiliar projects. As they learn and improve, they progressively shift to the traditional style. Figure 2.21 indicates that 43% of projects use a mix of Agile and traditional methodologies.

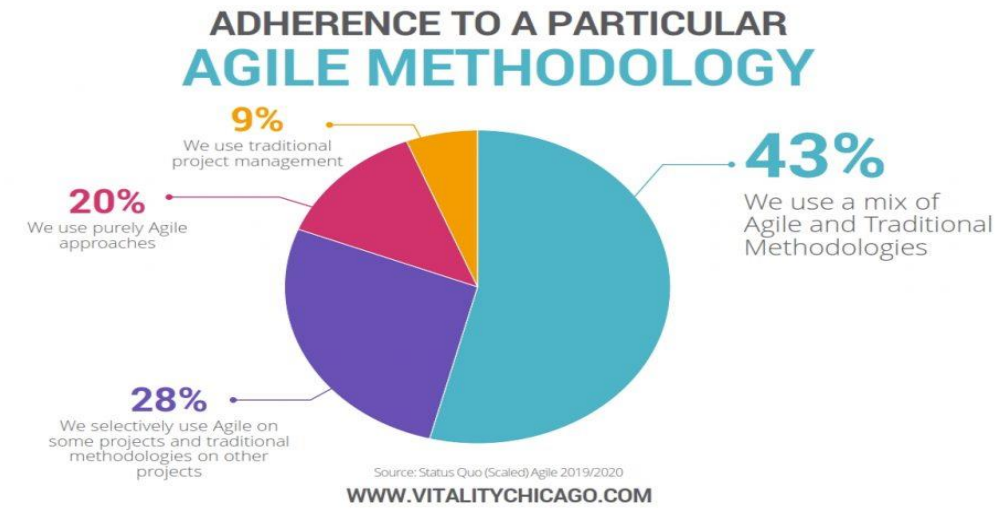

Figure 2.21 - Mix Use of Agile and Traditional Methodologies
(Source: Vitalitychicago.com 2019)

By nature, an Agile process is iterative and puts more responsibility on a client than a traditional approach. In order to have legal certainty and a guideline for development, contracts are also indispensable in Agile projects. Agile has been around for 20 years, which seems like enough time for industries to adopt and develop Agile contracts,

but that is not the case. As Madden stated, *I'm Agile, But My Contract Isn't*, "yet when it comes time for a company to enter into a contract about agile work processes and deliverables, we're still seeing Waterfall language persist (2014)." The conflicts between legal and financial certainties and nimbleness and creativeness remain as challenges to facility teams to solve in project executions. Well-designed risk control, carefully structured contract format, and skillfully handling situations are key contributing factors in successful Agile project management.

2.7. Sustainability Movement and Sustainable Facility Growth

Former Norwegian prime minister Gro Harlem is credited for the definition of sustainability: "development that meets the need of the present without compromising the ability of future generations to meet their own needs (1987)." Natural resources are finite and need to be wisely managed with a consideration of long-term consequences.

Research by earth scientist Hughes on the serious increasing challenges of global population and energy consumption revealed that "from 1965 to 2010, the world total energy consumption increased 218% and 85% of the total world energy consumption in 2010 is generated from non-renewable fossil fuels (2012)." Table 2.3 is the breakdown of world fossil fuel energy consumption increases.

Table 2.3 - World Fossil Fuel Energy Consumption 1965-2012
(Source: Hughes 2012)

Fuel Source	Increase 1965-2010
Oil	163%
Gas	381%
Coal	149%

From 1850 to 2010, the global population increased five-fold while the per capita energy consumption increased eight-fold (The U.S. Bureau of Census 2010). Obviously, the finite non-unrenewable resources are not sufficient for this to continue, and the hyped renewable technologies are unable to produce enough renewable energy yet to meet the current energy demands. The future of the world rests on radically reducing consumption and conserving natural resources and sustainable living.

Nuclear energy brings a dilemma with hope of its vast energy production and devastating threats; solar power, wind farms, and earth-thermal energy are safer options, but the total production is too little to replace a fraction of the current energy consumption. Other options are not out of reach, but none is practically feasible in the next 10-20 years to overcome the imminent energy crisis.

By definition, the ability of controlling and authority of allocation resources is power. Resource allocations is always a sensitive and complicated political issues between parties domestically and among countries internationally. The imbalance of power has been discussed by a number of scholars, here are a few, "the developed economies with global influence and strength are accused for unfairly exploiting the weaker ones (Sharhrier, et al. 2017)"; "current generation are selfish and irresponsible for intergenerational sustainability for subsequent generations (Milinski, et al. 2006)" and "capitalistic economic systems focusing on profit maximization fails to ensure fair allocation public goods and natural resources among the societies (Krutilla, 1967)." Sustainability is about resource management and inevitably sometimes becomes political maneuvers on multiple levels.

This dissertation focuses on the sustainability impacts on the facility management industry, how facility management professionals can capture these opportunities, and some outstanding issues in practice.

2.7.1. The Sustainable Facility Management Market and Trends

The market demand for sustainable green facilities in the United States is expected to reach $81 billion in 2020 (Tiseo 2020) with a compound annual growth rate of 26.8% (MarketWatch 2020). The sustainable facility market's fast growth is propelled by the following drivers.

1. Government regulations on carbon emission and energy conservation.
2. Client demands, cost reduction, new business, and improving company image.
3. Social obligations, goodwill communities, local supports, and financial incentives.
4. Operating cost optimization with new technologies.
5. Productivity increase, talent retention, and employee wellbeing and happiness.

Kwawu and Elmualim conducted a survey in 2011. 268 participants ranked government legislations, corporate image, and organizational ethos as the top 3 drivers for facility sustainability development. Survey results are summarized in Table 2.4.

Table 2.4 - Drivers of Facility Sustainable Practices
(Source: Kwawu and Elmualim 2011)

Drivers for Facility Sustainability Development by:	Kwawu and Elmualim
Legislation	66.2%
Corporate Image	60.6%
Organizational Ethos	42.9%
Pressure from Clients	28.8%
Lifecycle Cost Reduction	28.3%
Pressure from Employees	21.2%

Pressure from Shareholders	16.2%

Dodge Data and Analytics (2018) conducted a global online survey with 2,078 facility management and construction professionals to rank the factors with significant impacts to the facility industry's sustainability growth. Client demands, government regulations, and health building are ranked as the top three drivers as shown in Table 2.5.

Table 2.5 - Rank of Facility Sustainability Drivers
(Source: W. Kwawu and A. Elmualim, 2011).

Drivers for Facility Sustainability Development	Dodge Data and Analysis
Client Demand	34%
Government Regulation	33%
Healthier Building	27%
Market Demand	25%
Right Thing to Do	25%
Lower Operating Cost	23%
Internal Corporate Commitment	17%
Higher Building Value	15%
Branding and Public Relationship	13%

Both surveys indicated that external pressures such as financial incentives, government regulations, client demands, company image, and marketing needs are the main drivers of the sustainability development. Evidently, most corporations are not intrinsically motivated to take voluntary initiatives to go green. The situation has improved slightly between 2011 and 2018, when the government regulation rank dropped from first to second place and its significance decreased from 66% to 33%. As Kwawu and Elmualim stated, "The perception of sustainability, as benevolence with no direct impact on organizational core business strategies, has changed over the years as organizations actively incorporate sustainability principles into their core business strategies (2011)."

2.7.2. The Political Aspects of Sustainability Development

Though this research is about facility lifecycle sustainability management practices, it is helpful to have a broader understanding of sustainability and be aware of sensitivity in any politicized society. As shown in Figure 2.22, sustainable development has a broad concepts of environment protection, economic resources allocation, and social significance.

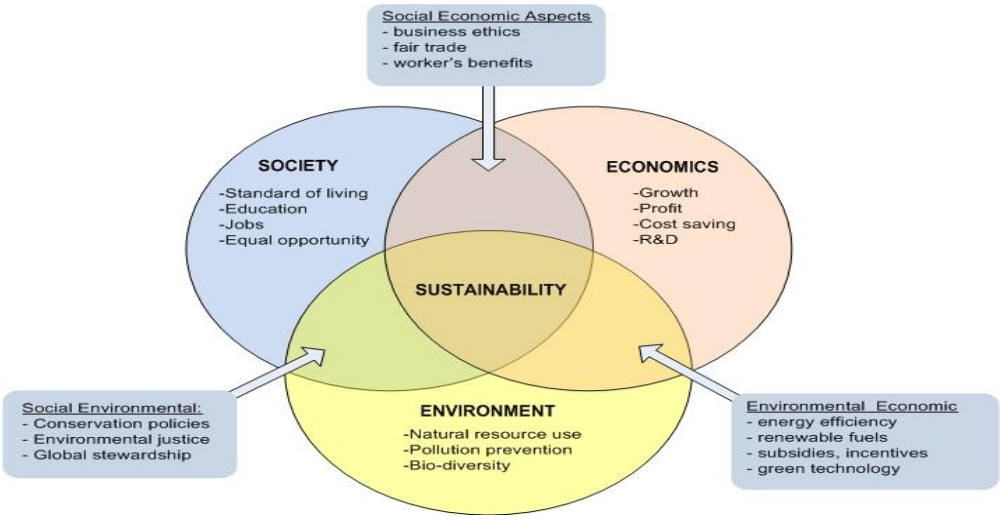

Figure 2.22 - Interplay of Sustainability Elements (Source: Irsan and Utama 2019)

Political power is a capacity using economic and social strengths and/or authority of resource allocation to influence the conducts and beliefs of other people. Essentially, a sustainability movement is about balancing the finite natural resources between the present and future, developed and underdeveloped, local and global, and among business industries and social classes. Undeniably, sustainability has a deep political root with international and social complications.

Adams Smith believed that the overall economic outcome of a society arises from the accumulated self-interested actions of individuals and the invisible hands of market

would lead individuals to find any legally possible ways to maximize their profits. Smith's capitalism theory assumes that the natural resources is accessible and infinite which fundamentally contradicts to the principles of sustainability and the fact that natural resources are finite and quickly depleting. Sustainability movement proponents, like socialists, believe that natural and social resources are finite public wealth and belong to everyone who lives on earth and who will live on it.

Wars between countries, fights between political parties, and social struggles among classes are all about resource allocation. Sustainability is about resource allocation and will remain as a sensitive political topic.

2.7.3. Facility Sustainability Management as an Academic Discipline

The sustainability development started in the early 1980's with little science content, and eventually the broad concept incorporated environment engineering, ecology, agriculture, health, and more. It has now become a transdisciplinary body of knowledge. The increasing number of research articles, seminaries, conferences, and classroom courses have shaped an evolving science of its own unique characteristics. It was the first time that the US National Academy of Sciences (UNAS) called the sustainability development of a science in its annual report 1999. In 2003, the Processing of the National Academy of Science USA (PNAS) created a dedicated science section for sustainability. Through years of evolution, sustainability development has now become a dynamic young academic discipline of its own.

Contrasting to basic sciences that search for fundamental understandings of natural or social phenomenon, sustainability is a "practice-inspired" science that emphasizes the interactions and improvements between natural and social systems. A separate

academic discipline should possess the following six characteristics: 1) a significant object of research; 2) a substantial body of knowledge; 3) proven theories and concrete concepts; 4) technical language; 5) distinguished research methods; and 6) institutional manifestation. Today's general sustainability study meets all the six criteria. In 2014, Norwegian scholars Junghans and Olsson who used the same six criteria successfully argued that facility management should be accepted as a separate academic discipline.

Regarding the academic study on facility sustainability management, it is better conducted within the framework of facility lifecycle management. Though more literature is published, and more real-life cases are studied, the facility sustainability study is still far from ready to become a separate discipline. At the Denmark Technology University, a group scholars conducted an extensive literature review on sustainable facility management and concluded that

> Sustainable facility management has yet to reach the stage of maturity necessary to be identified as an academic discipline in itself, but it is a topic of growing importance within the academic discipline of facility management (Nielsen, et al. 2016).

2.8. Corporate Practices of Sustainable Lifecycle Facility Management

Typical sustainability management practices in facility management are energy conservation, water saving, recycling, air quality and emission control, fleet and transportation reduction use, and ecological site planning. Sustainable maintenance and procurement have huge impacts on facility sustainability as well. With a keen awareness of balancing business needs with social and environmental obligations, organizations should develop actionable and measurable sustainability policies and implementation plans with

clearly defined goals. Table 2.6 summarizes practices that are commonly included in organizational lifecycle facility sustainability plans**.**

Table 2.6 - Sustainable Practices in Facility Lifecycle Management
(Source: Kwawu and Elmualim 2011)

Lifecycle costs and benefits planning
Ecological planning
Reward and encourage sustainable efforts
Walk-out and turn-off
Incentivize users of public or shared transportation systems.
Training
Technical training
Awareness education
Sustainability certification
Design and Construction
LEED certification
Sustainable automation
Highly efficient insulation
Procurement Management
Use local service providers and suppliers
Support local products
Use recycled materials and forest preserving products
Site Planning
Nature resources preservation
Endangered spices protection
Ecological green landscaping
Wetland protection
Environment
Ozone protection
Contamination prevention
Reduce greenhouse emission
Reduce sound and light pollutions

Brownfield redevelopments
Carbon footprint reduction
Energy Efficiency
Solar system
Renewable sources of energy
Use variable speed motors and program monitoring
Workspace
Natural lighting and ventilation
Efficiency of space layout
Shared social multifunction areas
Minimize travels
Gym and fitness for wellbeing
Walk trails and dog parks
Indoor Quality
Asbestos abatement
Mold prevention
Safe and non-toxic cleaning and pest control products
Highly efficient micro filter system against viruses or micro particles
Water Reservation
Waterless fixtures, rainwater capture, storage, and irrigation.
Water reservation and recycling
Transportations
Fleet using clean fuels
Vanpools or carpools
Bike racks and showing accommodations
Dedicated parking stations for hybrid or electric vehicles
Telework
Waste Management
Source reduction,
Sorting and Recycling
Paperless environment
On site composting of organic materials
Eliminate disposal of usable materials at landfills or incinerators
Maintenance Planning
Predictive and proactive maintenance
Boiler and chiller operation optimization
Replace old lights with LEDs
Motion and photo sensors for lighting and devices control
Use bio-safe products

New Technologies
AI analysis
Remote sensor and testing
Drone surveillance
Automated power down feature on idle office equipment
Coordination and Auditing
Third party sustainability professional audition
BIM to benchmark, measure, and track sustainability implementations

2.8.1. Energy Conservation and Building Automation

Building facilities use total 39% of global energy consumption and 71% of global electricity consumption. The vast majority of energy consumed in commercial facilities is from non-renewable resources. Therefore, any efficiency improvement in facility energy management will have significant outcome to sustainability development. Energy demands reduction, energy efficiency improvement, and new renewable energy sources are the fundamentals of facility energy conservation.

2.8.2. Energy Demand Reduction

Passive design is widely adopted in green buildings to take advantage of using natural daylighting, ventilation, colling, heating, and shading to reduce artificial lighting, energy consumption, greenhouse emission, and machinery maintenances. Rameshwar, et al. stated in their book *Green Buildings - A Key to Sustainable Global Solution*, "careful passive designs of facility orientation, layout, overhangs, shading, envelope insulation, glazing, and thermal control, can reduce energy consumption as much as 80% (2020)."

2.8.3. Energy Efficiency Improvement

Using high energy efficient HVAC equipment and Energy-Star electronic devices, installing variable-frequency speed motors on large equipment to reduce energy losses during startups, shutdowns, and transmission; using photo and motion sensors to improve lighting efficiency, installing building automation systems to reduce over-heating or over-colling, balancing air flows with zone monitoring system and pre-heated/pre-cooled makeup air, leveling off energy consumption spikes, and using integrated electricity and heating co-generation to increase combustion/heat energy exchange efficiency.
New renewable energy sources: Whenever feasible, using solar panels, wind turbines, geothermal, or biomass energy generation options to reduce fossil energy consumption.

2.8.4. Waste Reduction and Material Recycle Management

Not every company has the financial resources or the need to install a high-tech CHP like big conglomerate AstraZeneca does, although each organization or individual can help make this world more sustainable by reducing waste and recycling reusable material. Small changes in habit can make big differences such as going paperless in the office, minimizing plastic and cardboard uses, and recycling reusable glass and forest products. The EPA reported (2018) that the total reusable wastes recycled in the US from 5 million tons in 1960 increase to 70 million tons in 2018.

Repurposing is an effective way to reduce waste. For example, concrete rubble from construction jobsites is crushed and recycled to make excellent underlayment materials (RC3 or RC6) for roads or building foundations. Legally recycling hazardous materials such as florescent lights, batteries, refrigerant, copier cartridges, bio-toxic, or chlorofluorocarbons CFC refrigerants prevent soil and underground water contaminations.

2.8.5. Facility Site Ecological Preservation Management

Optimization of site-sustainable design has an enormous ecological impact. Facility sustainability management can preserve ecological balances by selecting facility sites that do not damage natural surroundings, disturb endangered species habitations, or interference with emigrant wildlife corridors.

Building orientation and layout should enhance fresh air ventilation with prevailing wind, maximize solar power production, optimize natural lighting, and avoid overheating exposure to sun. Providing bike racks and building trails accessible to public transportation in local communities to reduce private car use and emission. Besides beautifying the sites, landscaping helps erosion control, localized climate enhancement, and greenhouse gas absorption. Use on site retention systems to prevent stormwater runoff, protect wetland vegetations and wildlife, minimize negative impacts to natural surroundings, and reuse harvested stormwater for land irrigation.

2.9. Government Regulations on Sustainability Development

This section discusses federal and state regulations and incentive programs on superfunds, brownfields, clean air, clean water, and wetland protection.

2.9.1. The Federal Superfund Cleanup Program

Before the environmental law was enacted, many people dumped hazardous waste in the ground or rivers and created thousands of contaminated sites. Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), the U.S. Environmental Protection Agency (EPA) created the Superfund Cleanup Program in 1980 to manage abandoned, accidentally spilled, or illegally dumped hazardous

substances. The EPA evaluates each case required by Federal action and takes one of three response actions: emergency responses, early actions, or long-term actions.

For the long-term action cases, the EPA reviews the application information, conducts tests on-site, and uses the Hazard Ranking System (HRS) scorecard to evaluate the environmental impacts to groundwater that may be used for public drinking water, surface water drinking water as well for plants and animal habitats, soil that people may come in contact with or that can be absorbed lower in the food chain, and 4) air that carries contaminants. Sites that get a high score on the HRS can be put on the National Priorities List (NPL) for extensive, long-term cleanup action under Superfund. Usually, the EPA pays NPL site cleaning from the Superfund pool which is mainly funded by the taxes on chemical and petroleum industries while state agencies pay 10% and administrate the projects. The EPA has the authority to decide how much the Potentially Responsible Parties (PRPs) must pay.

The Superfund provides practical solutions to the contaminated sites that have difficulty identifying the responsible parties and helps those who are responsible but do not have the financial resources to stop contaminating the environment and stop introducing hazardous threats to the public.

2.9.2. The Brownfields Revitalization Act

The main purpose of the Brownfields Revitalization Act is to promote business reinvestigation in abandoned properties in order to increase local tax bases for inner cities and struggling blight suburban areas. The US. Congress' official definition for a brownfield site is

> a real property, the expansion, redevelopment, or reuse of which may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. Cleaning up and reinvesting in these properties protects the environment, reduces blight, and takes development pressures off greenspaces and working lands (EPA 1995).

The EPA started a pilot program in 1995, then later Congress made it a law in 2002 and reenacted it in 2018. The Brownfields Revitalization Act has proven successful in assisting states, communities, and other stakeholders to work together to prevent, assess, safely clean up, and sustainably reuse brownfields. The EPA offers a list grant in the Brownfield Program to promote and support revitalization efforts by funding environmental assessment, cleanup, and job training activities.

The real encouraging message that the business community received from the EPA is the forgiveness towards new owners who do not have to bear the costly liability of cleaning up the previously contaminated sites. It was one of many reasons for some of inner cities to go blight and industrial suburban areas to abandon properties. The overly harsh environmental regulations frightened business owners and developers, causing them to hesitate in investing and more inclined to exit.

2.9.3. Regulations on Clean Air

The EPA's Clean Air Act (CAA) is a comprehensive federal law regulating air emission from facilities and automobiles. The top sources of air pollution are coal-fired power plants, fertilizer plants, petrochemical refineries, cement plants, and automobiles. The major pollutants are nitrogen oxides (NO_X), sulfur oxides (SO_X), benzene, volatile organic compounds (VOC), and the smog-causing micro-particle matters (PM). The

Union of Concerned Scientists (2012) proclaimed that the Clean Air Act helped cut ground-level ozone by more than 25 % since 1980, reduced mercury emissions by 45% since 1990, reduced the main pollutants that contribute to acid rain by 71%, reduced NO_X and SO_X by 46% since 1980, and reduced the lead content in gasoline fume pollution by 92% since 1980. The achievements contribute greatly to global sustainability growth and protect public health and welfare.

The CAA does not regulate indoor quality issues and largely leaves the matter to be administered by state agencies with a series of guidelines provided by the EPA. However, the laws give the EPA the authority to step in and enforce compliances when necessary. Most states the EPA agencies follow the Toxic Substances Control Act (TSCA) and develop their own indoor quality regulations with stricter requirements.

Under the TSCA subchapter II: Asbestos Hazard Emergency Response Act (AHERA), the EPA addresses this common issue that facility teams often encounter in property management. Facilities built before 1970's were constructed with materials containing asbestos in the forms of chrysotile, crocidolite, amosite, and tremolite. The rarely-found long asbestos fibers are the best thermal insulation material which are used in the NASA rockets that sent Challenger and Perseverance to Mars. Short asbestos fibers were commonly found in various types of construction components. The asbestos containing materials (ACM) became health hazards once the asbestos disperses airborne and causes potential lung cancers. The AHERA provides detailed instructions of ACM reporting, investigation, abatement, and monitoring with specific requirements. In the 1970s and 1980s, the EPA banned and phased out asbestos products.

Mold is another common facility indoor quality issue which is under state regulation. Currently regulations are weak and almost non-existent, due to the difficulties of setting concrete standards for the bio-complexities and thousands of types of mold spores and pollens. Civil lawsuits and the Occupational Safety and Health Administration (OSHA) citations and penalties are the main concerns for facility management. Mold remediation can be a quick simple bleach treatment or multimillion total remodel if the spore grows out of control. In facility management practices, the most important task for the team is to find and fix water leaks or remove sources of moisture. Mold remediation is almost always included in corporate facility disaster response plans. Storms, floods, and water main bursts cause the soaked facility to become immediate mold hazards; earthquakes and structure failures usually collapse with the waterlines; and the water used to put off a major fire breakout leaves the facility soaked for days. Though mold is not regulated, it always remains a chief threat to the facility operation management.

2.9.4. Regulations on Clean Water

The purpose of the Clear Water Act (CWA) is to protect the public water bodies from environmental hazards to public health and welfare. It affects industrial production facilities more than commercial facilities and impacts to facilities in the coastal and great lake states more than the landlocked states. The main issue for the commercial facility management is storm water runoff at the sites or discharge to public systems.

2.10. LEED Certification and Local Government Incentive Plans

Developed by the U.S. Green Building Council, Leadership in Energy and Environmental Design (LEED) is the primary design rating system evaluating facility

sustainability achievements the primary design rating system evaluating facility sustainability achievements on four levels of Platinum, Gold, Silver, and Certified. The LEED rating is based on five subject categories: 1) Sustainable sites: minimize sprawl and negative environmental impact. 2) Water efficiency: reduce water usage. 3) Energy and atmosphere: conserve energy and use renewable energy. 4) Material and resources: reduce and recycle. 5) Indoor air quality: clean, healthy, and comfort. The benefits of LEED design are listed in Table 2.7.

Table 2.7 - Benefits of LEED Design
(Source: The USGBC 2018)

Benefit of LEED Design	Percentage
Operating Cost Decrease	8% -9%
Building Value Increase	7.5%
Financial Return on Investment	6.6%
Occupancy Increase	3.5%
Rent Increase	3%

To promote sustainability, local governments often link the LEED certification rating with programs that offer various incentives such as tax reduction, priority for project approval, real estate density bonus, and zoning variance. The finical value of these financial incentives, translated in dollars, worth tens of millions for a large size urban commercial development project.

2.11. Corporate Sustainability Policies

More and more enterprises voluntarily develop and publicize corporate sustainability policies on company websites to provide guidance and standards to promote

sustainability awareness, measure implementation performance, and improve public images. High-sustainability companies disclose annual sustainability reports with measurable data to increase their credibility. Due to differences in business and company culture, companies may have different technical and procedural details, but corporate governance, measurement, and result disclosure are the fundamental attributes to well-developed corporate sustainability policies.

There are two schools of thought about corporate sustainability policies. Some scholars argue that companies can "do well by doing good (Parma et al. 2010)." They believe meeting the needs of non-shareholding stakeholders creates shareholder value. They also assume that by not meeting the needs of non-shareholding stakeholders, companies can destroy shareholder value because of potential customer boycotts and cancel culture or the inability to attract talents. Others believe sustainability is the right thing to do but it is an extra cost that has negative financial implications for the organizations (Balotti and Hanks 1999). Both schools embrace corporate sustainability policies and implementation, but the difference is the financial return on the efforts invested. Large corporations with greater liability and social exposure evaluate and manage corporate sustainability programs differently than smaller companies who are less motivated.

2.12. Information-Based Facility Management

The increasing complexity of facility lifecycle and sustainability management can no longer be handled with old fashioned "pencil-notebook." The interdisciplinary interface and extensive electronic automation control coordination require sophisticated computerized information processing and decision making.

> As the scope and complexity of FM have increased, so too have the supporting information technologies… these technologies have been placed in categories based on core functionality, they now fall on a spectrum of capabilities, the foundation of which are computerized maintenance management systems (Whittacker 2017).

With remote monitoring, drone surveillance, satellite GIS, automatic responding systems, graphic imaging processing, and statistical modeling, information-based facility management method helps facility managers to make well-informed decisions in facility lifecycle planning.

Information-based facility management approaches heavily rely on computer-aided information sharing platforms to integrally manage facility functions and systems. These computer-aided applications are not only useful tools for systematic facility sustainability management, but also represent management concepts or methodologies. BIM is an example, as the International Organization for Standardization (IOS) defined,

> Building Information Modeling (BIM) can be considered as a tool or a method to face information management challenges throughout a building life cycle. It has been defined as the "use of a shared digital representation of a built asset to facilitate the design, construction, and operation processes to form a reliable basis for decisions (The International Organization for Standardization 2019).

2.12.1.1. BIM Application in Sustainable Facility Management

Building Information Modeling (BIM) is "an IT enabled approach that involves applying and maintaining an integral digital representation of all building information for different phases of the project lifecycle in the form of a data repository (Davtalaba and Delgadob 2014). BIM is a platform that shareholders update and share information over

the facility's life and creates added value to the facilities. Beyond 3D graphic model or data storage, BIM becomes the backbone of data-based analysis for lifecycle and sustainability facility management.

BIM enables the management team to build a visible and digital structure containing information to optimize facility performance throughout the project lifecycle stages. In the design stage, BIM facilitates interdisciplinary collaboration, innovative design, and value engineering analysis; in the construction stage, BIM provides visualized coordination, enables offsite prefabrication, generates cost savings, and reduces delays; in the facility operation stage, BIM supplies critical data sharing for maintenance modeling, tracking, and forecasting.

Sustainability and BIM are generating a remarkable synergy and revitalizing the facility industry. BIM provides a potent tool and integrated approach to manage sustainable lifecycle facilities, and the sustainable lifecycle facility management presents a robust market for BIM applications. On digital and visual BIM platforms, facility teams can build energy modeling, day lighting and water usage analyses, waste reduction, reusable material recycling tracking, emission control, remediation audits, cost saving, and forecast reports. In 2010, McGraw-Hill surveyed a group of architect and engineering firms. Table 2.8 are the percentages of firms that use BIM for design.

Table 2.8 - Percentage of AE Firms Use BIM in Sustainability Design
(Source: McGraw-Hill 2010)

Sustainability Item	Percentage
Energy Performance	67%
Lighting Analysis	60%
HVAC Design	52%
LEED Certification	48%

Reusable Material Tracking	42%
Electrical Design	41%
Cost Estimating	40%
Renewable Energy	32%
Carbon Emission Analysis	17%
Landscaping and Water Usage	12%

2.12.2. Challenges of BIM Application in Facility Sustainability Practices

BIM's effectiveness heavily depends on the quality of the initial data collection and rigorous maintenance throughout the facility lifecycle. One patch of poor data could significantly contaminate the database and the compromised BIM may produce misleading information and cause systematic issues. How does one collect BIM data? Who maintains the BIM database? How does one trace down the responsible party for operation failures caused by BIM compromised data and misanalysis? Those are questions that remain to be addressed.

Interoperability is a legitimate challenge in BIM application. Architects and engineers enjoy using their preferred design software, making BIM data consolidation cumbersome. Lack of interoperability is also problematic in BIM transitions between design, construction, and operating phases. The knowledge and technology gaps between designers and facility managers is a considerable hurdle to BIM application. The BIM data entered during the design phase is unnecessary and hard for facility team to comprehend. Charles Matta, GSA National Director of Strategic Programs, stated, "It is difficult to translate a design model into a sustainability energy model with the current BIM software (McGraw-Hill, 2010)." Aaron Philip, director of Technology of SHP Leading Design in Cincinnati, admits that due to the overwhelming details and complexity,

> Unfortunately, with most BIM energy modeling, you are going to have to cheat the system sometimes because the types of that we spec, install and measure are becoming more and more complex … we do fudge the system to mimic the results (McGraw-Hill, 2010).

SHP Leading Design is not the only one who fakes the BIM data entry, but they do not often get caught. The accumulation of "faking" defeats the purpose of using BIM.

Building and maintaining BIM platform is costly, so some firms tend to cut corners on BIM quality for cost savings. Some firms view BIM as distraction to their facility teams from their core duties. A majority of frontline facility teams are not trained to use those software. There are no industry guidelines, legal enforcement, or standard liability insurance policies to safeguard BIM practices. Government and industry associations need to work together and establish a framework to promote and unleash the potentials of the powerful BIM method.

3. Propositions and Research Methodologies

This research examines six propositions on the adoption of innovative management methods, preconditions for successful adoption, risk control in project execution, sustainable growth, and challenges and possible solutions in sustainable facility management practices. Case studies, surveys, interviews, *Grounded Theory Pre-Post* comparison, and qualitative comparative analysis (*QCA*) are the six approaches used to examine these propositions.

3.1. Propositions on Cross-Industry Learning and New Practice Adoption

Proposition #1: Cross-industry learning and adoption can effectively meet the increasing demands for innovative modern facility management methods.

Proposition #2: Assuring positive contributions from key factors is a precondition for successful new practice adoption.

Proposition #3: Pragmatic management of key risk variables is prerequisite for successful applications of adopted practices in facility project execution.

3.2. Proposition on Challenges in Sustainable Facility Management Practices

Proposition #4: Government involvement is the backbone of achieving sustainability.

Proposition #5: Corporate sustainability policies and practices play critical roles in converting government efforts into results.

Proposition #6: Public-private collaboration and learning from other countries are needed to overcome current challenges encountered in sustainable facility practices.

3.3. Qualitative (Inductive) Research Methodologies

Qualitative research collects and interprets data through conversations, interviews, survey questionnaires, and case studies. In this way is differs from quantitative research which uses mathematical modeling or statistical inference from data analysis. Quantitative research (usually although not always) focuses on testing hypotheses using Popper's hypothetico-deductive model of falsification. In contrast, qualitative research emphasizes inductive reasoning to understand complex phenomena and develop best explanations by studying words, concepts, experiences, and observations (Cresswell and Cresswell 2018). Research and inference based on experience and observation are most suitably treated inductively, while arguments based on laws, rules, or other accepted principles are most suitably studied deductively. A similar distinction between falsification and inductive reasoning exists in the statistical literature between null-hypothesis testing and Bayesian induction (Earman 1992).

Inductive research begins with detailed observations and case studies. These evolve into abstract generalizations and concepts. Preliminary relationships are identified as the research progresses. Generalizations are typically not identified at the preliminary stages of the research but only as the research is completed. As a result, the qualitative-inductive approach is sometimes referred to as a "bottom-up' method in which the research uses cases and observations leading to abstractions to describe the phenomena being investigated along the lines of Figure 3.1.

Figure 3.1 - Qualitative, Inductive Reasoning Approach

There is a broad literature on the topic of qualitative-inductive research. The better-known approaches include *Grounded Theory* (Strauss and Corbin 1990), phenomenology (Van Manen 1990), discourse analysis (Potter and Wetherall 1994), and narrative analysis (Leiblich 1998), but there are many other similar methods. An overview is provided by Thomas (2006), who describes the approach as consisting of three steps:

1. Condense extensive and varied raw text data into a brief, summary format.
2. Establish clear links between the research objectives and the summary findings derived from the raw data and to ensure these links are both transparent and defensible.
3. Develop of model or theory about the underlying structure of experiences or processes which are evident in the text (raw data).

Like any research method, qualitative analysis has its strengths and weaknesses. Miller (2019) points out key strengths and weaknesses of qualitative research: "It turns individual experience into useful data. It provides content that is useful for practical application. It uses smaller sample size than other research methods. It does not offer statistical representation. It can be subjective to research influence. It does not offer data rigidity. It is challenging to replicate results using this method."

In the notes for the ENCE688Y class at UMD, *Qualitative Research Methods*, Cui (2021) highlights major qualitative data collection and research methods, "Qualitative

methods also use data, tables, and examples. Data collection is through observation or interviews. Data descriptions are collected from informants (by others). The major methods include "Grounded Theory, Case Study, and Qualitative Comparative Analysis."

Using a combination of qualitative and quantitative analysis methodologies can improve research by ensuring that the limitations of one type of data are balanced by the strengths of the other. As Miller stated, "Both the quantitative and qualitative analyses are legitimate approaches in their ways, you can use a mix methods approach. This method allows you to carry out both approaches" (2019). Mixed uses of quantitative and qualitative methodologies are applied to the case studies in Chapter 4.

3.3.1. Pre-Post Comparation of Cases Studies and Sample Selection

Case study method is commonly employed to generate an in-depth understanding of a complex issue in its real-life context. It helps researchers develop new practice-oriented guidance or enhance exiting knowledge body. As Yin defined in his book, *Case Study Research Design and Method* (1984),

> A case study is an empirical enquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used.

Two commonly used case study types are longitudinal and cross-sectional. As Cui (2021) highlighted, "Longitudinal case study: the same case(s) over time, sometimes decades. Cross-sectional case study: a group of cases at the same time that who vary on some characteristic."

The *Pre-Post* comparation is a straightforward research method particularly fitting for analyzing longitudinal case studies that have records of repeated measurements over long time spans. In a typical Pre-Post analysis, researchers repeat relatively consistent measurements, apply basic mathematical means to quantify outcomes, look for patterns of commonalities and dissimilarities to develop case-based reasoning, and formulate new or examine existing propositions.

Pre-Post comparison is used to analyze two longitudinal case studies in Chapter 4 to develop and examine Proposition #1. The first case study is a single retail corporation with facility portfolio maintenance cost records over 14 years, and the other is a facility service company with 14 years of quarterly project performance reviews and audited financial statements.

In qualitative research there are two principal approaches to sampling case studies, the *purposeful* and *by convenience*. Most qualitative researchers use one of these two sampling techniques. While randomize statistical sampling is in principle possible it is rarely used in qualitative studies because of the difficulty of finding and documenting case histories. The purposeful approach (sometimes called *purposive* in the statistical literature) seeks out cases which are thought to explain a phenomenon. The by convenience approach seeks out cases which are readily accessible. The present study uses this latter approach based on case histories available in the records of the Buch Company.

3.3.2. Grounded Theory

Grounded Theory was developed by Barney Glaser and Anselm Strauss (Glaser and Strauss 1967; Strauss 1987; Strauss and Corbin 1990) to provide a systematic methodology for qualitative research. It is mostly used in the social sciences and management

literatures. Its approach is to construct theories inductively through the collection of qualitative data such as case histories and interviews, to seek patterns in that qualitative data, and from those patterns to discover theories inductively. Theories are said to "emerge" from the data. A key component of the *Grounded Theory* approach is to succinctly summarize properties of the case studies or surveys as ideas or concepts. This is called "coding."

As more data are collected, these codes are grouped into concepts and the concepts grouped into categories. The categories are used to identify new theories. This was a sharp departure from the hypothetico-deductive or falsification approach when it was first introduced. The argument was that the latter approach was inappropriate to the needs of qualitative and case study research. The purpose of *Grounded Theory* is to generate hypotheses. Those hypotheses may later be tested in other research efforts and either accepted or rejected.

Grounded Theory is an efficient research methodology that can practically explicate relations between actions and outcomes and develop suitable explanations that fit complex real-world situations. Charmaz and Bryant said, "*Grounded Theory* can make research content more analytic and focused on the empirical environment (2010)."

3.3.3. Qualitative Comparative Analysis (QCA) Methodology

Developed in 1987 by Charles Ragin, *Qualitative Comparative Analysis (QCA)* is one of the most commonly used quantitative-qualitative methodologies applied to case study research. Drawing strengths from both quantitative and qualitative analyses, *QCA* is a research tool for analyzing empirical data collected from complex business operation and project management. Though *QCA* does not provide the statistical rigor to guarantee

the theoretical-scientific causal ground, it delivers important empirical-scientific generalizations and adds an important dimension to qualitative analysis.

As Ragin and Rihoux stated in their book *Configurational Comparative Methods: Qualitative Comparative Analysis (QCA) and Related Techniques*, "The goal of qualitative and comparative research is not limited to description, as exhaustive as possible, of some corpus of observations, but for explicit connections (2009)." *QCA* is useful when the sample size is too small to apply statistical techniques like linear regression or too large for qualitative case-study methods like *Grounded Theory*. It is usually employed for analyzing an intermediate number of cases between 10-50.

When conventional hypothesis-testing methodologies are not sufficient to explain complex phenomena in business administration or project management, *QCA* offers a pragmatic alternative. As Ragin stated in his book *Moving Beyond Qualitative and Quantitative Strategies*,

> My interest in developing and formalizing techniques of qualitative and holistic comparison originated in the frustrations I experienced. I was trained to use multivariate statistical techniques whenever possible and often found that these techniques were not well suited for answering some of the questions that interested me.

A typical *QCA* analysis consist of the six steps:

1) Determine the research topic

2) Select cases

3) Group data, code categories, and prepare condition sets

4) Match cases, conditions, and outcomes, and develop the *Truth Table*

5) Generate a summary review table, and

6) Analyze and interpreter the findings.

Due to its small-to-intermediate typical sample size, *QCA* is unable to exhaustively examine all possible combinations of conditions that can achieve the same outcomes. The conditions selection and data collection depend on case complexity, research objectives, and researcher's experience and judgement. As Schneider and Wagemann said in their book *Standards of Good Practice in Qualitative Comparative Analysis (QCA) and Fuzzy-Sets* (2010),

> *QCA* takes this aspect of causal complexity into account by performing separate analyses for necessary and sufficient conditions in which conjunctural causal conditions are explicitly permitted and examined, and which allows for equifinal causal structures.

It should be reasonably acceptable that the outcomes of *QCA* research are likely to be equifinal and conjunctural. Equifinal implies that possibly there are other condition combination to achieve the same outcome, and conjunctural means that the outcome can only be achieved through a combination of conditions.

3.3.4. The Schneider and Wagemann Truth Table

Truth Table method was introduced by Schneider and Wagemann in their book *Set-Theoretic Methods for the Social Sciences: A Guide to Qualitative Comparative Analysis.* It is an adjunct to *QCA* but also may be used by itself. It provides an effective method for discovering situational conditions for outcomes in case studies. The concept of *Truth Table* originates in formal logic and uses conventional data matrices in the

analyzing processes. Each column in a *Truth Table* de-notes a different conditional variable set, while each row representing an individual case, see Table 3.1.

Table 3.1 - Sample of the Schneider and Wagemann Truth Table
(Source: Schneider and Wagemann 1972)

Row	Conditions			Outcome
	A	B	C	Y
1	0	0	1	1
2	0	1	0	0
3	0	1	1	0
4	1	0	1	1
5	1	1	0	1
6	1	1	1	
7	0	0	0	
8	1	0	0	

Boolean Algebra symbols may be used in *Truth Tables* to represent causal claims among the contributing conditions and outcomes: "1" indicates that a condition presents in a particular case; "0", the particular condition is absent; and "*blank*", the condition is irrelevant. *Truth Table* provides an important dimension and enhances analytical rigor to *Grounded Theory* research.

Schneider and Wagemann recommended using summary tables and X-Y plots to present analysis results, see Table 3.2. The summary tables are used in simple *Truth Table* analyses on small sample size case studies where the condition-outcome casual logics are relatively straightforward.

Table 3.2 - Example of Summary Table for Truth Table Analysis
(Source: Schneider and Wagemann 1972)

	Outcome	
	Presence	Absence
Condition (s) Have a Case	Have a Case	No Case
Condition (s) Absence	No Case	Have a Case

X-Y plots provide visual presentations in analyses on large sample sizes with complex condition-outcome casual logics, see Figure 3.2.

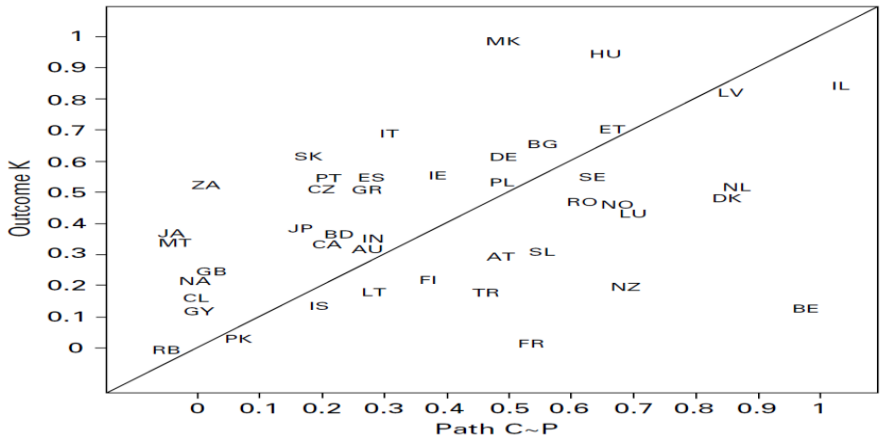

Figure 3.2 - Example of X-Y Plot for Truth Table Analysis
(Source: Schneider and Wagemann 1972)

3.4. Research Methodology for Proposition #1

Use two organizations as primary examples to discuss how they adopted innovative management practices to improve their facility management and service operation. Based on historical data and audited financial records collected from each case study, develop two series of *Pre-Post* chronical comparisons to analyze the effectiveness of new practice adoptions and examine Proposition #1. Apply modified *Grounded Theory* to analyzing the results.

The *Pre-Post* comparison is a basic qualitative comparative analysis approach commonly used in longitudinal case studies that have long timespans over years or decades. In Case Study 4.1, a series of comparisons is developed based on the May Company's facility unit cost historical database between 1992 and 2005 to analyze the impacts of new practices on corporate portfolio performances. In Case Study 4.2, a series of comparisons is developed based on the Buch Company's audited financial records between

2006 and 2019 to analyze the impacts of new practices to the company marketing and business performances.

3.5. Research Methodology for Proposition #2

Use a cross-sectional case study consisting of thirteen subcontracting companies, with similar background and business characteristics, to discuss the impacts of key contributing factors to the outcomes of new practice adoptions. Apply *QCA* method to analyze the empirical data and information collected form the case study, investigate the connections among the key contributing factors and adoption outcome, and examine Proposition #2.

QCA uses abductive reasoning in gathering, analyzing, and conceptualizing empirical qualitative data for the purpose of systematic guideline or theory construction. In preparation for the *QCA* analysis, this research collects and conceptualizes and categorizes the data and information collected from the discussions in Case Study 4.3. These concepts are further studied and grouped in subcategories of contributing factors and outcomes of adoptions. The *Truth Table* method is used to analyze and uncover the connections among the subcategories and examine Proposition #2.

3.6. Research Methodology for Proposition #3

Use of Agile method as a primary example to demonstrate pragmatic risk control in applying new practices in project management. Utilize seventeen case studies consisting of twenty-three Agile projects to discuss the impacts of key risk variables to project outcomes of new practice executions.

Use *QCA* and *Truth Tables* to analyze empirical data and information collected form the case studies, conceptualize the contexts, code the information into categories and subcategories, identify key risk variables and project outcomes, investigate the connections among the key risk variables and adoption outcome, and examine Proposition #3.

3.7. Research Methodology for Proposition #4, #5, and #6

Case studies, survey questions, interviews and research are used to discuss and analyze government involvements, corporate sustainability policies, industry standards, and current challenges encountered in sustainability movement. sustainable facility management. Solicit opinions from industry practitioners, demonstrate the concepts with cases, interview overseas executives and government officials, and conduct research to examine Propositions #4, #5, and #6.

4. Cross-Industry Learning and Innovative Management Practice Adoption

This chapter uses case studies, qualitative content analysis, *Pre-Post* compassion, and *Grounded Theory* to investigate the impact of innovative management method adoption to the facility management operation and discuss prerequisite circumstances and factors that necessitate successful implementation in practices.

4.1. Data and Methodology

Thirteen sample subcontracting companies and twenty-three Agile projects are presented in case studies. The empirical data collected from these samples are used in *Pre-Post* and *QCA* qualitative comparative analyses to develop and examine three propositions of Section 3.1.

4.1.1. Case Studies

The May Company, Buch Construction, and Coastal Corporation are the primary sources of the case studies.

The May Department Stores Company (The May Company)

The parent company of Lord & Taylor, Filene's, Kaufmann's, Hecht's, Strawbridge's, Robinsons-May, Meier & Frank, Foley's, Famous-Barr, David Bridal, After Hours, and Marshall Field's. Prior to the merger with the Federated Department Stores in 2015, the company operated 514 department stores and 710 formalwear shops nationwide.

The Buch Construction Company (The Buch Company)

One of the ENR Top 400 General Contractors. The company provides facility management and construction service to corporate office buildings, retail centers, real estate, and pharmaceutical research and production complexes.

The Coastal Corporation

An S&P 500 company. Prior to the merger with the El Paso Corporation in 2001, the company operated petroleum refineries, natural gas pipelines, and powerplants in the United States and overseas, with approximately 13,300 employees and an annual revenue above $8 billion.

Case Studies Used In Examining Proposition #1:

Case Study 4.1 - The May Company's P3M/PMO Practice Adoption

Case Study 4.2 - The Buch Company's APP/OPM3 Adoption

Case Studies Used In Examining Proposition #2:

Case Study 4.3 - Core Subcontractors' APP/OMP3 Adoptions

Case Studies Used In Examining Proposition #2:

Case Study 4.4 - The Buch Company CMiC Software Development Project

Case Studies Used In Examining Proposition #3:

Case Study 4.5 - The Coastal Corporation Powerplant Projects in China

Case Study 4.6 - Coastal Aruba Refinery Refurbishment Project

Case Study 4.7 - Macy's Herald Square & Bloomingdale Flagship Projects

Case Study 4.8 - Royal Garden and International Language Institute Projects

Case Study 4.9 - The Washington DC Union Station Amtrak Project

Case Study 4.10 - Two Unsuccessful Agile Projects of Places of Worship

Case Study 4.11 - IDIQ Contract and BMSA Agreement Projects

Case Study 4.12 - May D&C Project Management Software Development

Case Study 4.13 - Target Reverse-Bidding Experiment

Case Study 4.14 - Foley's Aurora Distribution Center Project

Case Study 4.15 - Under Armour and Lincoln Property Projects

Case Study 4.16 - The Sprinkle System Erosion Management Program

Case Study 4.17 - The May Company ADA Barrier Removal Program

4.1.2. Mixed Use of Ground Theory, Pre-Post Analysis & Case Study Methodologies

Since case studies are generally observational and qualitative, applying mixed uses of *Grounded Theory* and *Pre-Post* methodologies adds a quantitative dimensions to the case study analyses. *Pre-Post* analysis measures a series of repeated activities over long time spans, generates chronological comparisons, and develops new or examines existing propositions. The *Pre-Post* comparison analysis is effective particularly for longitudinal case studies, like Case Study 4.1 and Case Study 4.2.

Case Study 4.1 demonstrates how the May Company adopted the PM3/PMO management practices to reduce corporate facility portfolio operation costs. *Pre-Post* analysis was applied to analyze 14 years of portfolio maintenance cost records. Based on the costs and total square feet of the portfolio, the costs of basic facility maintenance per square foot (BFM/SF) were calculated. Based on the annual BFM/SF records, a series of year-to-year consecutive *Pre-Post* comparations were developed and summarized in tables and graphics for identifying patterns, developing best interpretations, and examining Proposition #1.

Case Study 4.2 demonstrates how the Buch Company integrated the *APP*/*OPM3* practices to improve project planning and marketing strategies. *Pre-Post* analysis was applied to analyze 14 years of quarterly project review records and audited financial statements and develop a series of year-to-year consecutive *Pre-Post* comparations. The comparisons were summarized in tables and graphics for further analysis, discovering patterns, and developing best interpretations. Case Study 4.2 combined with *Pre-Post* analysis provided another research to examine and support Proposition #1.

4.1.3. Mixed Use of QCA and Case Study Methodologies

As discussed in Section 3.3.3, *QCA* is a set-based analysis approach. It studies causal connections between data sets of conditions and outcomes to develop relatively modest generalizations that are useful to explain complex business or project management phenomena. The *QCA* approach was augmented with *Truth Tables* to summarize relationship patterns.

In the *APP/OPM3* integration process, the Buch Company strongly encouraged its core subcontractors to adopt similar concepts to help align their operation standards and marketing efforts. 13 core subcontractors with compatible backgrounds were selected in Case Study 4.3 to investigate their responses and adoption outcomes. Six key contributing factors 1) willingness, 2) knowledge, 3) company culture, 4) financial strength, 5) technical readiness, and 6) persistence in implementation were elaborated in each of the 13 sample subcontracting companies. The empirical data collected from the discussions were conceptualized, condensed into summary tables, coded accordingly into six condition and two outcome data sets (successful and failed adoption). A *Truth Table* was used

to uncover casual connections between the condition sets and outcome sets, develop best interpretations, and examine Proposition #2.

Between Case Study 4.5 and Case Study 4.17, a total of 23 Agile projects were selected to investigate risk control in new management practice execution. Six key risk variables: 1) project type, 2) risk control plan, 3) trust level, 4) competence, 5) communication, and 6) risk tolerance were discussed in detail in each of the 23 sample projects. The empirical data collected from the discussions was conceptualized, condensed into summary tables, coded accordingly into six condition and two outcome data sets (successful and failed execution) for further *QCA* analysis. A *Truth Table* was used to identify relationships and patterns between the condition sets and outcome sets, develop best explanations, and examine Proposition #3.

4.2. Grounded Theory, Pre-Post, and Longitudinal Case Studies for Proposition #1

Pre-Post comparison method is employed to analyze two longitudinal case studies of *Pre-Post* comparisons are used in this section to examine Proposition #1: "*Cross-industry learning and adoption can effectively meet the increasing demands for innovative modern facility management methods*."

Case Study 4.1 discusses how the May Company adopted the *P3M/PMO* practices and the impact on corporate facility portfolio operation cost management. Case Study 4.2 discusses how the Buch Company adopted the of *APP*/*OPM3* practices and impacts on its project planning and company marketing development.

4.2.1. Case Study 4.1 - The May Company's P3M/PMO Practice Adoption

The May Company made a series of strategic acquisitions between 1985 and 2005, and the number of corporate facilities increased from 176 to 1,240. In the summer of 2005, the company's facility portfolio consisted of 461 department stores, 13 distribution centers, and 3 service call centers, totaling 97 million square feet as shown in Appendix AB which did not include the recently acquired 53 Marshall Field's stores from the Target Corporation and 710 bridal shops from After Hours Formalwear, due to the unfinished facility management transitions from the previous owners to the May Company.

In the early stage of the expansion, the May Company converted the acquired retail chains into a standalone regional divisions and inherited the previous owners' operation teams to manage acquired facilities with existing procedures and system. The compartmentalized management structure worked to the advantage of the May Company and allowed it to focus on rapid growth. There was no urgent need for alternate methods. As the corporate facility portfolio kept growing, the company realized that the flat management approach became inadequate and started seeking innovative methods to meet the emerging challenges. With extensive research and consideration, the May Company decided to adopt and progressively integrate *P3M* practice into its facility operation management.

The *P3M* method is widely used in soft engineering development, government contracting, and general industry project management. *P3M* provides a hierarchy infrastructure with multiple portfolio, program, and project levels to help organizations streamline the governance matrix, build effective communication channels, optimize resource allocation, and provide managerial and technical supports. The May Company

believed that the *P3M* management philosophy and layered concepts would fit its company culture and organizational structure.

Following the implementation steps suggested by the consultants, all facility activities were gradually arranged into the three levels of the *P3M* matrix.

1) Portfolio: On the corporate level, the *P3M* matrix provided guidance and governance to all facility activities by defining corporate policies and operation standards, coordinating internal collaboration, and optimizing company resources allocation. Figure 4.1 shows the number of facilities in the May Company's portfolio on the corporate level between 1992 and 2005.

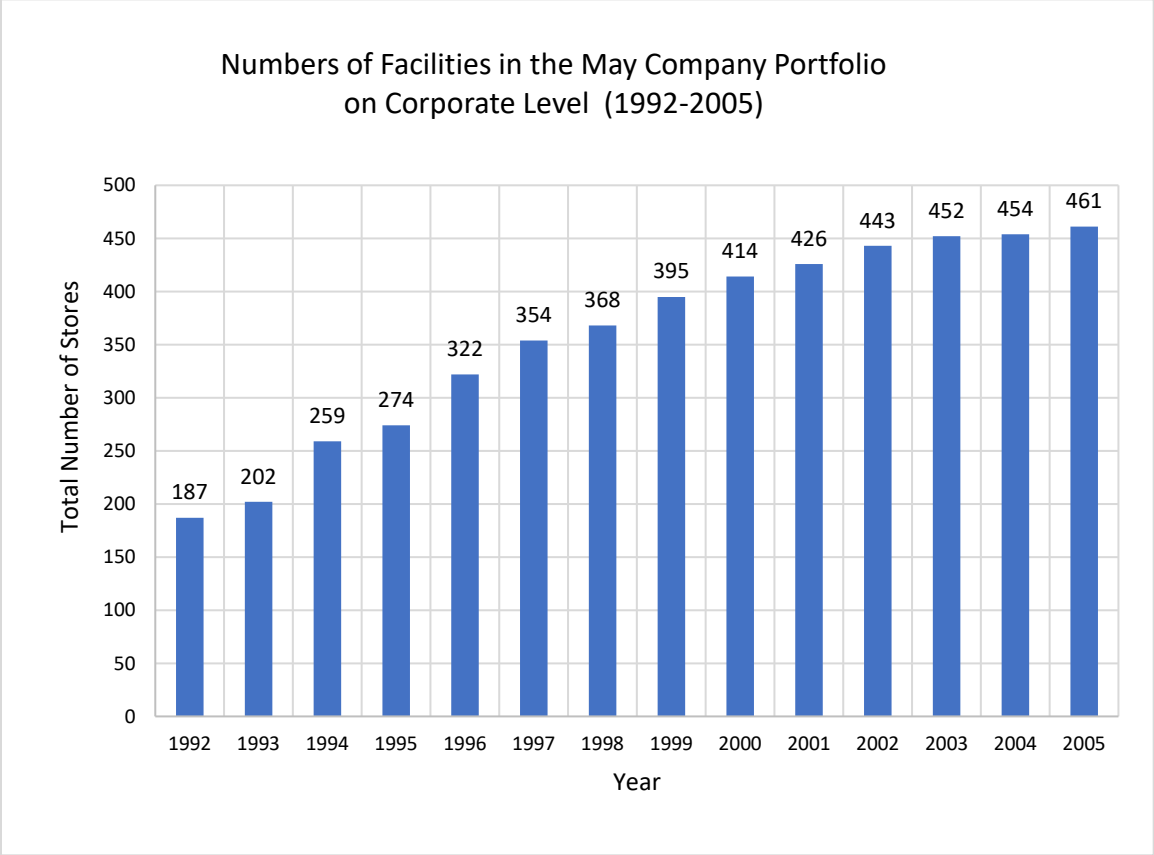

Figure 4.1 - Numbers of Facilities in Portfolio on Corporate Level (1992-2005)

2) Program: On the branch level, these programs functioned as "smaller portfolios" to support individual projects in the geographic areas where the branches operate. Some programs remained on the corporate level to manage activities that have great significance to the corporate business or require unique technical expertise. Table 4.1 shows the number of facilities were in the programs on the branch level between 1992 and 2005.

Table 4.1 - Number of Facilities in the Programs on the Branch Level (1992-2005)

Year	Robin-son's May	Meier Frank	Lord & Taylor	Kauf-mann	Hecht's	Fo-ley's	File-nes	Famous Barr	Total
1992	0	8	51	28	30	32	22	16	187
1993	0	8	56	30	31	35	23	19	202
1994	43	8	59	32	36	37	26	18	259
1995	46	8	61	33	38	39	30	19	274
1996	47	8	65	49	55	42	33	23	322
1997	51	9	70	50	63	47	37	27	354
1998	51	9	73	50	67	51	40	27	368
1999	54	9	75	52	71	53	43	38	395
2000	57	15	77	54	73	53	45	40	414
2001	57	16	80	55	73	57	46	42	426
2002	58	16	85	56	76	63	46	43	443
2003	58	16	87	57	77	66	47	44	452
2004	58	16	87	57	77	68	47	44	454
2005	59	17	88	57	80	69	47	44	461

3) Project: Individual facility activities were carried out by assigned task teams. Majority of the facility projects were managed under the division programs.

A *PMO* is an internal or external group that defines and maintains operation procedures and standards, oversees project implementation, enforces corporate policy compliance, provides administrative and technical supports. The *PMO* was used first by the

US Army in complex weaponry system development, and eventually adopted by other government agencies and large corporations.

As the *P3M* management approach being progressively integrated into daily facility operation, the May Company decided to adopt the *PMO* method to augment the effectiveness of the new *P3M* practice. In a mirror image to the lately adopted *P3M* facility management infrastructure, the May Company developed a customized *PMO* structure to fit its organizational characteristics and company culture. The *PMO*s were established within corporate headquarters, regional branches, and local groups to administrate facility management activities.

1) *PMO* on the corporate level: The Corporate Projects Group (CPG) was the May Company's *PMO* that oversaw all facility operation related matters such as corporate facility management policies, budget reviews and audits, and managerial and technical supports. CPG was also directly involved in special programs or projects. Table 4.2 provides an example of the activities and budgets that the CPG managed in a typical year.

Table 4.2 - Annual Budget 2004 Managed by the Corporate Projects Group (CPG)

Type of Project in 2004	Quantity	Avg. Budget Per Project	Subtotal
Merger/Acquisition Due Diligence	25	$ 100,000	$2,500,000
Real Estate - Phase I and II Environmental Studies	40	$7,500	$300,000
Prototype Stores	3	$10,000,000	$30,000,000
Distribution/Service Center Facility Management	16	$65,000	$1,040,000
Parking Structure Restoration Program	3	$1,100,000	$3,300,000
Chiller Management Program	6	$500,000	$3,000,000
Decommission of Closed Stores	6	$1,000,000	$6,000,000
Roof Maintenance and Replacement Program	3	$500,000	$1,500,000
Fire Sprinkler Monitoring/Replacement Program	10	$200,000	$2,000,000

Asbestos Abatement and Clear Air Program	24	$250,000	$6,000,000
ADA Defense and Barrier Removal Program	100	$80,000	$8,000,000
Underground Contaminant Remediation Projects	8	$500,000	$4,000,000
Disaster Response Funded separately from Corporate Special Reserve			NA
Total annual budget managed by the Corporate Projects Group =			$67,640,000

2) *PMO*s on the corporate level: Nine *PMO*s were established within the branches and played a key role in implementing corporate facility management policies, administrating facility programs, and providing supervision and support to project teams in their geographic areas. See Table 4.3 for budgets that the nine branch *PMO*s managed between 1992 and 2005.

Table 4.3 - Baseline Facility Maintenance Annual Budget by Branch PMOs

	Robin-son's May	Meier Frank	Lord & Taylor	Kauf-mann	Hecht's	Foley's	Filenes	Famous Barr
1992	$0	$3,924,926	$14,857,371	$8,979,303	$10,775,559	$13,972,644	$7,739,448	$6,372,690
1993	$0	$3,917,185	$15,859,497	$9,555,919	$11,003,662	$14,769,743	$7,993,132	$7,307,838
1994	$17,485,669	$3,916,411	$16,469,676	$10,163,053	$12,268,504	$15,359,334	$8,919,090	$6,877,148
1995	$18,362,106	$3,908,669	$16,781,503	$10,366,898	$12,706,338	$16,009,256	$9,913,279	$7,101,059
1996	$18,575,370	$3,902,863	$17,525,222	$16,865,842	$18,225,611	$16,864,632	$10,691,319	$8,382,990
1997	$19,731,315	$4,075,292	$18,629,100	$17,143,790	$21,578,032	$18,287,547	$11,910,605	$9,718,463
1998	$19,713,177	$4,071,233	$19,210,775	$17,143,459	$22,761,784	$19,578,801	$13,115,918	$9,721,975
1999	$20,407,024	$4,059,056	$19,551,058	$17,656,688	$23,820,704	$20,037,168	$13,870,752	$13,520,656
2000	$21,204,970	$5,800,593	$19,947,467	$18,020,065	$24,162,179	$20,023,142	$14,430,244	$13,944,488
2001	$21,177,384	$6,051,728	$20,496,365	$18,218,578	$24,130,746	$21,218,646	$14,643,007	$14,432,533
2002	$21,476,472	$6,050,516	$21,494,767	$18,465,175	$25,073,820	$23,140,547	$14,640,073	$14,833,071
2003	$21,437,729	$6,039,601	$21,859,013	$18,668,514	$25,286,751	$23,873,291	$14,814,456	$15,068,779
2004	$21,416,205	$6,033,537	$21,837,066	$18,649,771	$25,261,362	$24,355,101	$14,799,582	$15,053,650
2005	$21,605,934	$6,230,996	$22,013,695	$18,640,399	$25,878,784	$24,643,599	$14,792,145	$15,046,085

3) *PMO* on the corporate level: The project *PMO*s were only in major metropolitan areas to support clusters of local individual projects within the vicinities.

The adoptions of *PM3* and *PMO* practices helped the May Company in establishing accountability, improving decision making processes, facilitating transparent communication, preventing counterproductive politics, enhancing internal cooperation, and developing knowledge depositories and training. Figure 4.2 provides an illustration of the May Company's *P3M/PMO* management structure.

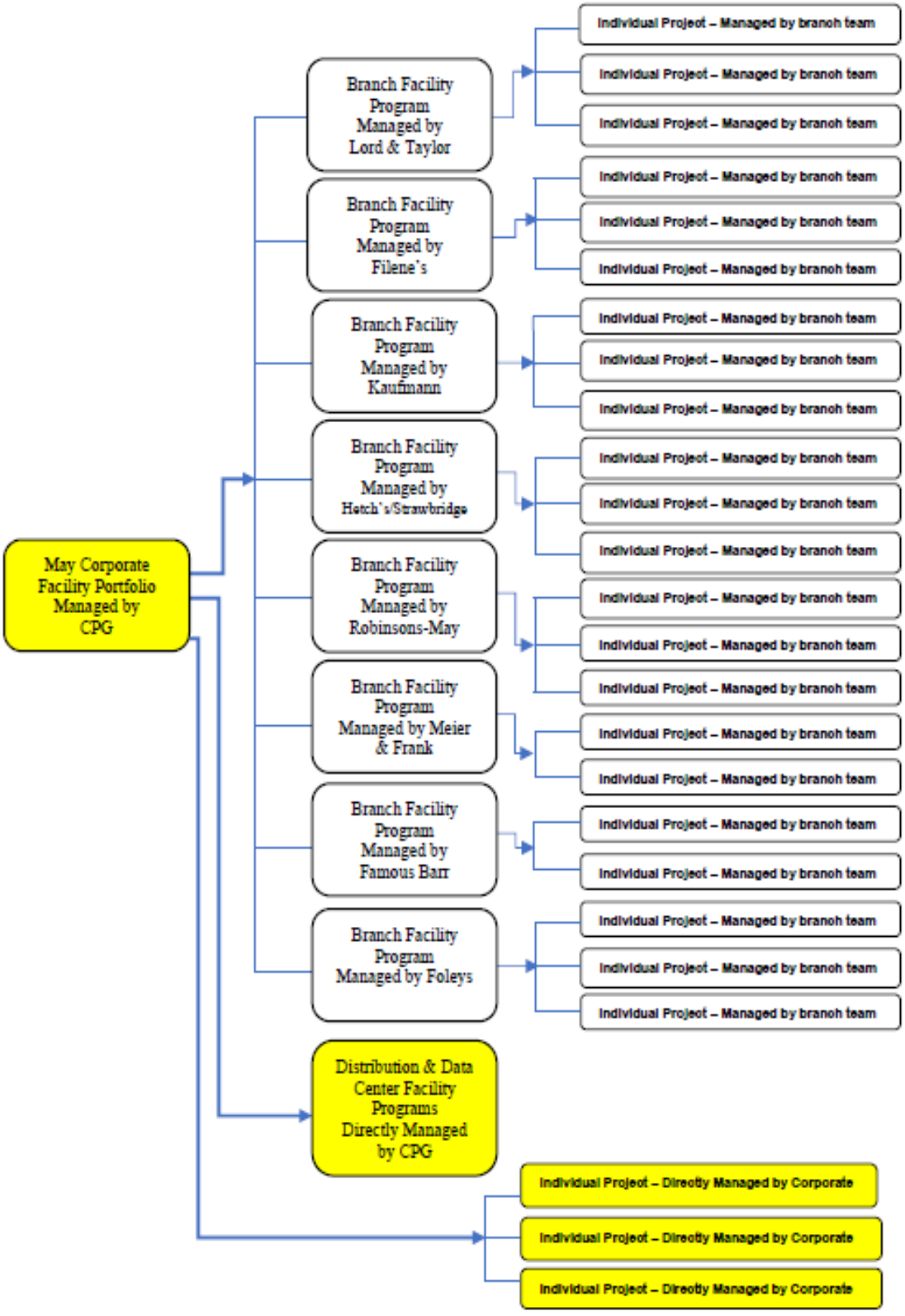

Figure 4.2 - The May Company P3M/PMO Structure

Because *P3M* and *PMO* share similar management fundamentals, the combined application of *P3M/PMO* practices generated a synergy in the May Company's facility operation. It not only provided a matrix infrastructure, but also changed the philosophy of corporate facility management. The hybrid *P3M/PMO* application helped the company align facility operation with corporate business objectives, develop benchmark-based facility budgets, remove redundancies, share resource and knowledge, apply data-based statistical facility planning, and realize the benefits of size of economy. The overall performance improvement of facility operation reflected in the May Company's facility portfolio annual cost reduction from 1992 to 2005.

Based on historical data, cost trend in previous year, and projections, the CPG team developed annual baseline facility maintenance (BFM) budgets for companywide facility operations. Figure 4.3 provides the May Company's BFM budgets between 1992 and 2005. The BFM budgets did not include emergency responses, disaster restorations, or major facility upgrades. Those events were funded by separate contingency reserves. In the end of each year, the CPG team audited the actual BFM cost against the annual budget.

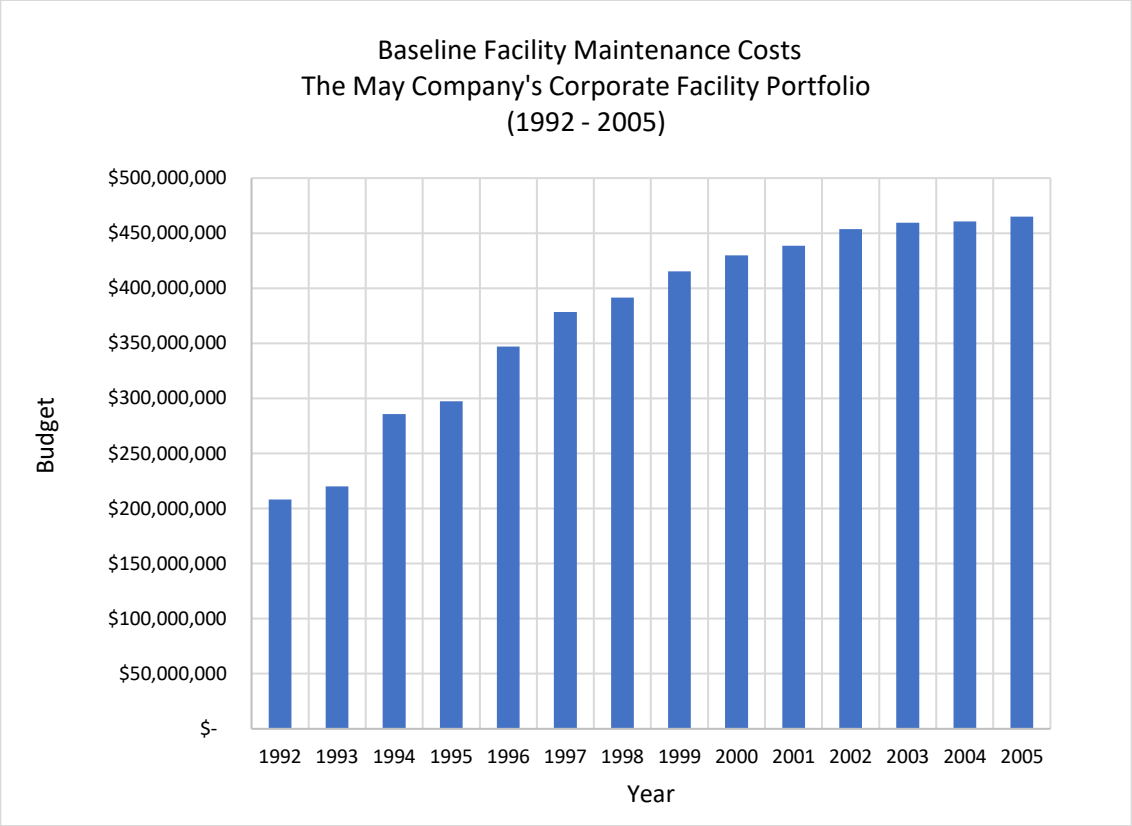

Figure 4.3 - The May Company's Corporate Facility Portfolio Annual Costs

Facility Baseline Maintenance Cost Per Square Foot (BFM/SF) was one of the key performance indexes that the May Company used to evaluate the corporate facility portfolio performance.

$$BFM/SF = \frac{Total\ BFM\ Costs}{Current\ Total\ SF\ of\ the\ Corporate\ Facility\ Portfolio}$$

The May Company's annual BFM/SF records are shown in Figure 4.4.

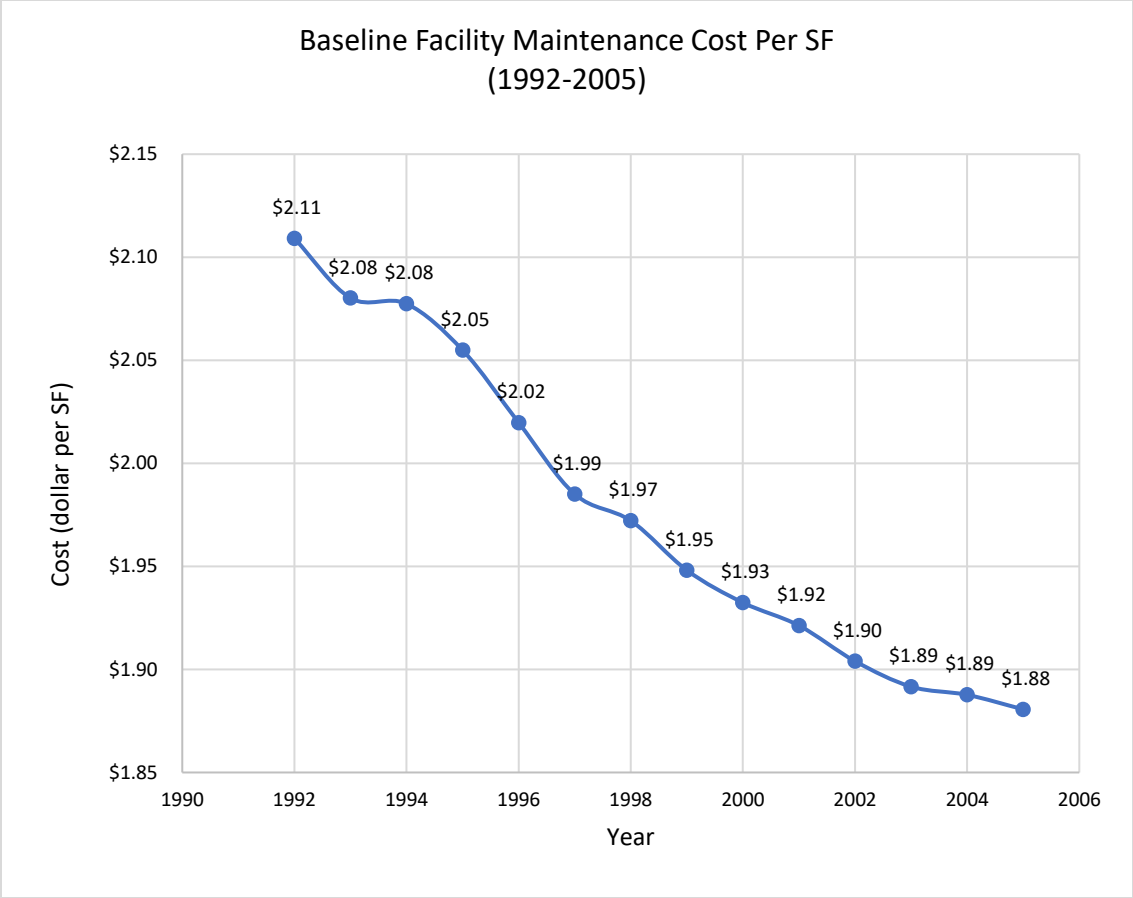

Figure 4.4 - Baseline Facility Maintenance Cost Per SF (1992-2005)

4.2.2. Case Study 4.2 - The Buch Company's APP/OPM3 Adoption

The Buch Company was founded in the owner's basement in 1984 and heavily relied on a single client during the first ten years. When the company was small, it took any projects that would help to sustain the business and did not invest in systematic project planning or long-term business strategic development. The company steadily grew its presence in the facility services and construction markets, it developed a stable and diversified clientele. In year 2005, the annual revenue recorded above $35 million, first time in the company history. As the workload and customer demands increasing, the company realized the need for a more effective method to systematically prioritize projects,

optimize resource usage, and prepare for future growth. Kogan Associates, a management consulting was hired in 2006 to help the company to develop a solution to the challenge. After a thorough review of the company's financial audits and project historical records and discussions with every project manager and executive, Kogan recommended, and the Buch Company agreed to adopt the *APP* method for project screening and prioritization.

APP was originally developed by the manufacturing industry to systematically manage the product development. Based on criteria of importance, urgency, resource optimization, client demands, and short-term or long-term business goals, organizations categorize projects in four *APP* groups: 1) Advance and Mission Critical, 2) Breakthrough, 3) Platform, and 4) Derivative. Following the *APP* criteria, Kogan consultants coached the Buch teams and built the very first *APP* framework for the company, going through the steps below.

1) All project managers were required to rate their projects completed in the past five years. The rating was on eleven project aspects: risk control level, company survival criticality, potential market breakthrough, impact to company long, middle, and short-term goals, existing client retention, fitness to company strengths, company core competence development, and technical and financial readiness.
2) Senior executives were asked to assign weight factors to each of the eleven aspects, 0.0 being the least and 1.0 the most important to company business operation. See the title rows in Table 4.4.
3) Kogan consultants calculated the score for each project.

$$Project\ Score\ = \sum(Manager\ Rating\ x\ Executive\ Weighing\ Factor)$$

Based on the scores, the projects were sorted in the four *APP* categories.

In the following years, the Buch Company progressively incorporated the *APP* practice into its project screen and selection. The original *APP* format had been improvised to fit the company characteristics and growth. Since 2006, the *APP* reevaluation became a routine session in the company's annual senior management business retreats. In the *APP* sessions, the executive group reviewed the effectiveness of previous year *APP* plan and adjusted categories to reflect situation changes and marketing visions. The *APP* adoption helped the company to establish a structured and scheduled procedure to have a realistic organizational self-awareness, shape a collective and focused business vision, and align project planning with the company present and future goals.

Table 4.4 provides an example of *APP* reevaluation score board that the Buch Company developed in the 2014 annual senior management retreat session. The scores represent the most favorability with 0 being the least and 10 being the best.

Table 4.4 - The Buch Company *APP* Evaluation Score Board 2014

Project Groups by Market Sector	Description	Risk Control Level	Company Survival Criticality	Market Breakthrough	Impact on Company Long-term Goal	Impact to Company Mid-term Goal	Impact on Company Short-term Goal	Existing Clients Retention	Fitness to Company Strengths	Core Competence Development	Technical Readiness	Financial Readiness	Scores
	Business Importance Weighing Factor	0.75	0.85	0.7	0.65	0.50	0.35	0.70	0.65	0.75	0.45	0.65	
National Brand Retailers	Macy's New Stores and Renovations	7.00	6.50	4.00	5.00	5.50	6.20	8.00	7.50	5.50	8.00	8.00	45.15
	Macy's Maintenance	9.50	6.30	4.00	5.20	3.00	3.00	8.20	8.00	5.00	8.20	8.00	44.79
	Lord & Taylor's New Stores and Renovations	7.00	5.50	4.50	4.80	5.00	5.00	7.80	7.40	5.40	8.00	8.00	43.57
	Lord & Taylor's Facility Maintenance	9.00	4.50	4.50	4.20	5.00	5.00	7.20	7.40	5.00	7.80	8.00	43.02
	Target New Stores and Renovations	5.00	5.30	6.20	5.50	5.40	5.20	6.00	7.10	5.80	7.50	8.00	42.43
	Target Facility Mainte-nance	8.00	4.30	5.30	5.20	5.00	4.80	6.00	7.00	5.60	7.00	8.00	42.23
	Bloomingdale's New Store and Renovations	7.00	5.40	5.00	5.30	6.00	6.50	7.90	7.50	5.00	8.00	8.00	45.02
	Bloomingdale's Facility Maintenance	9.00	6.50	5.00	5.30	6.20	6.80	7.30	8.00	5.00	8.00	8.00	47.56
	Nordstrom's New Stores and Renovations	4.00	5.50	6.50	6.00	5.40	5.10	6.80	7.30	6.00	8.20	8.00	43.51
	Nordstrom's Facility Maintenance	8.00	4.60	5.20	5.30	4.90	4.80	6.00	6.00	5.70	8.00	8.00	42.30
	Gap New Stores and Renovations	4.00	3.00	5.00	4.70	4.20	4.00	5.00	7.90	5.20	7.00	7.75	36.33
Real Estate Developer and Owners	Rosenthal Properties	5.00	5.00	5.00	5.00	5.00	5.20	5.50	6.00	5.10	7.50	8.00	39.22
	Richie Station Shopping Center	4.50	5.40	1.00	4.90	5.60	5.80	5.40	6.20	6.00	7.00	8.00	37.34
	Westfield Shopping Mall	6.00	7.20	5.50	7.00	6.80	6.80	6.80	6.50	6.00	7.80	8.00	47.00
	Simon Shopping Centers	4.00	5.20	6.00	5.10	5.10	5.20	5.80	6.50	6.10	7.00	7.80	40.39
	Macerich Tyson's Corner Mall	4.20	5.00	6.50	5.20	5.30	5.30	5.30	5.80	6.40	6.80	8.00	40.38
	Amtrac - Union Station	6.50	4.00	4.00	5.00	4.70	4.60	5.00	5.50	6.40	6.70	8.00	38.38
	BF Saul Real Estate De-velopment	5.20	6.50	5.20	5.00	5.00	6.00	6.00	6.60	6.50	7.20	8.00	42.72
Large Corporation Clients	Under Amour HQ Facility Management	0.35	6.00	6.70	6.00	5.70	5.30	5.50	6.20	6.40	6.80	8.00	39.60
	Freddie Mac HQ Facility Management	6.50	7.80	5.40	6.60	6.80	7.00	8.00	6.70	5.80	8.00	8.00	48.53
	Boeing - Imaging Lab	5.00	5.00	5.00	5.00	5.00	5.00	5.20	5.50	6.30	6.20	7.70	38.74
	Bechtel Engineering Corp	5.00	5.00	5.20	5.00	5.00	5.20	4.80	5.40	6.20	6.00	7.50	38.31
	OneMian Financial	6.00	6.50	5.60	5.10	5.20	5.40	5.40	6.50	5.50	7.80	8.00	42.59
	Raymond James Service	6.00	5.50	5.50	4.80	5.00	5.00	5.30	6.60	5.40	7.50	8.00	41.02
	Ulico Facility Projects	6.20	5.40	4.80	4.50	4.80	5.00	5.40	6.60	5.00	7.50	8.00	40.07
	BGE Facility Projects	5.50	6.20	6.50	6.40	5.30	5.10	6.40	5.70	6.40	6.50	7.80	43.52
	Xfinity Facility Project	5.00	6.20	6.60	5.80	5.20	4.80	6.20	6.70	5.00	7.00	8.00	42.49
Real Es-	Bernstein Real Estate Corp	7.00	7.20	6.50	6.50	6.20	6.20	7.60	6.60	6.80	7.50	8.00	48.70

	Harbor East Properties Facility Management	7.20	7.30	7.00	5.50	5.50	6.00	7.40	6.50	5.80	7.40	8.00	47.22
	Trammel Property	6.50	7.00	6.80	5.60	5.50	5.50	7.00	6.20	6.40	7.00	8.00	45.98
	Jones La Sallies Property	6.00	7.20	5.60	6.50	6.50	6.50	7.20	6.50	5.00	7.30	8.00	45.79
	CBRE	5.50	7.50	5.50	6.50	6.50	6.40	7.30	6.60	5.40	7.50	8.00	46.09
	Louis Dreyfus	7.00	7.00	5.40	5.10	5.10	5.00	7.00	6.50	5.30	7.60	8.00	44.32
	Cushman Wakefield	6.80	7.50	5.60	6.40	6.40	6.50	7.20	6.70	5.30	7.60	8.00	47.02
Pharmaceutical Life Science Clients	AstraZeneca - Global Capital Projects	5.60	8.20	5.50	7.80	7.60	7.50	7.80	6.50	6.30	7.00	8.00	49.28
	AstraZeneca - Facility Management Projects	7.50	8.00	5.00	8.00	7.90	7.80	8.20	7.20	5.20	7.90	8.00	50.88
	AstraZeneca - Facility Administration	8.00	7.50	5.00	5.00	5.00	5.00	6.00	6.60	5.00	7.00	8.00	43.97
	Gilead Facility Projects	6.00	7.00	6.50	7.50	6.50	5.50	5.40	6.00	6.10	6.80	7.80	45.44
	Kaiser Permanente	5.50	6.80	6.30	6.30	6.20	5.80	5.80	6.10	5.50	6.70	7.80	43.78
	Glycomitric Corp	5.00	6.00	6.70	5.20	5.00	4.80	4.80	5.80	5.70	7.00	8.00	40.86
	Genome Lab International	6.00	5.40	6.50	5.20	5.10	5.00	5.00	5.70	5.90	6.60	8.00	41.12
	Otsuka Bio Research Corp	6.30	6.00	5.00	5.90	5.80	5.80	6.20	6.30	5.60	7.20	8.00	43.17
Banks	Capital One bank	7.20	8.20	4.80	6.00	6.90	6.90	7.80	7.00	5.10	8.00	8.00	48.13
	PNC Bank	7.00	8.10	5.10	6.00	6.80	6.80	7.60	7.00	5.20	8.00	8.00	47.96
	Sandy Spring Bank	6.00	6.40	5.40	5.00	4.80	4.50	6.20	7.00	5.20	7.80	8.00	42.45
	M&T Banks	6.00	6.50	5.40	5.00	4.60	4.60	5.80	7.00	5.10	7.80	8.00	42.11
	Federal Credit Union	5.00	6.00	4.00	3.50	4.80	4.80	4.70	6.80	5.00	7.00	8.00	37.82
Trade Unions	Teachers Union	5.30	6.20	5.60	5.00	4.80	4.50	5.20	6.70	5.30	7.00	8.00	40.71
	Plumbers Union	5.80	6.50	5.50	6.10	6.00	6.00	5.80	6.70	5.20	6.80	8.00	43.37
	LiUNA Labor Union	6.80	7.00	5.00	7.80	7.90	8.00	6.80	6.80	5.40	7.90	8.00	48.36
	Marine Union	6.40	7.80	6.00	4.00	4.50	4.50	4.50	6.30	5.40	6.60	8.00	41.52
	IBEW Union	7.00	8.50	4.90	7.00	7.20	7.80	8.20	6.60	5.50	7.80	8.00	49.65
	Steamfitters and Welders Union	6.70	7.70	5.00	5.80	6.00	6.00	7.70	6.50	5.10	7.70	8.00	46.05
	Rosenthal Properties	6.00	6.20	5.50	4.80	4.60	4.40	6.50	6.70	5.20	6.90	8.00	41.69
Education Institutes	George Washington University	4.50	5.10	5.60	5.00	4.00	3.50	4.80	5.80	5.70	6.00	8.00	37.41
	Johns Hopkins University	4.50	6.20	6.50	6.80	5.00	4.50	5.00	5.90	5.80	6.20	8.00	41.37
	Montgomery Community College	5.50	7.50	6.80	7.20	6.80	5.50	6.50	6.20	5.80	6.80	8.00	46.46
	American Catholic University	4.80	5.00	5.00	4.20	4.10	4.00	4.50	5.70	5.50	6.00	8.00	36.41
Hospital	Children's Hospital	4.00	4.50	5.20	3.20	3.50	3.00	3.10	5.80	6.00	6.00	8.00	33.69
	National Rehabilitation Center	4.60	4.80	5.50	3.00	3.00	3.20	3.40	5.90	6.20	6.00	8.00	34.72
Second Tier Corporation Clients	Darcars Dealership	5.20	6.10	6.30	6.50	6.00	5.40	6.20	6.00	5.90	6.30	8.00	43.31
	Linsey Car Dealership	7.00	6.30	5.20	6.20	6.10	6.00	7.30	6.30	5.80	6.80	8.00	45.24
	Adobe HQ	5.00	4.80	4.30	3.30	3.40	3.30	4.50	6.30	5.00	7.50	8.00	35.41
	Herbalife Office	5.00	4.50	4.50	2.00	2.00	2.50	4.50	6.20	5.00	7.40	8.00	33.36
	NFL DC	5.00	4.50	4.50	2.40	2.50	3.00	4.00	6.40	5.10	7.30	8.00	33.86
	John Deer DC Office	6.40	5.20	5.00	3.00	3.00	3.10	6.10	6.50	5.20	7.80	8.00	38.36
	Gold Gym	6.10	4.00	5.20	3.10	3.20	3.30	4.80	6.20	5.40	7.85	8.00	36.56
	Ashley Furniture	4.75	3.00	5.30	3.00	3.30	3.30	4.40	6.40	5.00	7.90	8.00	34.32
Govt	FBI Facilities	6.10	5.20	6.20	6.00	5.40	5.10	5.80	6.00	5.90	6.50	8.00	42.23
	GAS Projects	4.80	6.90	7.00	7.20	7.00	6.70	6.40	6.10	5.70	6.40	8.00	45.69
Internal Improvement Projects	Interior Projects	5.50	6.50	5.30	6.50	6.60	6.90	7.50	6.50	5.30	7.60	8.00	45.37
	Base Buildings	4.20	8.00	6.40	8.00	7.00	6.50	6.50	5.80	6.80	6.60	8.00	47.00
	Facility Maintenance with Repetitive Clients	8.00	8.20	5.60	6.30	6.40	6.50	8.50	6.30	5.50	8.00	8.00	49.43
	Facility Maintenance - Promising Clients	6.00	7.50	6.80	6.80	6.50	6.00	5.80	6.30	5.80	7.50	8.00	46.49
	Safety Program	5.00	8.20	7.60	7.00	7.00	6.80	6.00	5.80	6.80	7.00	8.00	47.89
	Accounting System Upgrade	7.00	6.80	4.00	6.00	5.50	5.00	5.50	5.40	6.20	6.00	8.00	42.14

	Facility Maintenance - Unknown Clients > 150K	6.00	6.20	6.00	5.50	5.40	5.00	5.60	6.30	5.00	7.20	8.00	42.20
	Facility Maintenance - Unknown Clients < 150 K	5.00	3.00	4.20	4.10	4.30	4.80	4.30	6.40	4.30	8.00	8.00	34.93
Buch Real Estate Development Projects	Buch Real Estate Development	3.80	8.20	8.00	8.00	7.20	6.00	5.20	5.80	7.00	5.80	7.80	46.66
	Ballston Common Mall	6.00	7.00	5.20	7.50	6.20	5.00	5.30	6.00	6.50	6.00	8.10	44.27
	The Vine Apartments - Maple Lawn	6.20	8.20	7.20	8.00	7.80	7.00	5.20	5.90	6.80	5.50	8.10	48.53
	The Metro Station Apt - Gaithersburg	3.00	8.30	7.00	7.80	7.50	7.00	5.20	5.70	6.90	5.70	7.80	45.63
	Annapolis Development	3.50	4.00	4.60	5.10	5.00	4.80	4.00	5.80	6.20	7.50	6.40	35.50
	Sykesville Office Complex	5.30	5.00	4.80	4.80	4.50	4.00	4.00	6.00	6.00	7.40	6.00	36.79
Geographic Presence and Marketing	New York Office	4.20	6.00	7.20	6.70	5.90	5.80	6.20	5.50	7.00	5.70	7.20	43.04
	Florida - Westfield	4.00	5.20	5.20	4.00	4.00	3.50	6.00	5.40	6.00	6.10	7.50	36.72
	California - Medimmune	5.00	5.00	5.00	3.50	3.00	2.50	6.00	5.50	6.10	6.20	7.00	35.84
	Chicago - Westfield, Capital One, Macy's	4.20	4.00	5.10	4.00	4.00	3.60	5.80	6.00	5.80	6.20	7.10	35.70
	Pennsylvania - Macy's	5.50	5.00	5.20	4.20	4.10	3.10	5.70	6.30	5.50	6.10	7.50	37.71
	New Jersey - Macy's	6.00	5.20	5.30	5.10	5.00	4.00	6.70	6.20	6.20	6.70	7.80	41.30
	Connecticut - Macerich and Westfield	5.30	5.10	4.75	3.30	3.30	3.50	6.20	6.20	6.40	6.00	6.50	36.75

Note: Weight factor is senior executive assessment of importance of each item on company business operation. 0.0 being the least and 1.0 the most.

Based on the *APP* evaluation score board, projects were grouped into the four categories, see Table 4.5 below.

Table 4.5 - Buch Company APP Categories 2014

Advanced and Mission Critical Projects	Scores
AstraZeneca - Facility Management Projects	50.88
IBEW Union	49.65
Facility Maintenance with Repetitive Clients	49.43
AstraZeneca - Global Capital Projects	49.28
Bernstein Real Estate Corp	48.70
Freddie Mac HQ Facility Management	48.53
The Vine Apartments - Maple Lawn	48.53
LiUNA Labor Union	48.36
Capital One bank	48.13
PNC Bank	47.96
Safety Program	47.89
Bloomingdale's Facility Maintenance	47.56
Harbor East Properties Facility Management	47.22
Cushman Wakefield	47.02
Base Building	47.00
Westfield Shopping Mall	47.00
Buch Real Estate Development	46.66

Facility Maintenance - Promising Clients	46.49
Potential Breakthrough Projects	
Montgomery Community College	46.49
CBRE	46.46
Steamfitters and Welders Union	46.05
Trammel Property	45.98
Jones La Sallies Property	45.79
GAS Projects	45.69
The Metro Station Apt - Gaithersburg	45.63
Gilead Facility Projects	45.44
Interior Projects	45.37
Linsey Car Dealership	45.37
Macy's New Stores and Renovations	45.15
Bloomingdale’s New Store and Renovations	45.02
Macy's Maintenance	44.79
Louis Dreyfus	44.32
Ballston Common Mall	44.27
AstraZeneca - Facility Administration	43.97
Kaiser Permanente	43.78
Lord & Taylor's New Stores and Renovations	43.57
BGE Facility Projects	43.52
Nordstrom's New Stores and Renovations	43.51
Plumbers Union	43.37
Darcars Dealership	43.31
Otsuka Bio Research Corp	43.17
New York Office	43.04
Lord & Taylor's Facility Maintenance	43.02
BF Saul Real Estate Development	42.72
One Main Financial	42.59
Xfinity Facility Project	42.49
Sandy Spring Banks	42.45
Target New Stores and Renovations	42.43
Platform Projects	
Nordstrom's Facility Maintenance	42.30
Target Facility Maintenance	42.23
FBI Facilities	42.23
Facility Maintenance - Unknown Clients > 150K	42.20
Accounting System Upgrade	42.14
M&T Banks	42.11
Rosenthal New Properties	41.69

Marine Union	41.52
New Jersey - Macy's	41.37
Genome Lab International	41.30
Raymond James Service	41.12
Glycomitric Corp	41.02
Teachers Union	40.86
Simon Shopping Centers	40.71
Macerich Tyson's Corner Mall	40.39
Ulico Facility Projects	40.38
Under Amour HQ Facility Management	40.07
Rosenthal Existing Properties	39.60
Boeing - Imaging Lab	39.22
Amtrac - Union Station	38.74
John Deer DC Office	39.38
Bechtel Engineering Corp	38.31
Derivative Projects	
Federal Credit Union	37.82
Pennsylvania - Macy's	37.71
George Washington University	37.41
Richie Station Shopping Center	37.34
Sykesville Office Complex	36.79
Connecticut - Macerich and Westfield	36.75
Florida - Westfield	36.72
Gold Gym	36.56
American Catholic University	36.41
Gap New Stores and Renovations	36.33
California - Medimmune	35.84
Chicago - Westfield, Capital One, Macy's	35.70
Annapolis Development	35.50
Adobe HQ	35.41
Facility Maintenance - Unknown Clients < 150 K	34.93
National Rehabilitation Center	34.72
Ashley Furniture	34.32
NFL DC	33.86
Children's Hospital	33.69
Herbalife Office	33.36

The *APP* categories were converted into an *APP* chart for visual convenience and soliciting feedback from project management teams, see Figure 4.5.

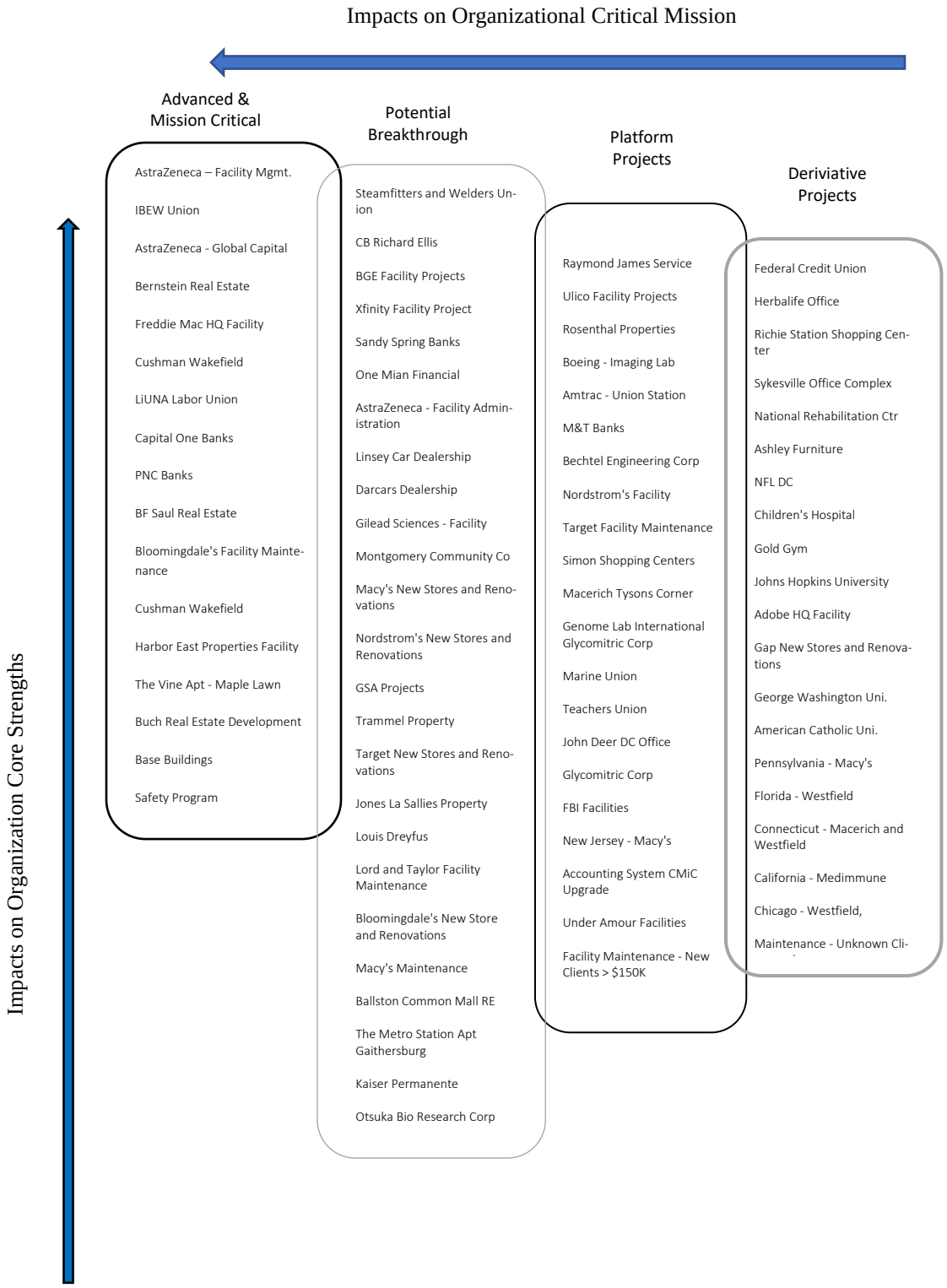

Figure 4.5 - The Buch Company 2014 APP Chart

The *APP* practice adoption process gradually changed the project management philosophy of the company. Senior executives shifted from micro-managing and chasing projects to competing with core strengths and focusing on building competence to sustain success. *APP* adoption was progressively integrated into project planning and operation, Kogan recommended that the company consider OMP3 practice to improve marketing strategy and organization performance.

OPM3 was introduced by the Project Management Institute (PMI) in 1998. It was based on the similar concept of the Capacity Maturity Model (CMM) that the US Department of Defense and the Software Engineering Institute (SEI) developed at in 1986. *OPM3* provides a structured and continuous self-examining process to evaluate an organization's current state of operation, identify strengths and weaknesses, develop core competencies, and avoid becoming complacent. A typical *OPM3* cycle consists of five steps: 1) prepare the assessment, 2) perform the assessment, 3) plan the assessment, 4) implement the assessment, and 5) repeat the process. Well implementation of the five-step cycle can help organizations improve their business management maturities.

Despite that revenue reached $41.6 million in 2006, a 17% increase from previous year, the Buch Company senior management noticed a number of mishandled projects and lost business opportunities due to technical unfitness and inefficient usage of company resources. Senior management brought Kogan back for help. After thorough investigations and brainstorm sessions, Kogan developed an *OPM3* practice adoption plan. In the training stage, Kogan coached the Buch senior management establishing *OPM3* cycle and using it to assess the company's strengths and weaknesses. Table 4.6 is a list developed by the Kogan and Buch teams.

Table 4.6 - The Buch Company Organizational Strength and Weakness List

Company Strengths
Employee loyalty and pride, strong sense of belonging, and cohesive team environment.
Solid leadership, dedicated staff, and reliable subcontractor bases.
Word of mouth reputation, long track records, and earned trust with clients.
Strong financial standing, nearly debt-free loan leverage, and excellent surety bonds.
Experience in facility projects, personalized service approach, and retail sensitivity.
Company Weaknesses
Difficulty to replace these field veterans who are approaching to retirement age.
Inadequate managerial and technical training for skills required for future market penetration.
Antiquated accounting software and project administrative supporting systems.
Subpar safety management and standards to attract large corporate clients.
Lacking coordinated marketing efforts in pursuing target clients.

Based on the organizational strengths and weakness assessment, Kogan suggested the Buch Company conduct periodical evaluation, adjust project alignment with company marketing, and invest in technical and managerial training. Following Kogan's suggestions, Buch Company developed an *OPM3* implementation plan, redesigned organization structure, revamped IT infrastructure, replaced legacy accounting system, assigned a VP to enforce higher safety standards, recruited young talent to fill the positions of aging veterans, encouraged employees to take continuing education, and streamlined marketing efforts with a clearly defined strategy. Now the *OPM3* evaluation has become routine agenda of the Buch Company's senior management meetings.

Following are examples to demonstrate how the Buch Company uses the *OPM3* method to continuously measure, adjust, and improve its marketing maturity in the pharmaceutical, retail, and financial service sectors.

The Pharmaceutical Sector

The very first two projects that the Buch Company did for AstraZeneca were in 2005 on the Medimmune research campus. Eventually the company became Astra-Zeneca's trusted go-to facility service provider in the Mid-Atlantic region. In the initial 2006 *OPM3*, AstraZeneca account was in the *Potential Breakthrough* category. The pharmaceutical was among the top five markets there the Buch Company decided to expand and improve its operation maturity. In the ensuing years, the company gave AstraZeneca the top priority in resource allocation, placed a dedicated onsite team, assigned a safety director to ensure compliance of AstraZeneca's strict safety standards.

Despite the annual billings generated from AstraZeneca grew slowly in the first four years, the Buch Company stayed with *OPM3* marketing plan. Efforts and persistence paid off in 2010, the annual billings from AstraZeneca jumped to $6.3 million and in 2019 reached to $66.6 million, see Figure 4.6.

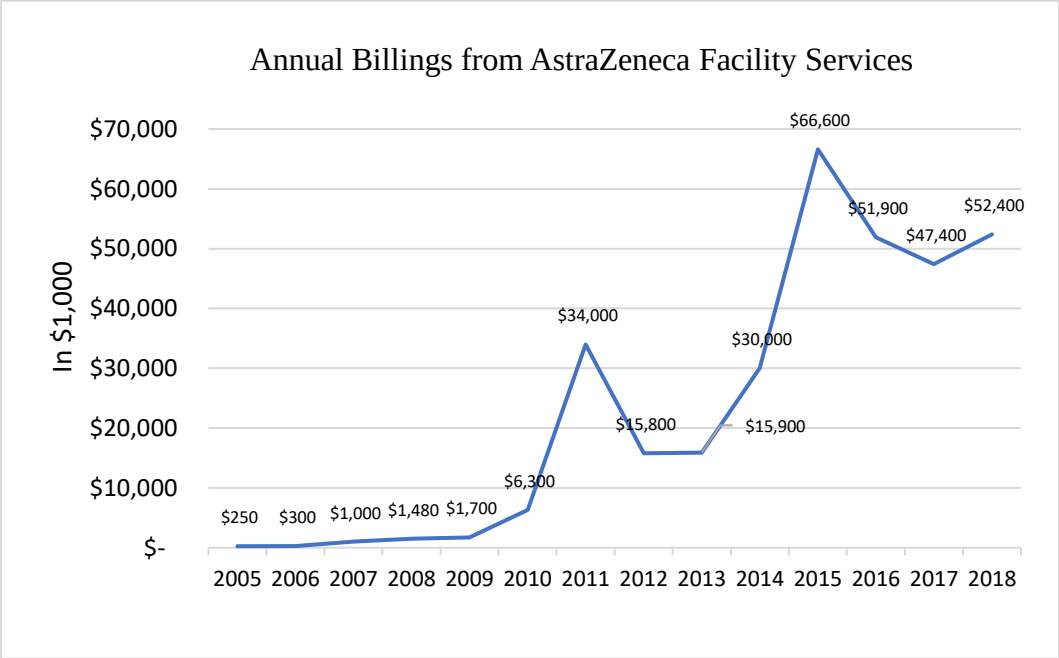

Figure 4.6 - Annual Billings from AstraZeneca Facility Service Account (2005-2019)

The Buch Company conducted scheduled *OPM3* assessment through the process of maturing the operation on the AstraZeneca account. As the project teams acquired experience and skills to compete in the life science market, the Buch Company planned to duplicate the AstraZeneca success on other pharmaceutical clients.

The first facility project that the Buch Company completed for Gilead Sciences Inc. was in 2015. The Buch team patiently increased built connections with Gilead and progressively grew the account annual billings from $300K to $1.2M in four years. With the FDA approved Remdesivir, a Covid-19 treatment medicine that the Gilead developed, the Buch Company is involved a major facility expansion program to help the client to meet the production demands and expecting a significant increase in service billings in the coming years.

The same marketing strategy and *OPM3* assessment and improvement cycle are used in maturing marketing and operations with other pharmaceutical accounts, namely Kaiser Permanente, Glycomimetic, and Otsuka Pharmaceutical. Though the success level on each account is varying, the Buch Company has developed its marketing and operation maturity beyond one single pharmaceutical client account to the promising life science business sector.

The Retail Business Sector

The first store that the Buch Company built for Macy's was at the Wheaton Shopping Mall in 2006. The annual service billings increased from $15.3 million to $18.2 million in 2007. In the following five years, impacted by tough economy and online shopping, the annual service billings dropped and averaged about $4 million. During the slowdown, the Buch senior management firmly believed the strategy they developed based on

OPM3 assessment and stayed on the plan to improve project management competence and mature company operation in the Macy's account. When Macy's sales recovered, the Buch's facility service billings rebounded to $25.2 million in 2013 and set a record of $62 million in 2017, see Figure 4.7.

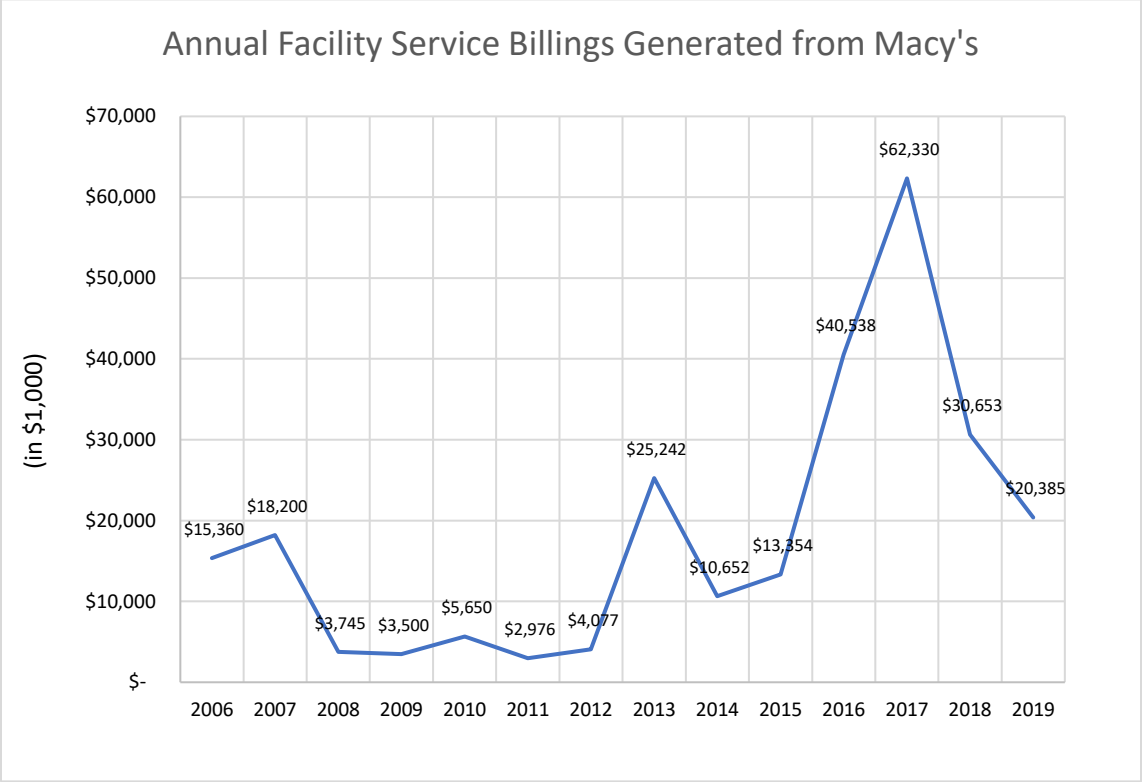

Figure 4.7 - Annual Facility Service Billings Generated from Macy's

The Buch Company utilized the core competences and matured retail facility operation management in marketing other national retailers namely Target, Nordstrom's, Saks 5th Avenue, TJ Maxx, Albertson. Safeway, Wegman, and Starbucks. With peaks and valleys, the additional facility billing generated from the new retail client accounts grew from $2.1 million in 2006 to $35.1 million in 2018, see Figure 4.8. With *OPM3* practice

adoption, the Buch Company successfully transferred its Macy's facility service operation maturity to the retail business sector.

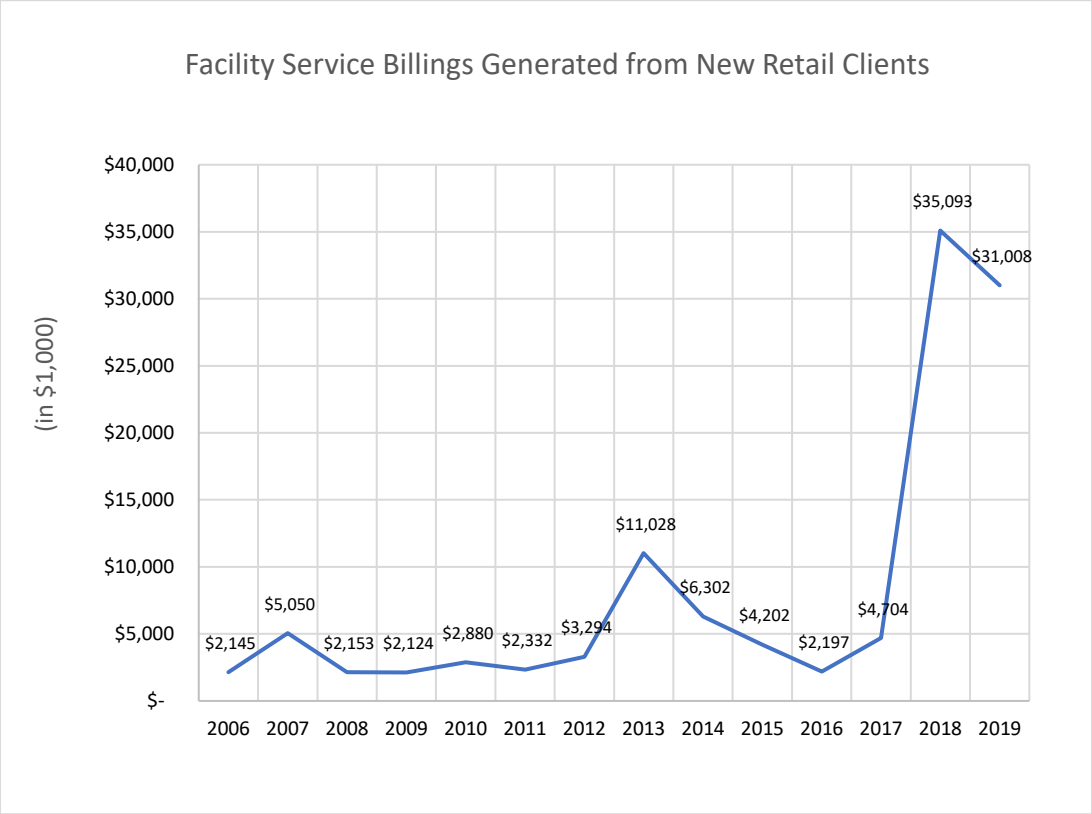

Figure 4.8 - Facility Service Billings Generated from New Retail Clients

The Financial Service Business Sector

Similar to pharmaceutical and retail business sectors, the Buch Company built a solid business relationship and matured its operation on the PNC Banks account. The annual facility service billings from $374,000 in 2006 to $7.2 million in 2008, during PNC's expansion in the DC metropolitan area. After PNC's expansion, the annual billings dropped and remained at an average of $3 million, see Figure 4.9.

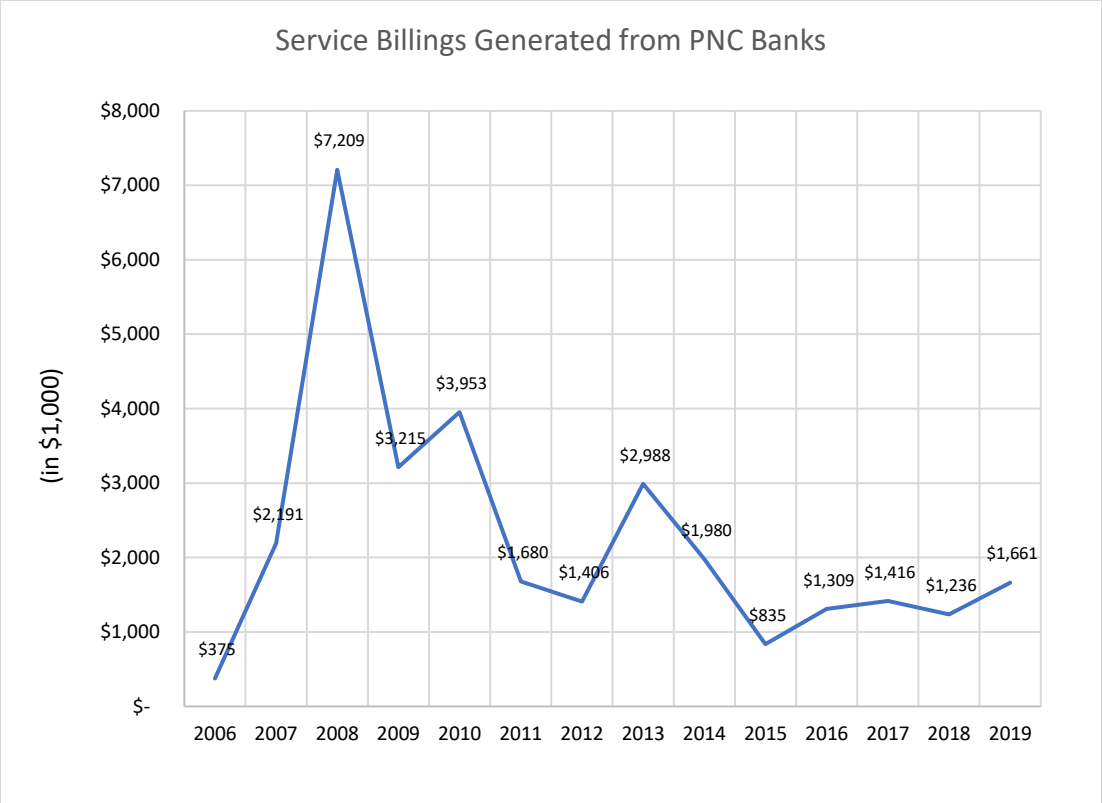

Figure 4.9 - Buch Construction Facility Service Billings from PNC Banks

While assisting PNC Banks, the Buch Company used the experience and operation skills matured in PNC projects to pursue Capital One and other financial service customers. In the in the first five years, Capital One award smaller projects to the Buch Company and the annual facility service billings averaged $1.5 million. In 2012 Capital One started its own expansion program and the annual billings generated from Capital One increased from $1.7 million in 2012 to $11 million in 2019, see Figure 4.10.

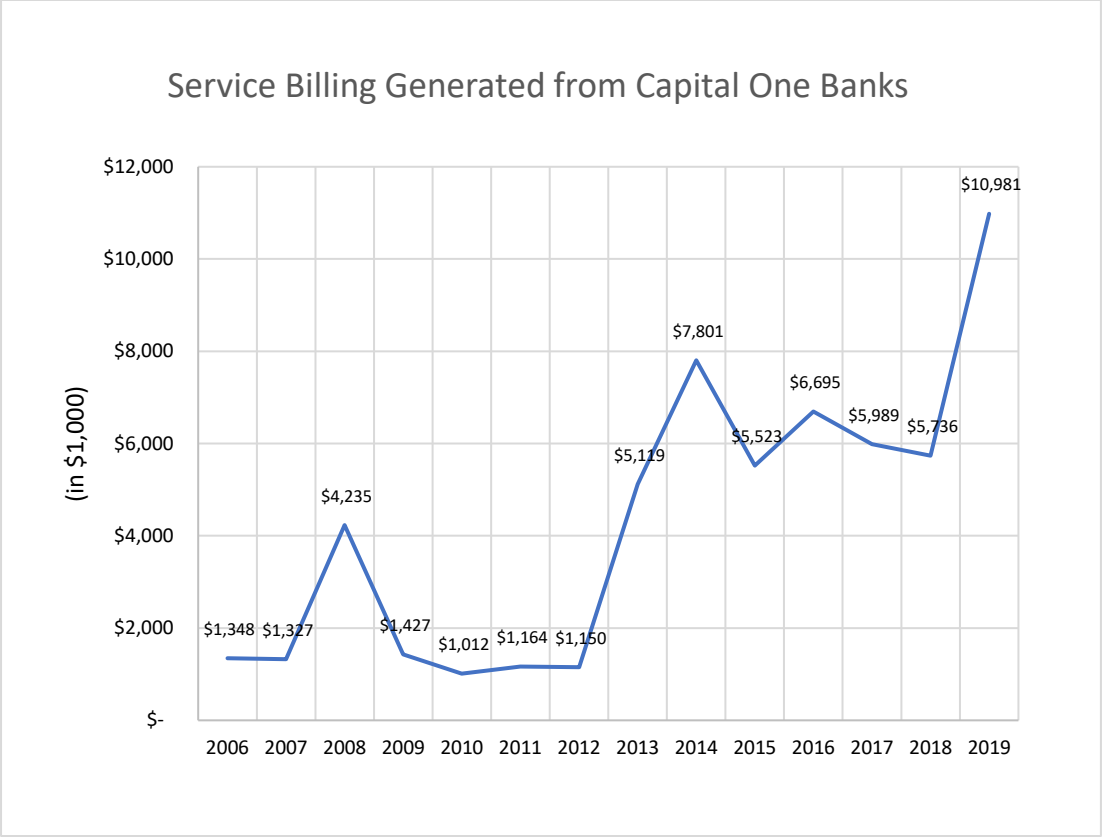

Figure 4.10 - Buch Construction Facility Service Billings from Capital One Banks

The Buch Company also implemented the *OPM3* practice on marketing other financial service clients and had considerable success with Chevy Chase and M&T Banks, moderate success with Sandy Spring, SunTrust, and Well Fargo Banks, unsustainable success with Legg Mason, One Main Financial, and Goldman Sachs, and little results with Apple Credit Union, Amalgamate, and Liberty Mutual. Overall, the *OPM3* helped the Buch Company expanded its operation into the financial service business sector.

4.2.3. Combined APP/OPM3 Practice

A well-implemented hybrid *APP*/*OPM3* practice can generate significant synergy. On the project level, *APP* emphases on developing and competing with core strengths

and provides a foundation to supports the *OPM3* practice. On the organizational level, *OPM3* matures operating and marketing and improve *APP* efficiency and overall company performance. Figure 4.11, Figure 4.12, and Figure 4.13 are the Buch Company *APP* categories in 2006, 20013, and 20019, measured in dollar amount of annual service billings.

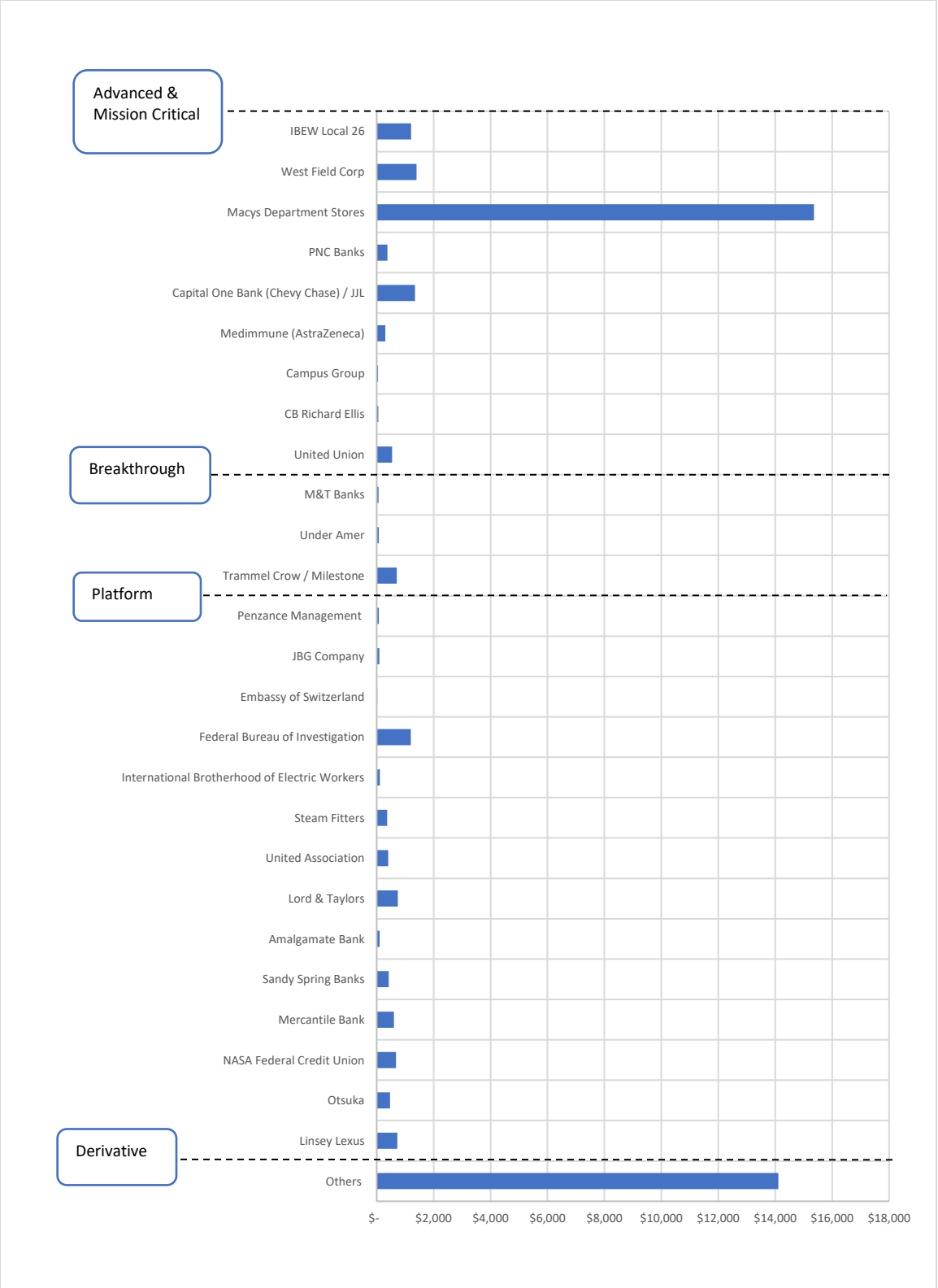

Figure 4.11 - The Buch Company APP Categories 2006

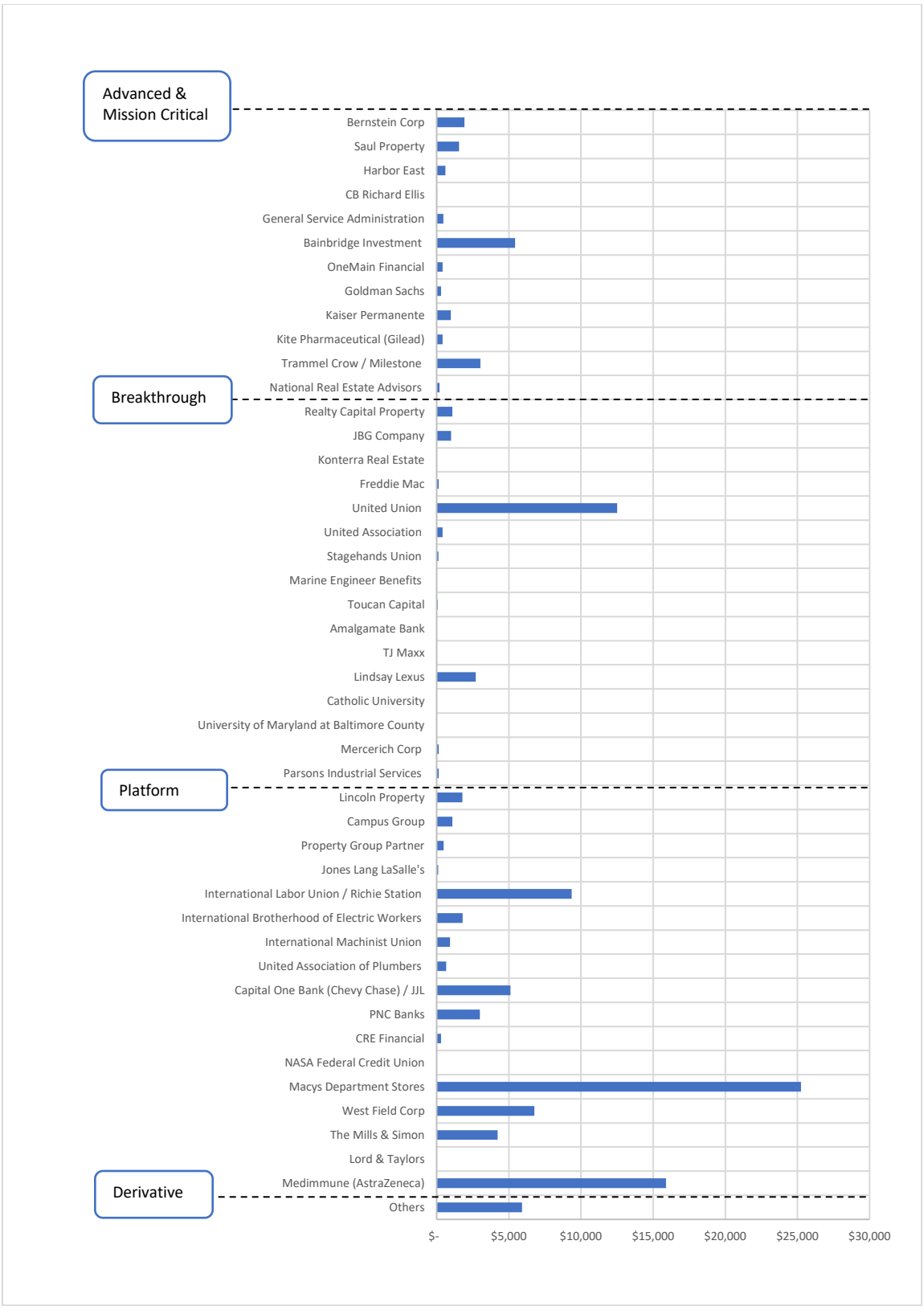

Figure 4.12 - The Buch Company APP Categories 2013

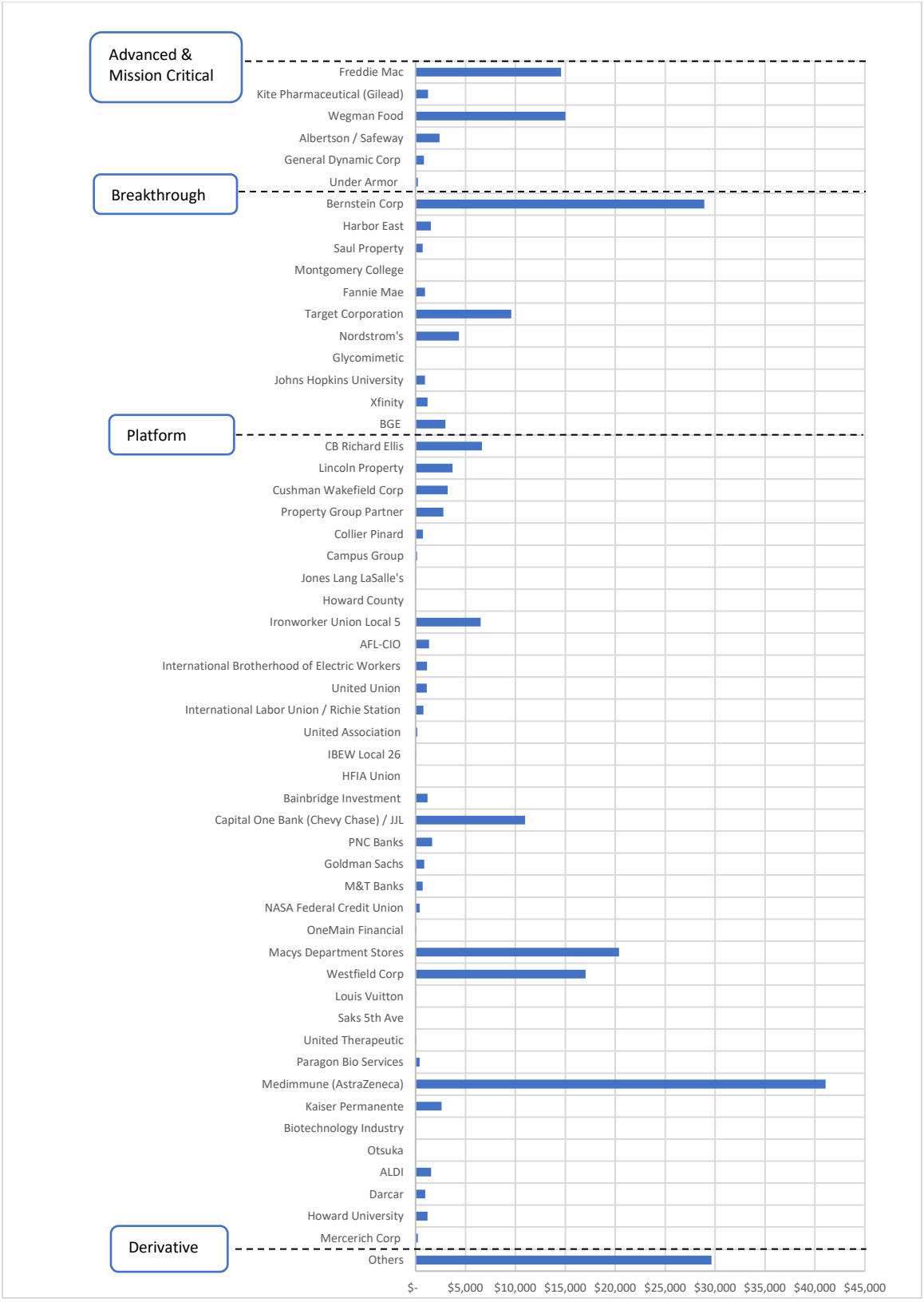

Figure 4.13 - The Buch Company APP Categories 2019

The combined *APP*/*OPM3* adoptions helped the Buch Company in strategically prioritizing overall projects and systematically reducing the derivative project ratio (DPR). From 2006 to 2012, the company successfully lowered DPR from 35% to 4%, and the lean composition remained at 4% between 2012 and 2016, except a pike in 2014. Between 2017 and 2019, the Buch Company implemented a marketing strategy increasing marketing exposure and penetrating to new geographic territories and adjusted DPR back to 10% - 15%, a balanced range that the company believed health for operation efficiency and marketing exposure. Figure 4.14 is a chat showing DPRs from 2006 to 2019.

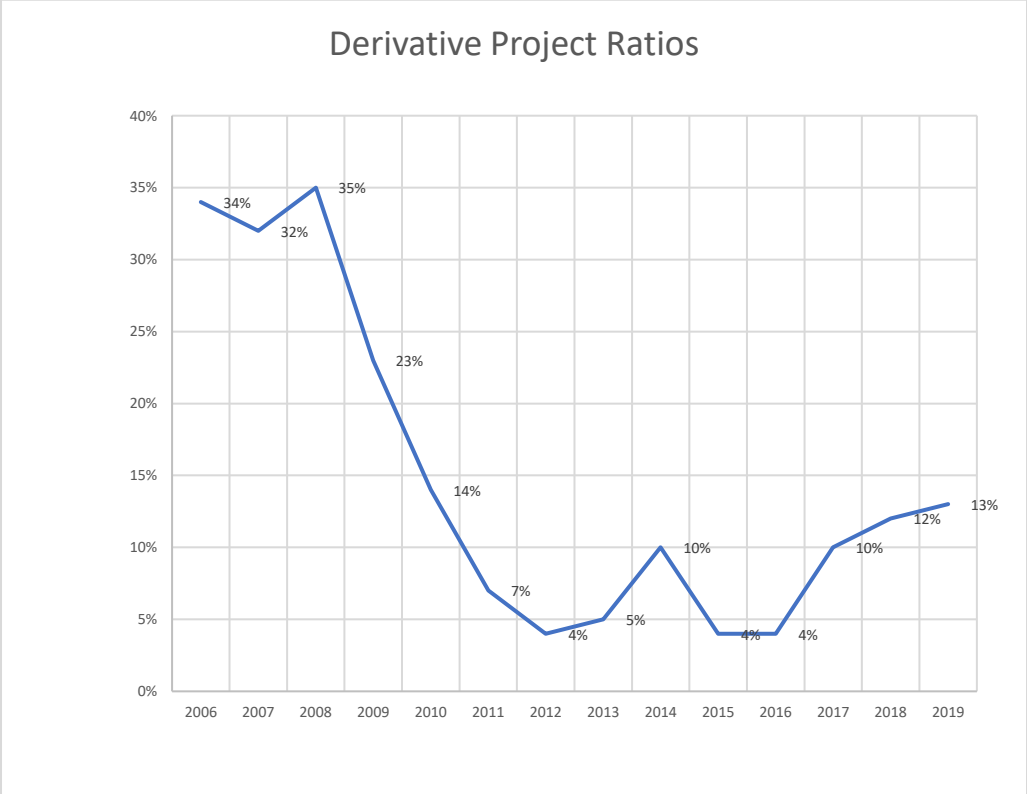

Figure 4.14 - Derivative Projects Ratios (2006 – 2019)

By reducing DPR, *APP*/*OPM3* adoptions helped the Buch Company in freeing up the resources idled or wasted in the derivative projects, providing more support to

mission critical and potential breakthrough projects, and avoiding missing opportunities. The over impact of *APP*/*OPM3* adoptions on the company performance is reflected in the annual accounting audit records. See Figure 4.15 for the Buch Company annual revenue audit records between 2006 and 2019.

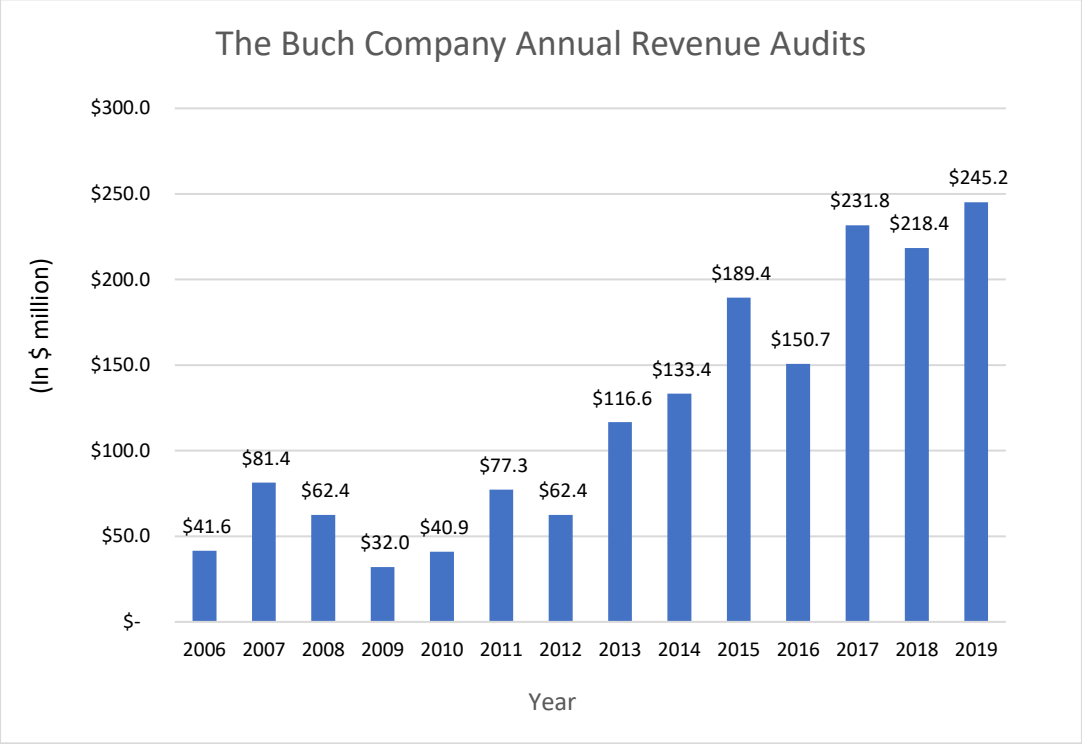

Figure 4.15 - Buch Company Audited Annual Revenues from 2006 to 2019

Along with other tangible and intangible factors, the hybrid *APP*/*OPM3* application played an instrumental role in the Buch Company's organizational maturity and operation performance improvement.

Considering an annual inflation rate 3% and using year 2006 as a baseline, the present values of the year between 2006 and 2019 are calculated and presented in Figure 4.16 below. The table indicates a stronger evidence of consistent revenue increase, expect

three exceptional years aforementioned in The revenue increased gradually by 268% over 14 years from $61.12 million to $245.17 million.

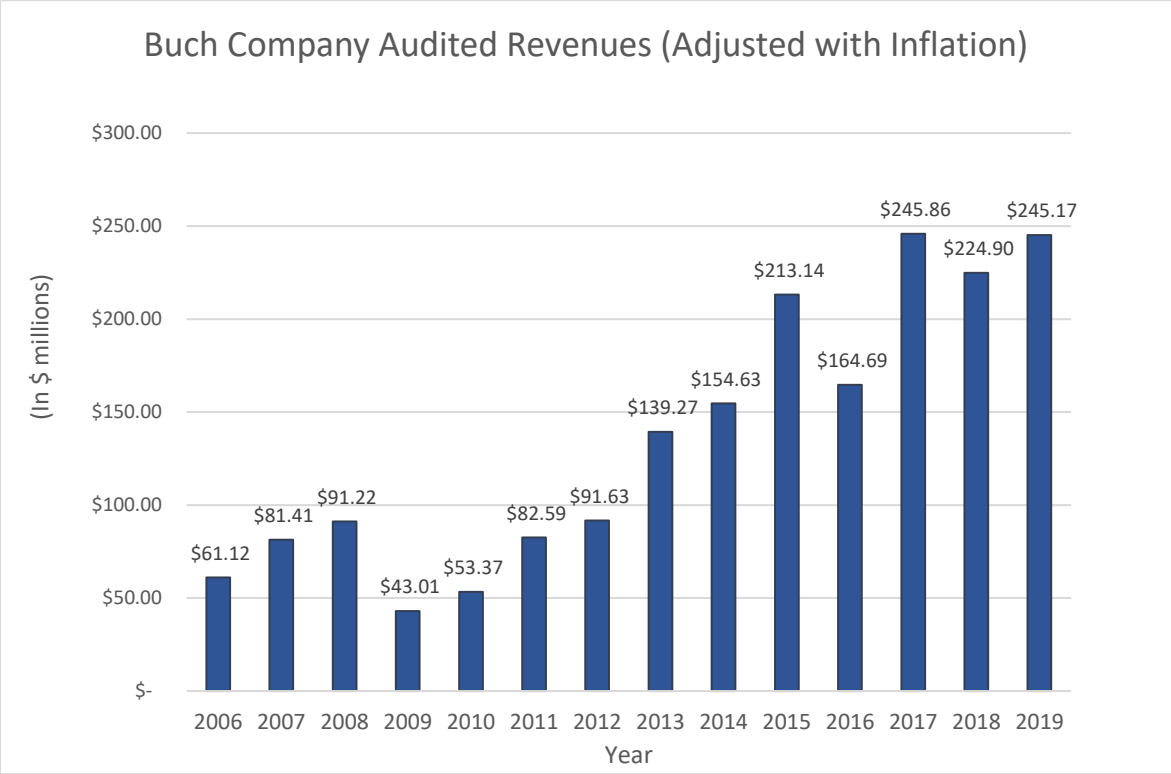

Figure 4.16 - Buch Company Audited Revenues (2006-2019) Adjusted with an Inflation Rate of 3%

4.2.4. Grounded Theory and Pre-Post Analysis of Case Study 4.1 and Case Study 4.2

Case Study 4.1 and 4.2 demonstrate how the May Company and Buch Company learned and adopted innovative practices to meet their needs for innovative management methods. The case studies used *Grounded Theory* and *Pre-Post* approaches to analyze the impacts of the new practices on corporate facility portfolio operation and company project planning and financial performance.

Ground Theory is "an inductive and comparative methodology that provides systematic guidelines for gathering, synthesizing, analyzing, and conceptualizing qualitative

data for the purpose of theory construction (Charmaz 2001)." Like other qualitative approaches, *Grounded Theory* is not well suited to hypothesis-testing research, but particularly appropriate for studying relationship patterns among ideas and outcomes, constructing useful propositions, and making predictions.

A typical *Grounded Theory* analysis process consisting of five steps: 1) gather and conceptualize information, 2) code collected data into general categories, 3) further break down general categories into subcategories, 4) uncovering connections among subcategories, and 5) analyzing and formalizing propositions. Information can be collected from case studies, first-hand experience, interviews, and field observations. Conceptualization is a process of summarizing the collected information; categorization, sorting empirical data into groups; and coding, labeling descriptive categories with symbols or numbers. In the notes for the ENCE688Y class at UMD, *Case Study Method in PM,* Cui (2021) provided a chart to graphically illustrate the basic concept of *Grounded Theory* process. Figure 4.17 is a modified chart of *Grounded Theory* Process, based on the one in the class notes.

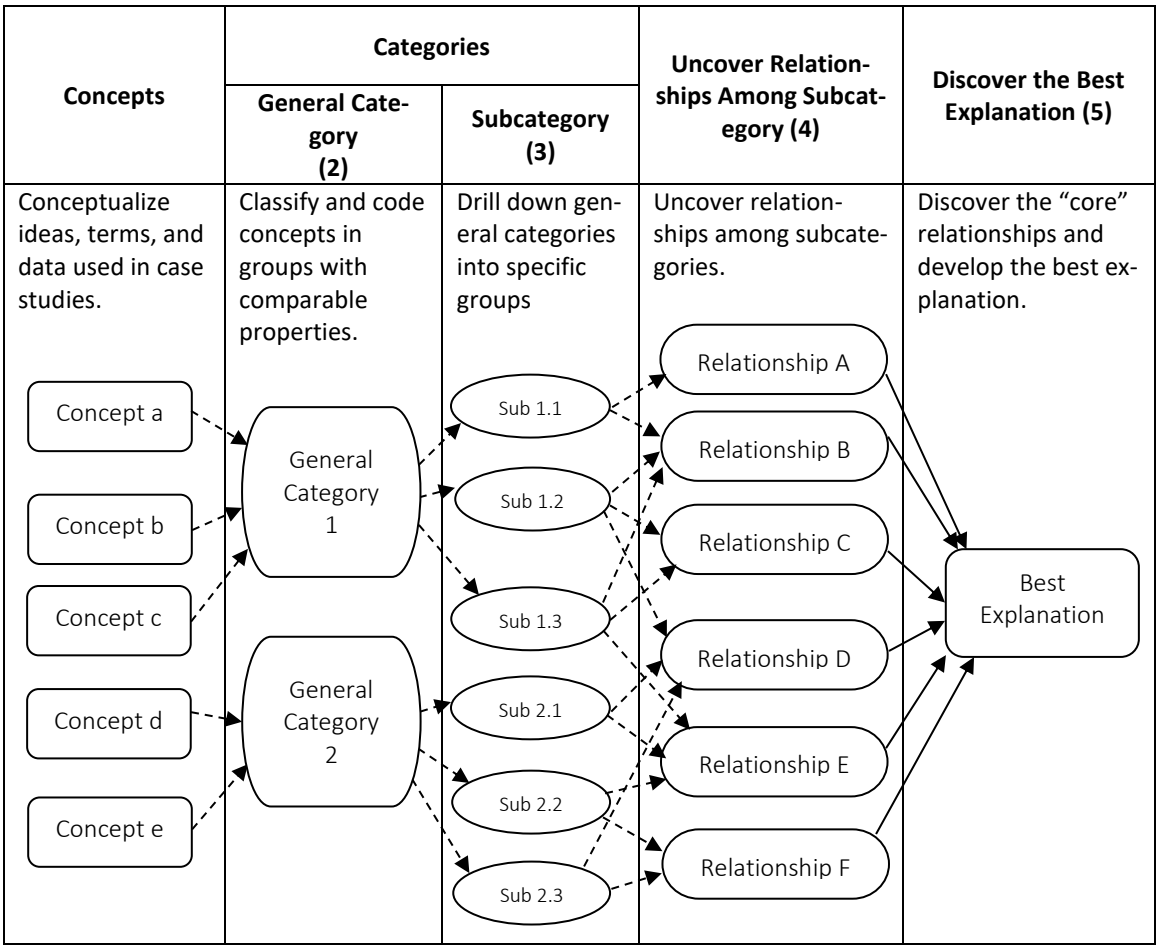

Figure 4.17 - Grounded Theory Process
(Resource: ENCE688A Case Study Methods in PM. 2021, Modified)

Grounded Theory provides a general "*bottom-up*" notion of developing propositions without a rigid format. Researchers have divergent approaches on information collection, conceptualization, and coding. Regarding information collecting Charmaz places an emphasis on observer involvement in data collection. As she stated in her book *Constructing Grounded Theory - A Practical Guide Through Qualitative Analysis*,

> In the classic *Grounded Theory* works, Glaser and Strauss talk about discovering theory as emerging from data separate from the scientific observer. Unlike their position, I assume that neither data nor theories are discovered. Rather, we are

> part of the world we study and the data we collect. We construct our grounded theories through our past and present involvements and interactions with people, perspectives, observations, and research practices (2006).

Charmaz takes a different position from Glaserians or Straussians on coding techniques. In the same book, Charmaz also criticized axial coding,

> Axial coding provides a frame for researchers to apply. The frame may extend or limit your vision. Those who prefer simple, flexible guidelines-and can tolerate ambiguity-do not need to do axial coding. I have not used axial coding according to Strauss and Corbin's formal procedures, I have developed subcategories of a category and showed the links between them as I learned about the experiences the categories represent the subsequent categories, subcategories, and links reflect how I made sense of the data (2006).

While applying *Grounded Theory* in analyzing Case Study 4.1 and Case Study 4.2, instead of Axial coding, *Pre-Post* compassion analysis is used to uncover the relationships among categories.

4.2.4.1. Grounded Theory Analysis of Case Study 4.1

Based on the discussions in Section 4.2.4, the research takes the following steps to conduct the *Grounded Theory* analysis. 1) collect concepts from general discussion of Case Study 4.1, 2) group and code the collected concepts in to general categories, 3) further break down the general categories into detailed subcategories, 4) identify and code the significant relationships among categories and subcategories, and use *strength and significance* factors to weight the importance of the identified relationships, 5) by

analyzing frequency and *strength and significance* weighted factors, to select "core" categories and relationships. A research chart is designed to guide the *Grounded Theory* and *Pre-Post* analysis process, see Figure 4.18.

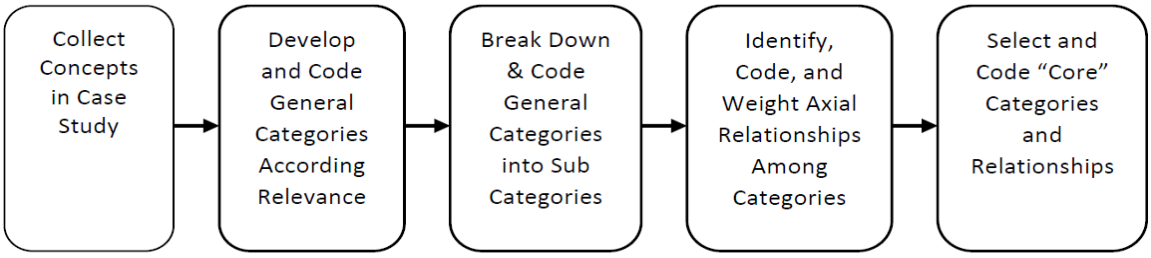

Figure 4.18 - Grounded Theory and Pre-Post analysis process

1) Collect, code, and summarize general concepts discussed in Case Study 4.1 and summarize them into Table 4.7.

Table 4.7 - Concept Collection from Case Study 4.1

Concept Code	Concepts Collected from Case Study Discussion
a	Acquisitions and mergers
b	Company expansion
c	Corporate facility portfolio management
d	Existing flat portfolio management
e	Corporate portfolio operation budget
f	Cost of corporate facility portfolio operation
g	Portfolio management on corporate level
h	Portfolio Management on division level
i	Needs for innovative management method for fast growing facility portfolio size
j	New practice adoption
k	Maintenance cost reduction
l	Data-based benchmark budgeting
m	Corporate portfolio budget
n	Number of facilities in corporate portfolio
o	Increasing number of facilities in division facility program
p	Internal conflicts over annual budgeting
q	Lacking standard corporate facility management
r	Corporate portfolio performance

2) Group the concepts in Table 4.7 into general categories in Table 4.8.

Table 4.8 - General Categories of Case Study 4.1

Category Code	Concepts	General Category
1	Acquisitions and Mergers	Need for innovative management method
	Expansion	
	Number of facilities in corporate portfolio each year	
2	Existing flat portfolio management	New practice adoption
	Need for efficiently manage fast growing facility portfolio size	
	Corporate hierarchy governance structure	
	Corporate hierarchy facility management structure	
	Portfolio Management on corporate level	
	Portfolio Management on division level	
3	Lacking standard corporate facility management	Corporate portfolio performance
	Cost of Corporate Facility Portfolio Operation	
	Internal conflicts over annual budgeting	
	Maintenance cost reduction	
	Data-based benchmark budget	
	Corporate portfolio budget	
	Corporate portfolio performance	

3) Further broken-down general categories in Table 4.8 into subcategories in Table 4.9

Table 4.9 - Subcategory of Case Study 4.1

Category Code	General Category	Code	Subcategory
1	Need for innovative management method for fast growing facility portfolio size	1.1	Number of facilities in corporate portfolio each year
		1.2	Portfolio management on corporate level
		1.3	Portfolio management on division level
		1.4	Resource sharing
		1.5	Operation synergy
2	New Practice Adoption	2.1	The year new management methods adopted
		2.2	*PMO* management method
		2.3	*P3M* management method

		2.4	Hybrid *P3M/PMO* practices
		2.5	Suitability of the new practices
3	Corporate portfolio operation performance	3.1	Records of annual cost of corporate facility operation cost between 1992 and 2005
		3.2	Baseline facility maintenance (BFM/SF) records between 1992 and 2005
		3.3	Maintenance cost reduction
		3.4	Corporate portfolio budget
		3.5	Number of facilities in corporate portfolio each year between 1992 and 2005

Identify and code relationships among the categories and subcategories in Table 4.9 and list them in Table 4.10.

4) Relationships exist between pairs of categories are summarized in Table 4.10. Each relationship is recorded in one row with the relationship code in column (a), two categories recorded in columns (b) and (c), and a *Significancy and Strength* weight factor assigned in columns (d), as illustrated in Figure 4.8.

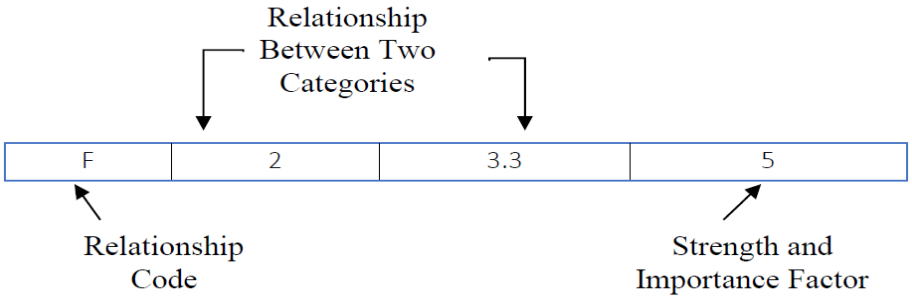

Figure 4.19 - Example of Relationship between Categories and Weight Factor

The value of the *Significancy and Strength* factor tis determined by the researcher based on the strength of each relationship and its importance to company performance or project outcome.

Table 4.10 - Relationships Among Categories of Case Study 4.1

Relationship Code (a)	Relationship Exist Between Categories (b)		Relationship Importance and Strength 1 – 5 (Least to Most) (c)
A	1	2.4	5
B	1	3.2	5
C	1	3.3	3
D	2	3.1	5
E	2	3.2	5
F	2	3.3	5
G	2	3.4	5
H	2	3.5	2
I	2	1.4	3
J	2	1.5	3
K	3	2.1	3
M	1.1	3.1	3
N	1.1	3.2	5
O	1.1	3.3	3
P	2.1	3.1	3
R	2.1	3.2	3
S	2.4	3.1	5
T	2.4	3.2	5
U	2.4	3.3	5
V	2.4	1.4	5
W	2.4	1.5	4
X	2.4	2.2	5
Y	2.4	2.3	5
Z	2.4	2.1	4
AA	3.1	2.4	5
AB	3.1	3.2	5
AC	3.1	3.3	5
AD	3.1	2.1	3
AE	3.2	2.1	3
AF	3.2	2.4	5
AG	3.2	1.1	3
AH	3.4	2.4	5

5) Analyze the frequency and *Significancy and Strength* scores to identify the most connected and important "core" categories and relationships among them. The categories and scores are summarized in Table 4.11. For example, the sum of all the scores associated with subcategories 2.4 is 50, which appears in first row and ranked #1 in Table 4.11.

Table 4.11 - Significancy and Strength Score for Categories in of Case Study 4.1

Ranking	Category	Score
1	2.4	50
2	3.2	37
3	3.1	32
4	2	27
5	2.1	19
6	3.3	19
7	1.1	16
8	1	13
9	3.4	8
10	1.5	8
11	1.4	6
12	2.2	5
13	2.3	5
14	3	3
15	3.5	2

The top four scored categories and subcategories identified in Table 4.11 are:

1. Subcategory 2.4 - Hybrid *P3M/PMO* practices
2. Subcategory 3.2 - Baseline facility maintenance records between 1992 and 2005.
3. Subcategory 3.3 - Maintenance cost reduction
4. Category 2 - New Practice Adoption

The scores suggest that *New practice adoption* (Category 2) and *Hybrid P3M/PMO practices* (Subcategory 2.4) have strong casual connection to *Baseline facility maintenance records between 1992 and 2005* (Subcategory 3.2) and *Maintenance cost reduction* (Subcategory 3.3), and that represents the "core" relationship of relationship of the analysis.

Therefore, the indictive analysis progressively developed by the *Grounded Theory* research on Case Study 4.1 delivers a case-based reasoning to support Proposition #1.

4.2.4.2. Pre-Post Analysis of Case Study 4.1

Every qualitative analysis approach has its strengths and limitations. To produce a balanced research outcome, a supplementary *Pre-Post* comparison analysis is used to in this section to challenge the *Grounded Theory* research conducted in Section 4.2.4.1 and examine Proposition #1 from another angle another angle.

Pre-Post comparison is a straightforward and efficient analysis approach. The value of the research outcome increases with the length of time span that the analysis studies. A typical *Pre-Post* analysis follows five basic steps: 1) select research object, 2) collects and studies empirical data, 3) organize collects data and generates comparable date sets, 4) identify the underlying trends and/or patterns and develop useful best explanations.

1) The research aim is examining whether the adoption of *P3M/PMO* practices helped the May Company in reducing corporate facility portfolio operation cost.
2) Organize and study the data collected from case study discussions.
3) The empirical data collected from Case Study 4.1 is summarized in Table 4.12.

4) Analyze the changes of BFM/SF, before and after the *P3M/PMO* adoption, and their impacts on company facility portfolio operation.

- Years and BFM/SF data sets in column (a) and (b) for used to compare BFM/SF changes each year since the May Company started learning and adopting *P3M/PMO* in 1992.
- Due to fact that the *P3M/PMO* adoption was in the early planning stage in 1992, the BFM/SF of 1992 is used as the baseline (*Pre*) to compare BFM/SF of the ensuring years (*Post*).
- The BFM/SF changes between 1992 and 2005 are summarized in column (c).
- Impacts to facility portfolio operation are summarized in column (d).

Table 4.12 - Baseline Facility Maintenance Cost Per SF (1992-2005)

No.	Year (a)	BFM/SF (b)	Unit Cost Change Compare to Previous Year (c)	Impact to Facility Portfolio Operation (d)
0	1992	$2.11	Baseline - The First Year of *P3M/PMO* Adoption	
1	1993	$2.08	Decrease	Positive
2	1994	$2.08	No Change	Neutral
3	1995	$2.05	Decrease	Positive
4	1996	$2.02	Decrease	Positive
5	1997	$1.99	Decrease	Positive
6	1998	$1.97	Decrease	Positive
7	1999	$1.95	Decrease	Positive
8	2000	$1.93	Decrease	Positive
9	2001	$1.92	Decrease	Positive
10	2002	$1.90	Decrease	Positive
11	2003	$1.89	Decrease	Positive
12	2004	$1.89	No Change	Neutral
13	2005	$1.88	Decrease	Positive

Among the 13 thirteen consecutive comparisons in Table 4.12, in 11 years the BFM/SF cost was reduced from previous year, except remained *No Change* in 1994 and 2004 due to absorbing acquired facilities resulting from major mergers.

Over 14 years, since the adoption of *P3M/PMO* practices, the May Company had gradually lowered BFM/SF by 11.73%, from the *Pre-adoption* baseline $2.11/SF in 1992 to a *Post-adoption* $1.88/SF in 2005. The *Pre-Post* analysis of Case Study 4.1 provides a supplementary examination to support Proposition #1.

Considering annual inflation rate 3% and using year 2005 a baseline, the present values of the year between 1992 and 2005 are calculated and present in Table 4.13 below. The table indicates a stronger evidence of consistent cost reduction. The BFM/SF had been gradually lowered by 64% over 14 years from $3.10/SF in 1992 to $1.88/SF in 2005.

Table 4.13 - Baseline Facility Maintenance Cost Per SF (1992-2005) with Adjusted with an Inflation Rate of 3%

No.	Year (a)	BFM/SF (b)	Unit Cost Change Compare to Previous Year (c)	Impact to Facility Portfolio Operation (d)
0	1992	$3.10	Baseline - The First Year of *P3M/PMO* Adoption	
1	1993	$2.97	Decrease	Positive
2	1994	$2.88	No Change	Positive
3	1995	$2.76	Decrease	Positive
4	1996	$2.64	Decrease	Positive
5	1997	$2.51	Decrease	Positive
6	1998	$2.43	Decrease	Positive
7	1999	$2.33	Decrease	Positive
8	2000	$2.24	Decrease	Positive
9	2001	$2.16	Decrease	Positive
10	2002	$2.08	Decrease	Positive
11	2003	$2.01	Decrease	Positive
12	2004	$1.94	No Change	Positive
13	2005	$1.88	Decrease	Positive

4.2.4.3. Grounded Theory Analysis of Case Study 4.2

Apply the same Ground Theory approach to Case Study 4.2 to analyze the impact sis of innovative adoption to the project planning and financial performance of the Buch Company.

1) Collect, code, and summarize general concepts discussed in Case Study 4.2 and summarize them into Table 4.14.

Table 4.14 - Concept Collection from Case Study 4.2

Concept Code	Concepts Collected from Case Study Discussion
a	Single client in the beginning
b	Fast growth in the 1990's
c	Seeking for efficient management methods to cope with increasing operation
d	Invited outside consultants in 2006
e	Adopted *APP* method in late 2006
f	Assess current operation status
g	Assess long term business goals
h	Align project planning with marketing strategies
i	Develop core competences for target clients
j	Screen project into four *APP* categories with *APP* evaluation scores
k	Operation efficiency
l	Resource use optimization
m	Derivative project ratio management
n	*APP* categories
o	Adopt *OPM3* to systematically manage company operation
p	Company self-awareness
q	Technical and financial readiness
r	Compete with strengths
s	Annual billing with Break-through market
u	Service billings from new retail clients
v	Service billing from target clients
w	Service billings from PNC Banks and Capital One
x	Buch annual revenue audits between 2006 and 2019

2) Group the concepts in Table 4.14 into general categories in Table 4.15.

Table 4.15 - General Categories of Case Study 4.2

Cate-gory Code	Concepts	General Category
1	Seeking for efficient management methods to cope with in-creasing operation	Operation Efficiency
	Assess current operation status	
	Assess long term business goals	
	Align project planning with marketing strategies	
	Screen project into four *APP* categories with *APP* evaluation scores	
	Derivative projects ratio management	
	Resource use optimization	
	Adopt *OPM3* to systematically manage company operation	
	Company self-awareness	
	Buch annual revenue audits between 2006 and 2019	
2	Fast growth in the 1990's	Marketing Strategy
	Single client in the beginning	
	Assess long term business goals	
	Align project planning with marketing strategies	
	Develop core competences for target clients	
	Derivative projects ratio	
	Company self-awareness	
	Technical and financial readiness	
	Compete with strengths	
	Annual billing with Break-through market	
	Service billings from new retail clients	
	Service billings from PNC Banks and Capital One	
	Buch annual revenue audits between 2006 and 2019	
3	Invited outside consultants in 2006	New Practice Adoption
	Adopted *APP* method in late 2006	
	Assess current operation status	
	Screen project into four *APP* categories with *APP* evaluation scores	
	Derivative projects ratio management	
	APP categories	
	Adopt *OPM3* to systematically manage company operation	

3) Further break down general categories in Table 4.15 into subcategories in Table 4.16.

Table 4.16 - Subcategory of Case Study 4.2

Cate-gory Code	General Category	Category Code	Subcategory
1	New Practice Adoption	1.1	Hybrid *APP*/*OPM3* Practice
		1.2	Project Screen
		1.3	*APP* evaluation charts
		1.4	Assess current operation status
		1.5	Assess long term business goals
		1.6	Derivative projects ratio management
2	Marketing Strategy	2.1	Pharmaceutical market development
		2.2	Retail market development
		2.3	Target client marketing
		2.4	Operation and marketing alignment
		2.5	Compete with strength
		2.6	Technical and financial readiness for new clients
3	Operation Efficiency	3.1	Long term business goals
		3.2	Derivative project ratios (2006-2019)
		3.3	Company annual financial audits (2006-2019)
		3.4	Macy service billings after *APP*/*OPM3* adoption
		3.5	PNC Bank service billings after *APP*/*OPM3*
		3.6	AstraZeneca service billings after *APP*/*OPM3*
		3.7	Company self-awareness
		3.8	Resource allocation optimization
		3.9	Capital One service billings

4) Identify and code axial relationships among the categories and subcategories in Table 4.16. Assign a *Significancy and Strength* weight factor to each relationships. See Table 4.17.

Table 4.17 - Relationships Among Categories of Case Study 4.2

Relationship Code	Relationship Between Categories		Relationship Importance and Strength 1 – 5 (Least to Most)
A	1.1	2.3	5
B	1.1	2.4	5
C	1.1	2.5	4
D	1.1	2.6	4
E	1.1	3.2	5
F	1.1	3.3	5
G	1.1	3.4	5
H	1.1	3.5	5
I	1.1	3.6	5
J	1.1	3.7	5
K	1.1	3.8	5
M	1.1	3.9	5
N	1.3	3.2	4
O	1.3	3.3	4
P	1.3	2.3	3
R	1.3	2.5	3
S	1.4	3.2	3
T	1.4	3.3	3
U	1.5	3.2	3
V	1.5	3.3	3
W	1.6	2.3	4
X	1.6	3.2	5
Y	1.6	3.3	5
Z	1.6	3.8	3
AA	2.1	3.2	4
AB	2.1	3.3	5
AC	2.2	3.2	4
AD	2.2	3.3	5
AE	2.3	3.4	4
AF	2.3	3.5	4
AG	2.3	3.6	4
AH	2.3	3.9	4
AI	2.4	3.2	5
AJ	2.4	3.3	4
AK	2.5	3.3	4

AM	2.5	3.4	3
AN	2.6	3.1	5
AO	2.6	3.2	5

5) Analyze the frequency and *Significancy and Strength* scores to identify the most connected and important "core" categories and relationships among them. The categories and scores are summarized in Table 4.18.

Table 4.18 - Significancy and Strength Score of Case Study 4.2

Ranking	Category	Score
1	1.1	58
2	3.2	38
3	3.3	38
4	2.3	28
5	1.6	17
6	1.3	14
7	2.4	14
8	2.5	14
9	2.6	14
10	3.4	12
11	2.1	9
12	2.2	9
13	3.5	9
14	3.6	9
15	3.9	9
16	3.8	8
17	1.4	6
18	1.5	6
19	3.1	5
20	3.7	5

The top four scored categories and subcategories identified in Table 4.18 are:

1) Subcategory 1.1 - Hybrid *APP*/*OPM3* practices
2) Subcategory 3.2 – Derivative project rations between 2006 and 2019

3) Subcategory 3.3 – Company annual financial audits between 2006 and 2019
4) Category 2.3 – Target client marketing

The scores suggest that *Hybrid P3M/PMO practices* (subcategory 1.1) and *Derivative project rations between 2006 and 2019* (subcategory 3.2) have strong casual connection to *Company annual financial audits between 2006 and 2019* (subcategory 3.2) and *Target client marketing* (subcategory 3.3), and that represents the "core" relationship of the analysis.

Therefore, the inductive analysis progressively developed by the *Grounded Theory* research on Case Study 4.2 delivers a case-based reasoning to support Proposition #1.

4.2.4.4. Pre-Post Analysis of Case Study 4.2

This section provides a supplementary *Pre-Post* comparison analysis to the *Grounded Theory* research in 4.2.4.3 and examines Proposition #1 from an additional angle. The *Pre-Post* analysis follows the four basic steps below.

1) The research aim is examining whether the adoption of *APP*/*OPM3* practices helped the Buch Company in improving project planning and company financial performance.
2) Organize and study the data collected from case study discussions.
3) The empirical data collected from is summarized in Table 4.19 and Table 4.20.
4) Analyze the changes of DPRs and company revenues, before and after the *APP*/*OPM3* adoption, and their impacts on company performance,

- Years and DPRs data sets in columns (a) and (b) in Table 4.19 are used to compare the DPR change each year since the Buch Company started working with consultants and preparing the *APP*/*OPM3* adoption in 2006.
- Due to the fact that that the *APP*/*OPM3* adoption was in its early stage in 2006, the DPR of 2006 is used as the baseline (*Pre*) to compare BFM/SF of the ensuring years (*Post*).
- The DPR changes between 2006 and 2019 are summarized in column (c).
- Impacts to company performance are summarized in column (d).

Table 4.19 - The Buch Company's Derivative Project Ratio Between 2006 and 2019

No.	Year (a)	Derivative Project Ratio (DPR) (b)	Ratio of Derivative Projects Change (c)	Impact to Company Performance (d)
0	2006	34%	Baseline	Baseline
1	2007	32%	Decrease	Positive
2	2008	35%	Increase	Negative
3	2009	23%	Decrease	Positive
4	2010	14%	Decrease	Positive
5	2011	7%	Decrease	Positive
6	2012	4%	Decrease	Positive
7	2013	5%	Increase, but below 15%	Positive
8	2014	10%	Increase, but below 15%	Positive
9	2015	4%	Decrease	Positive
10	2016	4%	No Change	Positive
11	2017	10%	Increase, but below 15%	Positive
12	2018	12%	Increase, but below 15%	Positive
13	2019	13%	Increase, but below 15%	Positive

Among the 13 thirteen consecutive comparisons in Table 4.19, DPRs decreased in six years, remained below 15% (the balanced mix between efficiency and exploring new market) in another six years, and only increased in 2008 during a market downturn. The

APP/*OPM3* adoption had significantly lowered the DPR from 34% in 2006 to 13% in 2019 and consequentially improved the company financial performance.

5) Analyze the changes of annual operation revenues, before and after the adoption of *APP*/*OPM3*, and their impacts on company financial performance.
    - Years and revenue data sets in columns (a) and (b) in Table 4.20 are used to compare the revenue change each year since the Buch Company started working with consultants and preparing the *APP*/*OPM3* adoption in 2006.
    - Revenues of 2007/2008 and 2011/2012 need to be adjusted to reflect the actual operation: 1) 2007 revenue $81.4 was inflated due to a late start of the Macy's Madison Township distribution center project in New Jersey. Partial of the payment was made to Buch for heavy equipment and log lead material procurement and $15.5 million should be credited to 2008 operation. 2) The ownership change from Medimmune to AstraZeneca triggered a spending spree at the end of 2011. Fearing the new management may slash the facility budget, the facility team made payments for a list of major equipment, but the purchases occurred in 2012. $12.1 million in 2011 should be credited to 2012 operation. These adjustments are reflected in Table 4.21.
    - Due to the fact that that the *APP*/*OPM3* adoption was in its early stage in 2006, the revenue of 2006 is used as the baseline (*Pre*) to compare BFM/SF of the ensuring years (*Post*).
    - Revenue changes between 2006 and 2019 are summarized in column (c) in Table 4.21.

- Impacts to company financial performance are summarized in column (d) in Table 4.21.

Table 4.20 - The Buch Company's Annual Revenue Between 2006 and 2019

No.	Year (a)	Annual Revenue $ million (b)	Ratio of Derivative Projects Change (c)
0	2006	41.6	Baseline
1	2007	81.4	Increase
2	2008	62.4	Decrease
3	2009	32.0	Decrease
4	2010	40.9	Increase
5	2011	77.3	Increase
6	2012	62.4	Decrease
7	2013	116.6	Increase
8	2014	133.4	Increase
9	2015	189.4	Increase
10	2016	150.7	Decrease
11	2017	231.8	Increase
12	2018	218.4	Decrease
13	2019	245.2	Increase

Table 4.21 - Summary of the Buch Company Revenue Between 2006 and 2019 (Adjusted)

No.	Year (a)	Annual Revenue $ million (b)	Revenue Change (c)	Impact to Company Financial Performance (d)
0	2006	41.6	Baseline	
1	2007	57.1	Increase	Positive
2	2008	65.9	Increase	Positive
3	2009	32.0	Decrease	Negative
4	2010	40.9	Increase	Positive
5	2011	65.2	Increase	Positive
6	2012	74.5	Increase	Positive
7	2013	116.6	Increase	Positive
8	2014	133.4	Increase	Positive
9	2015	189.4	Increase	Positive

10	2016	150.7	Decrease	Negative
11	2017	231.8	Increase	Positive
12	2018	218.4	Decrease	Negative
13	2019	245.2	Increase	Positive

Two out the three revenue decreases in Table 4.21 were results of out of the control of the Buch Company. 1) 2009 global financial crisis and 2) 2016 a regional real estate market setback. These two years should be taken out the analysis. With the adjustments and explanations, 10 out of 11 years since the adoption of *APP*/*OPM3* practices, the Buch Company experienced consistent growth and increased operation revenue from $41.6 million in 2006 to $245.2 million in 2019.

Considering an annual inflation rate 3% and using year 2006 as a baseline, the present values of the year between 2006 and 2019 are calculated and presented in Table 4.22 below. The table indicates a stronger evidence of consistent revenue increase, expect three exceptional years aforementioned in Table 4.21. The revenue increased gradually by 268% over 14 years from $61.12 million to $245.20 million.

Table 4.22 - Summary of the Buch Company Revenue Between 2006 and 2019 Adjusted with an Inflation Rate of 3%

No.	Year (a)	Annual Revenue $ million (b)	Revenue Change (c)	Impact to Company Financial Performance (d)
0	2006	61.12	Baseline	
1	2007	81.41	Increase	Positive
2	2008	91.22	Increase	Positive
3	2009	43.01	Decrease	Negative
4	2010	53.37	Increase	Positive
5	2011	82.59	Increase	Positive
6	2012	91.63	Increase	Positive
7	2013	139.27	Increase	Positive
8	2014	154.63	Increase	Positive
9	2015	213.14	Increase	Positive

10	2016	164.69	Decrease	Negative
11	2017	245.86	Increase	Positive
12	2018	224.90	Decrease	Negative
13	2019	245.20	Increase	Positive

The *Pre-Post* analyses of innovative management method adoptions discussed in Case Study 4.2 their impacts on derivative projects ratios and company operation venues provide another supplementary examination to support Proposition #1.

4.3. QCA and Cross-sectional Case Studies for Proposition #2

The *QCA* is applied to analyze a cross-sectional case study consisting of 13 sample subcontracting companies. The research seeks for the underlying relationships between condition and outcome data sets to examine Proposition #2: "*Assuring positive contributions from key factors is a precondition for successful new practice adoption.*"

4.3.1. Case Study 4.3 - Core Subcontractors' APP/OMP3 Adoptions

As a general contractor, the Buch Company's operation heavily depends on the performance of its subcontractors. To implement the *APP*/*OPM3* practices in project executions, the Buch Company strongly encouraged its core subcontractors to consider incorporating the *APP*/*OPM3* concepts and adopt similar practices to align their operations with Buch's new initiatives and pursue the targeted markets and clients together.

Due to management philosophies, company culture, financial status, expertise readiness, and other factors, the subcontractors responded to Buch's request differently. Case Study 4.3 selects thirteen core subcontractors with similar backgrounds and investigates five key factors that influenced their decisions and implementations in the new practice adoptions. This cross-sectional case study also discusses the impacts of new practice adoptions to their company performance. The thirteen subcontractors selected for

this research had collaborated with the Buch Company since the year that the company began to subcontract the work out. Together they went through similar successes and struggles and built close personal connections and a trusted business partnership.

1) Lloyd Plumbing Corp was established in 1998 and has been one of Buch's core plumbing subcontractors since early 2000's. Promptly responding to Buch's request, the leadership recognized the need, performed its own due diligence study on the *APP*/*OPM3* practices, adjusted, and implemented a well-designed adoption. The company culture, financial strength, and persistence were key in the successful adoption. The new practices helped the company to shape a clear business vision and significantly improved its company competence. In the ensuring years, the company expanded services to include Northrop Grumman, Enterprises, Chipotles, Petco, Potbelly, and Harris Teeter.

   Key Contributing Factors: Awareness of the needs for innovative management methods, willingness to improve, embracing company culture, understanding of the practices, healthy financial wellbeing allowing experimenting new practices, matured technical readiness, and persistence in implementation.

   Outcome: Successful *APP*/*OPM3* adoption and improved company operation.

2) RHI Inc was founded in 1996 and has been a loyal core subcontractor to the Buch Company. Eager to grow its business, the company learned the *APP*/*OPM3* management concepts from Buch and developed a practice program to fit its own operation. The *APP*/*OPM3* adoption, helped the company sharpen the focus on serving the retail markets. In the past dozen years, RHI developed highly skilled project teams that traveled with major clients' projects nationwide and built strong business

relationships with Nordstrom, Under Armor, Dick's Sporting, Westfield, Simons, Mills, and more.

Key Contributing Factors: Ambitious leadership was willing to learn and grow its business with innovative management methods, adequate administrative skills and technical expertise, and sufficient financial resources to support the new practice implementation and absorb setbacks through the learning curve.

Outcome: A successful *APP*/*OPM3* adoption that significantly improved the company marketing and business performance.

3) Poole Mechanical Corporation was one of the original subcontractors who played a key role in Buch's growth in the early years. Faithfully responding to Buch's request, the company learned and planned to adopt the *APP*/*OPM3* practices. An unexpected ownership change caused the company to lose a few major clients and the consequent financial hardship forced the company into a surviving mode, leading to a stop in the new practice adoption. Even though the new leadership tried to resume the adoption after a slow business recovery, the financial weakness and lack of technical training hindered the attempts. The company missed an opportunity to grow with Buch and became a third-tier mechanical subcontractor for smaller projects.

   Key Contributing Factors: weakened financial strength and loss of skilled veterans derailed the new practice adoption.

   Outcome: An unsuccessful implementation *APP*/*OPM3* and critical business opportunity losses.

4) The Electric Shop Inc was founded in 1987 and built close personal and business connections with the Buch teams through many projects delivered together. The company

enjoyed a fast business growth in the 2000's. The company did not respond to Buch's request enthusiastically, because the ownership did not believe in standardized formal management methods and was reluctant to make investments in marketing and employee trainings. In the late-2000's the company experienced financial crises in the economy downturn and suffered major personnel turnovers. After a prolonged struggle, the company was driven out of business by competitors and bankrupted in the mid-2010's.

Key Contributing Factors: nearsighted business vision, unsupportive company culture, and resistance to changes and improvement.

Outcome: Refusal to adopt innovative practices causing the company to struggle and go out of business.

5) Mid-Atlantic Interiors Inc was established in 1995 and soon became one of the Buch Company's reliable painting subcontractors. The founder's son took over the management and brought in a vision to expand the company. Promptly responding to Buch's request, the company learned and adopted a modified *APP*/*OPM3* and made a series of investments in advancing the new practice. The efforts slowly paid off. Teaming with Buch, the company won more high-profile projects and upgraded its operation. With improved marketing, track records, and core competence, the company expanded its business presence geographically and attracted new clients.

Key Contributing Factors: Recognition of the need for innovative management methods, due diligence study of the new practices, willingness of investing time and resources in practices, employee engagement, embrace of company culture, adequate technical skills, and persistence in the adoption.

Outcome: A successful *APP*/*OPM3* adoption that helped the company to thrive in later years.

6) ISI Demolition Inc, formerly known as Interior Specialist Inc, was a small handyman operation that started in 1990. With sound business judgments, the founder consolidated the operation around demolition and carved a niche market for the company. Working together through some tough projects, ISI earned battle-tested trust with Buch teams and performed nearly 80% of the Buch's demolition work in the 2000's. Promptly responding to Buch's request, the company studied and designed a similar program to adopt the practice to fit its operation. In the implementation process, ISI elevated safety standards, and increased insurance coverage limits and bond capacities to align with Buch's new marketing initiatives. With newly acquired competence, ISI expanded its clients with Gilbane, Clarks, Whiting Turner, PDR, Hoar, and Clayco.

   Key Contributing Factors: Vision and determined leadership, embrace of company culture, willingness to improve, prudent research and adjustments, sufficient financial support and technical readiness, and persistence in execution.

   Outcome: A successful adoption and long-term benefits to company operation.

7) MT Laney Company was founded with a dump truck in 1978 and struggled in the early years. The company began the small residential paving operation in the 1990's and slowly grew a successful business. At the time the Buch Company was encouraging core subcontractors to consider the *APP*/*OPM3* practices, MT Laney was parallelly seeking a similar innovative management method to retool its operation. Aiming to pursue large corporate clients, the company hired a law firm and improved its

contracts and legal documents, upgraded fleet equipment, elevated safety standards, and invested in core competence training. The efforts paid off in the ensuing years, leading MT Laney to become a formidable force in the regional markets of site development, municipal, industrial, and commercial grading and paving, soil modification, reclamation, recycling, aggregate supply, and roll-off services.

Key Contributing Factors: Keen awareness of the need for innovative management methods, visionary leadership and embrace of company culture, prudent study selection, understanding of new practices, willingness to take calculated risks and invest in adoptions, adequate financial support and technical readiness, and persistence in implementation.

Outcome: Successful *APP*/*OPM3* adoption and improved operation performance.

8) RF Hurley Masonry Inc, a small family-owned local masonry company, had a close personal connection with the Buch Company and used to perform nearly all masonry work for the Buch Company in the early years. The company prided its craftsmanship and quality work and shrugged off Buch's suggestion to adopt the *APP*/*OPM3* practices to upgrade its operating standards and expand core competencies to pursue higher-end clients. Eventually the Buch Company had to replace RF Hurley with other masonry subcontractors who shared the same market vision and operating philosophy. Today the RF Hurley Masonry Inc remains a small company and is no longer on the Buch Company's subcontractor rotation list.

Key Contributing Factors: Stubborn leadership, lack of vision, conservative company and prideful culture, complacency in status quo, and financial weakness.

Outcome: Opportunity losses and business failure resulted from resistance to innovative and systematic management practices.

9) Extreme Steel, Inc is steel services company that was established and enjoyed a fast growth in the 2000's. Responding to Buch's request for aligning business strategies and marketing collaboration, the company studied and incorporated the *APP*/*OPM3* concepts into its operation, increased investment in core competencies development and employee training, revamped IT and AutoCAD capacity, and elevated safety and quality standards. To differentiate itself from other steel contractors, the company built its own steel fabrication yard to better control the inventory and deliveries. Since the adoption, the company tripled gross operating revenue from 2007 to 2019.

   Key Contributing Factors: Keen awareness of the need of innovative management methods, strong willingness to improve, risk tolerant company culture, solid financial balance sheets, advanced technical readiness, and determination in implementation.

   Outcome: Successful *APP*/*OPM3* adoption and improved operation performance.

10) Commercial Flooring Inc, established in the late 1970's, was one of Buch's core floor covering subcontractors in the early years, and the two companies together completed a long list of successful projects. Expecting an immediate success, without a thorough study of the new practices, CFI quickly responded to Buch's request for *APP*/*OPM3* practices. CFI tried to copy the steps that the Buch Company took without proper adjustments to its own business characteristics. The initial adoption struggled and was aborted a year later when conflicts arose among the owners due to business disagreements and personal issues. The internal strife severely hit the company operation to

the point that it filed a bankruptcy claim in 2008. As the original owners exited, a group of veteran employees purchased the falling company. The Buch Company provided financial assistance and business opportunities to help the "new" company survive and resurrect in the first two years. Responding to the Buch's request, the new CFI leadership promptly learned the *APP*/*OPM3* concepts from Buch and adopted a modified practice to align its business operation with the Buch's marketing pursuits. The new CFI has fully recovered and expanded its presence beyond the Mid-Atlantic region.

Key Contributing Factors:

- The original CFI was aware of the need for an innovative management method but was hasty to act without gaining a full understanding of the new practice, leading to a weakened financial strength, disrupted company operation and culture, and exodus of veterans.
- The new CFI management took time to study and adjust the new practices before implementing the adoption, leading to recovered financial strength, a rebuilding operation and company culture, return of loyal veterans with technical expertise, and persistence in implementation.

Outcome:

- Original CFI had an aborted *APP*/*OPM3* adoption experiment.
- The new CFI had a successful *APP*/*OPM3* adoption implementation.

11) Avon Tile, Inc was established in mid-1950's as a side-kick business of a wealthy real estate developer who had close political connections with local union trades. The company had a word-of-mouth reputation about the high quality of its work and

relied heavily on union funded projects. The Buch Company encouraged Avon Tile to adapt the *APP*/*OPM3* practices, improve the operation model, and pursue clients beyond the union circles. Too proud of its craftsmanship and confident in longstanding union connections, Avon Tile was reluctant to make the change or invest resources in technology and personal training. As the union market declined, the company struggled to adjust and compete against others due to antiquated administrative systems, lack of technical training, and high union labor costs.

Key Contributing Factors: Disbelief in adopting innovative modern management methods, nearsighted business vison, and unsupportive company culture.

Outcome: A stagnant operation in the slowly declining union market.

12) General Concrete Inc was established in 2001 by two young brothers who emigrated from Salvador. Their very first project was the front door concrete pad for the Buch Company. While taking any project they could get to stay afloat in the early years, the company accumulated much needed experience and grew financial strength. Eagerly responding to Buch's request for the *APP*/POM3 practices, the company hired a preconstruction VP to spearhead estimation and marketing efforts, installed an accounting software, and concentrated project planning on the business development in commercial projects. With focused vision and persistence, the company had achieved a significant success from 2007 to 2019.

Key Contributing Factors: a dynamic young company led by visionary entrepreneurs, keen awareness for innovative management methods, willingness to make actions, investments in technology and employee training, and resolution in the adoption process.

Outcome: Successful *APP*/*OPM3* adoption and improved operation performance.

13) Executive Glasses Services Inc, a commercial glazing contractor established in 1988, was one of Buch's core subcontractors. Responding to Buch's request, the company promptly conducted research and implemented a modified *APP*/*OPM3* practice to align its operation and marketing strategies with Buch's new initiatives. The company upgraded its safety and quality standards, invested in technology and equipment, and expanded operations into Class-A office building's exterior curtain walls. Despite being off to a strong start, the adoption implementation fizzled when the company encountered setbacks in the 2008-2009 economic recession. Due to business distractions, even after the economic recovery, the company did not resume the implementation. The company was eventually removed from Buch's bid rotation and replaced with more suitable glazing subcontractors.

    Key Contributing Factors: awareness of the need for innovative management methods, willingness to study and adopt, sufficient financial and technical readiness, but lack of persistence in the learning curve.

    Outcome: An aborted *APP*/*OPM3* adoption and a business opportunity loss.

4.3.2. QCA Research on Proposition #2

The *QCA* method is employed to analyze a cross-sectional case study consisting of 13 sample subcontracting companies, investigate the causal connections between condition and outcome data sets, and examine Proposition #2.

Case Study 4.3 discusses the responses of 13 core subcontractors to Buch's request for adopting *APP*/*OPM3* practices and their adoption processes. *QCA* method is employed to analyze the collected empirical information to examine Proposition #2.

- Condense and conceptualize empirical information in case study discussions.
- Select six key contributing factors (conditions) to the new practice adoptions.
- Repeat the same process with all 13 sample subcontractors and produce six condition data sets and one outcome data set.
- Code and the condition and outcome data sets and construct a *Truth Table*.
- Analyze the *Truth Table*, identify connections between condition and outcomes sets.
- Analyze the relationship between the *Truth Table* findings and the proposition statement and determine whether the *QCA* research results support Proposition #2.

4.3.2.1. Condense and Conceptualize Empirical Information in General Discussions

QCA is used to analyze a cross-sectional case study consisting of 13 sample subcontracting companies. The research seeks for the underlying relationships between condition and outcome data sets to examine Proposition #2.

General discussions about the 13 sample subcontractor companies in Case Study 4.3 are condensed below in Table 4.23. The information is used to develop condition and outcome data sets for further *QCA* analysis.

Table 4.23 - Summary of General Discussions in Case Study 4.3

NO	Case Study #	Case Study Company	General Discussion	Project Performance Outcome
1	4.3 (1)	Lloyd Pluming	Awareness of the needs for innovative practices, willingness to learn and adopt, visionary leadership, supportive company culture, healthy financial wellbeing, suitable technical readiness, and persistence in implementation.	Successful
2	4.3 (2)	RHI Flooring	Visionary leadership, keen awareness of the needs for new practices, willingness to learn and adopt, supportive company culture,	Successful

			adequate financial strength and technical readiness, and persistence in implementation.	
3	4.3 (3)	Poole Mechanical	Awareness and willingness to learn and adopt innovative management methods, weakened financial strength, loss of skilled veterans, and lack of technology investment and training.	Failed
4	4.3 (4)	The Electric Shop	Nearsighted leadership, not believing in systematic management, unsupportive company culture, and aversion to taking calculated risks investing in technology and training.	Failed
5	4.3 (5)	Mid-Atlantic Painting	Keen awareness of the needs for innovative management methods, willingness to learn and adopt, visionary leadership and supportive company culture, solid financial strength, adequate technical skills, and persistence in implementation.	Successful
6	4.3 (6)	ISI Demolition	Keen awareness of the needs for innovative practices, desire to learn and take actions, visionary owners, supportive company culture, solid financial strength, willingness to invest in equipment and technical training, and patience in adoption process.	Successful
7	4.3 (7)	MT Laney Paving	Awareness of the needs for innovative practices, visionary leadership, embracing company culture, desire to learn and improve, strong financial backing, adequate technical expertise, and resolution in implementation.	Successful
8	4.3 (8)	RF Hurley Masonry	Old-school management mentality, resistance to learning new practices, not believing in technology or systematic management.	Failed
9	4.3 (9)	Extreme Steel	Strong desire to learn and adopt innovative practices, visionary leadership, supportive company culture, solid financial backing, significant investment in new fabrication facilities and equipment, and persistence in adoption.	Successful
10	4.3 (10.1)	Commercial Flooring Service (Old)	Awareness of the needs for innovative practices, hastily copying other's success without learning and adjusting.	Failed
11	4.3 (10.2)	Commercial Flooring	Awareness of the needs for innovative management methods, understanding of the new practices, experience from previous attempt,	Successful

		Service (New)	learning management's failure, adequate financial backing, recovery of loss of skilled veterans, and prudence and persistence in implementation.	
12	4.3 (11)	Avon Tile	Overconfidence in personal connections, overdependence in union market, ignorance of the need for innovative management practices, healthy financial wellbeing, and suitable technical readiness.	Failed
13	4.3 (12)	General Concrete	Keen awareness of the needs for innovative practices, eagerness to learn and adopt, ambitious leadership, supportive company environment, adequate financial strength and technical readiness, and determination in adoption.	Successful
14	4.3 (13)	Executive Glass	Awareness of the needs for innovative practices, willingness to learn and adopt, sufficient financial support, suitable technical readiness, but lacking persistence in implementation.	Failed

4.3.2.2. Select and Code Conditions and Outcomes

Six key contributing factors are identified in the case study discussions: 1) Awareness and Willingness: leadership vision and motivation, 2) Knowledge of New Practices: learning and acquiring in-depth understanding of the new practices, 3) Company Culture: Collective attitude and engagement from senior management and teams toward innovative practices and changes, 4) Financial Strength: sufficient resources to support new practice implementation and absorb costs through the learning curve, 5) Technical Readiness: adequate expertise, personnel training, equipment, IT infrastructure, and administrative skills, and 6) Persistence in Implementation: patience and resolution in execution. The six key contributing factors are categorized and coded in Table 4.24.

Table 4.24 - Categories and Codes of Key Contributing Factors

No.	Key Contributing Factors to New Practice Adoption	Contribution Code	
		Positive	Negative
Factor 1	Awareness and Willingness	1	0
Factor 2	Knowledge of New Practices	1	0
Factor 3	Company Culture	1	0
Factor 4	Financial Strength	1	0
Factor 5	Technical Readiness	1	0
Factor 6	Persistence in Implementation	1	0

The outcomes of the new practice adoptions are coded below in Table 4.25.

Table 4.25 - Categories and Codes of New Practice Adoption Outcomes

New Practice Adoption Outcome	
Successful	Failed
1	0

4.3.2.3. Truth Table Analysis

Six sets of conditions and one outcome are used to develop the *Truth Table* in Table 4.26.

Table 4.26 - Truth Table for QCA Analysis of Case Study 4.3

No	Case Study	Key Factor Contribution						Organizational Performance Outcome
		#1	#2	#3	#4	#5	#6	
1	4.3 (1)	1	1	1	1	1	1	1
2	4.3 (2)	1	1	1	1	1	1	1
3	4.3 (3)	1	1		0	0		0
4	4.3 (4)	0	0	0	1	1		0
5	4.3 (5)	1	1	1	1	1	1	1
6	4.3 (6)	1	1	1	1	1	1	1
7	4.3 (7)	1	1	1	1	1	1	1
8	4.3 (8)	0		0		1		0

9	4.3 (9)	1	1	1	1	1	1	1
10	4.3 (10.1)	1	0	1	1	1	0	0
11	4.3 (10.2)	1	1	1	1	1	1	1
12	4.3 (11)	0	0	0	1	1		0
13	4.3 (12)	1	1	1	1	1	1	1
14	4.3 (13)	1	1	1	1	1	0	0

Note: Blank cells indicate these contributing factors have insignificant impacts or are irrelevant to the organization performance outcomes.

Table 4.26 is rearranged by successful and failed outcomes, see Table 4.27 below.

Table 4.27 - Rearranged Truth Table Analysis of Case Study 4.3

No	Case Study	Key Factor Contribution						Organizational Performance Outcome
		#1	#2	#3	#4	#5	#6	
1	4.3 (1)	1	1	1	1	1	1	1
2	4.3 (2)	1	1	1	1	1	1	1
3	4.3 (5)	1	1	1	1	1	1	1
4	4.3 (6)	1	1	1	1	1	1	1
5	4.3 (7)	1	1	1	1	1	1	1
6	4.3 (9)	1	1	1	1	1	1	1
7	4.3 (10.2)	1	1	1	1	1	1	1
8	4.3 (12)	1	1	1	1	1	1	1
9	4.3 (3)	1	1		0	0		0
10	4.3 (4)	0	0	0	1	1		0
11	4.3 (8)	0		0		1		0
12	4.3 (10.1)	1	0	1	1	1	0	0
13	4.3 (11)	0	0	0	1	1		0
14	4.3 (13)	1	1	1	1	1	0	0

The following relations, among the contributing variables and project performance outcomes, are observed in Table 4.27:

1) The first eight adoptions have successful outcomes and positive contributions from all the key factors, and no negative contribution from any key factors.
2) The last six adoptions have failed outcomes with mixed contributions from the key factors, and at least one negative contribution from the key factors.

The connections observed in Table 4.27 and their relations to Proposition #2 are further generalized in Table 4.28 below.

Table 4.28 - QCA Summary of Case Study 4.3

		Outcome		Supporting Proposition #2
		Successful	Failed	
Key Contributing Factors	All Positive	8		Yes
	At least one negative		6	Yes

In conclusion, the case study and *Grounded Theory* analysis conducted in this section support that Proposition #2 *"Assuring positive contributions from key factors is a precondition for successful new practice adoption"* generally holds true in the facility project management practices. Not all the contributions of the conditions need be positive, but none can be negative.

4.4. QCA Analysis and Case Studies for Proposition #3

While cross-industry learning can effectively meet the increasing demands for innovative modern facility management methods, it also brings need challenge and risks in new management practices adoption. This section uses Agile method as a prime example to analyze the critical role that risk control plays in new practice adoption.

Flexibility and nimbleness are Agile's strengths, as well as its Achille's heels. Yang stated in his article *Rethinking Agile: A Structured Approach to Risk Management* (2020),

71% of surveyed organizations regularly incorporated Agile into their projects and majority of senior executives agreed that Agile is essential to the success of strategic initiatives, but 2018 data indicated that Agile has not fully permeated the business world. This might be due, at least in part, to Agile lacking formalized risk management protocols.

While the "*fail fast, fail little, and recover fast*" Agile approach is dynamic in managing loosely defined scopes, it brings various associated risks to facility projects. These risks need to be prudently harnessed in project execution.

4.4.1. Case Studies for Proposition #3

Agile only works well where certain prerequisite conditions exist. At the core of Agile is an implicit acknowledgement of mutual trust among competent and engaged parties. The emphasis on fair dealing with presumed obligations makes Agile projects vulnerable where disputes arise. Team competence, risk control strategy, communication effectiveness, and corporate risk tolerance are other key risk variables in Agile project execution. Mismanaged risks can lead projects to complicated legal entanglements.

Total 23 Agile projects (15 successful and 8 failed) are studied in this section to demonstrate and analyze the impacts of key risk variables on project outcomes.

4.4.1.1. Case Study 4.4 - The Buch Company CMiC Software Development Project

By the summer of 2012, the Buch Company was using the following software products: 1) *Star Builders*, an outdated software with basic accounting; 2) *Sure*

Track/Primavera/Microsoft Project, a cluster of project scheduling software; 3) *Primavera and Expedition,* two rigid project administration software products; 4) *Timberline and GTCO Digitizer,* an antiquated estimating software and a digital takeoff tools; 5) *Blue Beam and Revu,* two bid soliciting and tacking software; 6) *PlanGrid,* a standalone software for project close-out, punch-lists, and as-built document management, as well as few others. Essentially, the Buch IT infrastructure was a patch-up collection of the individual software products that the company previously purchased in the past years. Theses software products were incompatible with one another, while the IT system was inefficient and problematic.

In 2012 the Buch Company decided to rebuild the IT infrastructure and solicited proposals from a group of specialty software firms. Through evaluation and extensive interviews, the Computer Methods International Corporation (CMiC) was selected for its expertise in facility and construction project management, market share, and more importantly for its track record and reputation of collaboration with clients. The Buch Company, with very limited knowledge of IT infrastructure, needed a trustworthy partner.

Suggested by the CMiC team, the two parties agreed to apply the Agile approach to manage this vaguely defined project. The Buch Company and CMiC entered an initial contract purchasing and installing basic CMiC Accounting. The two teams intentionally started the project with the well-defined Account package to learn from each other, foster trust, and design an Agile working model that fit best for this project.

After the initial phase, with developed trust in each other and elevated confidence in Agile practice, the teams added the second phase to the original contract, transferring the historic data from Star Builder to CMiC accounting platform. To manage the much

less defined scope of work in the second phase, the teams heavily relied on Agile feedback-improvement iterations to clarify expectations, design creative solutions, and resolve technical and budget issues.

To accommodate the Agile trial and error iterations, Buch kept both old and new systems running parallel for eight weeks, allowing and accounting staff and project managers ample time to engage, learn, and give constructive feedback. The CMiC team spent considerable time training Buch staff with the new accounting platform. The patience and efforts turned the previous resistance from those who were skeptical, into acceptance and embracement.

After the teams progressively built trust, developed the Agile working model, and fine-tuned the practice in the first few months, the project accelerated into its final phases of integrating individual standalone software into the new CMiC platform. The same brainstorming and feedback-improvising iterations carried throughout the projects and post-installation services.

The CMiC team comprised of experienced Agile coaches. They broke down the ambiguous project scope into small manageable objectives through rounds of collaboration and improvement. Through this CMiC IT infrastructure project, the Buch Company gained a valuable hands-on experience in Agile management and risk control.

Project Risk Control Strategy: Progressively build trust and confidence in each other and incrementally incorporate justifiable risks and scope level in this Agile project.

Main Contributing Variables to Control: Appropriate project type, adequate trust level, competent Agile partners, tolerant project environment, and effective feedback-improvement iteration.

Project Outcome: A well-designed risk control strategy executed and a successful Agile project.

4.4.1.2. Case Study 4.5 - The Coastal Corporation Powerplant Projects in China

In 1996 Coastal Power China and Henan Electric Power Company (HEPC) signed a joint venture (JV) agreement to redevelop the Hebi Powerplant (鹤壁电厂), see Figure 4.20. The Coastal held 51% of the JV shares and was in charge to deliver an EPCOT (engineering, procurement, construction, operation, and transfer) project through three phases: 1) *Engineering, Procurement, and Construction (EPC),* in 2.5 years retrofit existing two 200MW and two 300MW units, design and install two new 600MW units, and reconfigure the entire facility to integrate new and existing production systems. 2) *Plant Operation*, after the new power production is fully online Coastal operates the power plants in the first 25 years. 3) *Ownership Transfer*, at the end of the 25th year, Coastal transfers its ownership to HEPC for a nominal amount of $1.

Figure 4.20 - Hebi Electric Powerplant

The EPC phase was estimated to be $385million to install two new supercritical 600MW units and retrofit four existing subcritical units, upgrade the in-plant railroad and coal pulverizing assemblies, widen the water cannel to River Qi, build two new steam cooling towers, and enlarge the existing power switchyard. The Coastal Houston headquarters deployed a team to China to manage the EPC phase. The EPC team

consisted of powerplant experts but had no experience in China. They quickly realized that the conventional project management method would not be adequate to manage the technical complexities, cultural differences, language barriers, and government bureaucracy. The team decide to apply an adaptive strategy to creatively manage the project.

To avoid regulation pitfalls, EPC hired Wuhan Electric Power Design Institute (WEPDI) to translate Chinese engineering standards and regulations to narrow the technical and language gaps and familiarize themselves with local power industry. The EPC team took steps in building up trust with WEPDI. As the confidence grew in WEPDI's technical capacity and fair business dealing, the EPC team awarded WEPDI with the engineering design contact for the Hebi project. The two teams collaborated through numerous frequent feedback-improvement cycles in resolving project issues, a true adaptive approach that worked effectively for this loosely defined and complex project.

With better understanding of the Chinese power market and assistance from JV partner and engineering consultants, the EPC team dissected the complex project into manageable packages within the Coastal corporate risk tolerance. The EPC team conducted extensive market research and solicited proposals from international and domestic power equipment suppliers. The bid reviews revealed that Chinese manufacturer outpriced their USA and European rivals by about 40%, but inconsistent power output efficiency was a risk concern. After rounds of consulting sessions with WEPDI and JV partners and evaluation discussions with headquarters in Houston, the EPC team decided to take the savings and to find creative contractual arrangements to manage the power output efficiency risk.

First, the EPC team requested WEPDI to design the portions of the project with relative defined scope, solicit proposals from short-listed bidders, secure committed agreements of individual packages, and negotiate contract provisions for later adjustment and integration. Out of three Chinese manufacturers, Dongfang Electric Ltd outbidded Shanghai Electric Group Limited Company and Harbin Electric Ltd and won the main power train (*furnace-turbine-excitor*) equipment contract with competitive prices and overall technical scores. The Power China Henan Engineering Ltd (PCHE) outbidded three other installation companies and won the construction contract with its business connection with the JV partner, relatively low price, and the advantage of knowing the home province.

Secondly, the EPC team and WEPDI performed extensive research and discovered that the system control console designed and manufactured by Dongfang was the problem behind its power output inconsistence. The EPC team conducted a separate bidding process on the system control console package. Siemens outbidded its USA rivals, Foster Wheeler and Stewart Stevenson, and won the contract. With major identified risks broken down, evaluated, and separately contained, the EPC team began to combine individual contracts back together in a creative risk management structure. Exercising the assignment clauses tactfully embedded in every aforementioned contract, the EPC team took the system control console portion out of Dongfeng's original contract and replaced it with Siemen's contract. The assignment made Siemens a subcontractor under Dongfang who would contractually guarantee the production efficiency of the entire "*power train + control*" system.

The EPC team shifted focus to the risk of overall "*power to national grid*" production efficiency. To avoid the interface risks between power-train equipment manufacturer and the auxiliary facility construction, the EPC team assigned PCHE's contract under Dongfang, and made Dongfang the prime contractor of the project. To avoid the interface risks between engineering and prime contractor, the EPC team assigned WEPDI's contract under Dongfang, and made Dongfang the *design-supply-construction turnkey* contractor for the entire Hebi project. In the final negotiation, the EPC team agreed to increase the contract amount in exchange for a binding guaranty that, in case the "*power to grid*" production blow the 95% contractual requirement. Dongfang would pay the JV the electricity production shortage. The guarantee is endorsed by a China state bank.

The similar adaptive practice was used to manage NOx's and Sox's emission compliance risks to World Bank's high environmental standards that had a significant financial impact to the project loan financing.

Project Risk Control Strategy: Break the complex project into manageable packages layer by layer, understand and contain the risk within corporate risk tolerance. Reverse the process, use the assignment clauses to integrate induvial packages into a turnkey contract and transfer the risks to the prime EPC contractor.

Main Contributing Variables to Risk Control: Appropriate project type, prudently designed risk control structure, trusted and competent partners, tolerant corporate environment, and productive feedback-improvement iterations.

Project Outcome: A well-designed risk control strategy and a successfully executed Agile project.

4.4.1.3. Case Study 4.6 - Coastal Aruba Refinery Refurbishment Project

Before declaring the war against Nazi Germany, the United States could only supply the British Airforce aviation with gasoline produced from the Aruba refinery on the neutral Dutch island. The refinery was one of the world's largest in WWII. In February 1942, the German submarine U-156 attacked the refinery and torpedoed three large oil tankers. Due to demand declining after the war the refinery was shut down. In 1985 the Coastal Corporation acquired the refinery from Exxon. Amid the Caribbean crude oil surge in the mid-1990's, Coastal decided to refurbish the refinery. The project started in 1996 with refurbishing pressured vessels and storage tanks, see Figure 4.21.

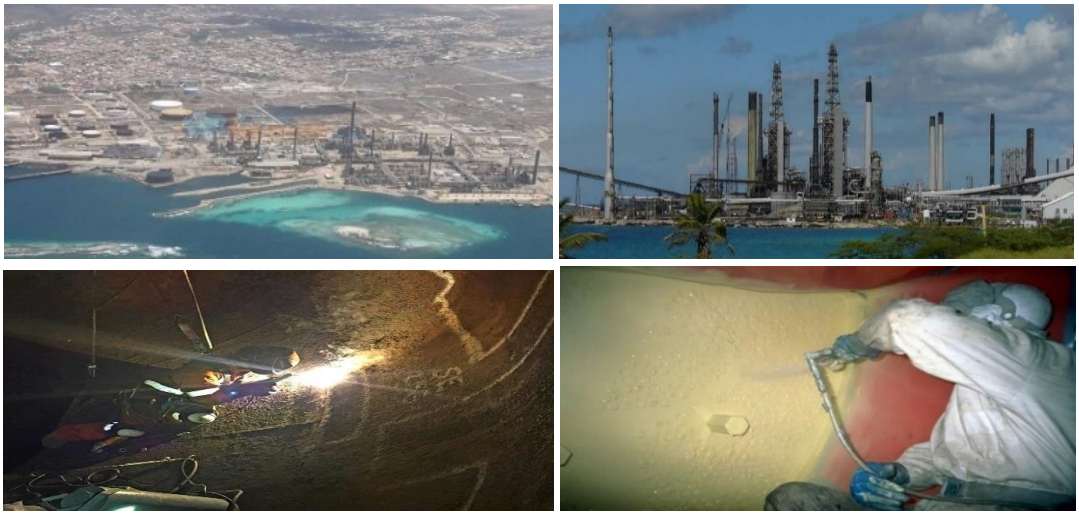

Figure 4.21 - Coastal Aruba Refinery Refurbishment Project

The vessels and tanks had taken abuse from chemical residual and natural weather for decades and the metal walls were seriously damaged by corrosions. A team was deployed from Houston to Aruba to oversee the restorations and ensure all components were mechanically sound and ready for system commission.

The interior surfaces of the vessel walls were protected by a special coating to separate metal from contacting acidic chemicals inside the vessels. As the coating wore down and peeled off, the abrasive chemicals aggressively attached to the metal and caused irregular pits on the wall surfaces, significantly compromising the mechanical integrity of the vessels. Contractors needed to clean up chemical residue, sandblast off existing coatings rust, use special welding to fill the pits and restore the wall thickness, and apply layers of new coatings. The corrosion conditions hiding behind the existing coating or rust presented a challenge to determine the project scope of work. The actual work only could be defined after the coatings and rust were removed. Due to space, scheduling, and safety restrictions, the restoration work had to be completed in one assigned area in one shift before moving onto the next.

The project team applied the flexible Agile approach to manage the undefined scope of work while creatively using the contract formats approved by corporate counsels to control the project risks. A third-party engineering firm was entrusted to develop a chart of corrosion severities, restoration options, and unit cost. The team invited Cust-O-Fab Inc, a petrochemical specialty service company from Tulsa, Oklahoma, to perform the onsite restoration as an Agile partner. Cust-O-Fab employed 800 highly skilled welders certified for pressured equipment repairs and the company had developed a trusted relationship with Coastal in previous projects.

The Coastal and Cust-O-Fab entered a *Maximum Not-to-Exceed* Contract which provided the legal terms and a level of financial certainty mandated by Coastal headquarters while allowing a level of autonomy for the project team to effectively manage situations on site. The Coastal and Cust-O-Fab teams worked side by side to identify issues,

evaluate solutions, and process requests as well as authorization paperwork at a real time pace. The parties discussed and addressed potential problems, creative suggestions, and conflicts at daily coordination meetings. The feedback-improvision iterations played a key role to the project success.

Project Risk Control Strategy: Use the *Maximum Not-to-Exceed* format to control contractual risks, while allowing project teams sufficient autonomy to exercise Agile practice in project management.

Main Contributing Variables to Risk Control: Appropriate project type, frequent and effective feedback-improvement irritations, long trusting relationship, and highly professional Agile partners.

Project Outcome: A well-designed risk control strategy and a successfully executed Agile project.

4.4.1.4. Case Study 4.7 - Macy's Herald Square & Bloomingdale Flagship Projects

The Herald Square store on 5th Avenue in NYC is a Macy's national flagship store, where the iconic Macy's Thanksgiving Parade takes place, see Figure 4.22. A 10-year renovation program of $50 million started in 2012 to progressively upgrade the interior and exterior totaling 1,250,000 SF on all eleven floors. The objective of the investment was vaguely defined by the Macy's headquarters as "optimizing the financial return of the investment and invigorating the public image of this prestigious store."

Figure 4.22 - Macy's Herald Square Flagship Store, 5th Avenue, New York

Due to aging and numerous remodels in the past, most of the work to be performed in this vintage store would involve hidden conditions behind walls, under floors, or above ceilings. The scopes could not be determined until after removing layers of materials. Based on long a track record of quality services and established mutual trust, Macy's selected the Buch Company as an Agile partner in this challenging project. The two companies entered a *Construction Manager at Risk* contract which provided the legal and financial verbiages mandated by Macy's corporate policies while allowing sufficient flexibility for the project teams to exercise Agile principles in project execution. The contract is subject to annual evaluation and renewal.

In each annual renewal, Macy's and the Buch Company renegotiated weekly key financial items such as general condition costs and markups (%) on direct, indirect, and subcontractor costs. The renewed contract amount had zero dollar in the beginning of the year, the actual scopes of work would be added on later as the project evolved. The teams from both sides worked together and developed transparent open-book cost estimates. Frequent progress meetings served as Agile feedback-improvisation iterations for real time communication, problem solving brainstorm sessions, quick document processing,

and prompt decision making. The following example demonstrates how the open-book cost estimating processed. To estimate a typical project cost item, 1) the Buch team would prepare a request for proposals (RFP) based on their best knowledge and information available and recommend a list of bidders; 2) Macy's team would review and approve the RFP and listed bidders; 3) the Buch team would administrate the bidding process and prepare a recommendation report; 4) the Buch and Macy's teams would evaluate the RFPs together, award the work to the winning bidders, and add the new cost items to the *Construction Manager at Risk* contract between Macy's and the Buch Company; 5) the Buch team would assume the management duties and contractual liabilities of execute the work.

The *Construction Manager at Risk* contract format sufficed the risk control policies required by Macy's Financial and Legal departments, while providing the flexibility that the teams needed to effectively manage field situations. This creative approach delineated the commercial risks from technical risks and managed them with appropriate measures respectively. By so doing so, Macy's took advantage of savings from competitive bidding while effectively holding Buch Construction accountable for the conventional project commercial and legal obligations.

Between 2013 and 2018, Macy's had a facility upgrade program with an annual budget of $1.5 million to renovate its prestigious Bloomingdale flagship store on the 59th Street in NYC, see Figure 4.23. It was a project with a smaller scale than the Herald Square project, though these two programs shared many similarities. The Buch Company and Macy's successfully applied the same project management and risk control practices in both projects.

Figure 4.23 - Bloomingdale Store on 59th Street, New York City

Project Risk Control Strategies: Use the *Construction Manager at Risk* contract format to control commercial risks, while allowing the project teams adequate autonomy to apply Agile practices in managing uncertain project situations.

Main Contributing Variables to Risk Control: Appropriate project types, a trusted business relationship, competent Agile partners, highly compatible expertise composition, efficient feedback-improvement cycles through multiple years.

Project Outcomes: Two successfully executed Agile projects with well-designed risk control strategies.

4.4.1.5. Case Study 4.8 - Royal Garden and International Language Institute Projects

In 2014 the Buch Company was approached by Royal Garden Inc. to build a senior adult health daycare center. Knowing little about Royal Garden, Buch turned down this relatively small project. Later, persuaded by a mutual acquaintance and reconsidering the possibility of penetrating the promising assisted senior living market, Buch agreed to take the project.

During the contract negotiation, the Buch team realized that the owner from overseas was not familiar with the design and construction market and only had a vague concept for the project. To manage the loosely defined scope, the parties agreed to apply the Agile approach and would work out the details through collaboration. The Buch Company and the owner entered a *Construction Consulting* contract to provide professional advisory service only.

In the beginning the project went as planned and two companies worked well together. Because of management philosophical and cultural differences, as the project progressing, the two parties started disagreeing on various issues and situations. Language barriers led to critical miscommunication and misunderstanding, consequently undermined trust, and deteriorated collaboration. At the end the Agile partnership collapsed, and two companies were on the verge of taking legal action against each other.

Before the Buch Company was involved in the project, the owner drove a self-centric hardnosed bargain and signed a design contract that the local AE firm was only obligated to provide a bare minimum design to obtain the country permit. To cut down costs, the owner stubbornly requested the AE firm not to include the construction administration in the contract. Inevitably, discrepancies emerged during the construction, the owner came back to the AE firm and asked for help, the AE firm was busy and could not add the project into schedule, the owner held up the contract retainage payment to pressure the issue, and the situation turned into a hostile standoff. The conflicts between the owner and the AE firm consequentially caused project delays and subcontractor claims and walk-offs. As project consultant, the Buch offered professional suggestions to mitigate the situation, but the distrustful owner did not believe that the Buch Company was

looking out for his best interest. The owner started hold up the progress payments and provoked more claims and lawsuits. The Buch Company dissolved the contract on the ground of owner's breaching contract and walked away with a financial loss. Trust is at the core of the Agile practice but makes Agile projects vulnerable to risks. In the events where disputes arise, mismanaged risks lead to potential legal complications. Ignorance, arrogance, distrust, and incompetence turned this Agile project into a fiasco.

Another failed Agile project that the Buch Company was involved in was the International Language Institute project in Rockville, MD. It had a different owner, but a similar situation, and a similar project outcome. With lessons learned from these failed projects, the Buch Construction became selective when accepting projects from international investors.

Project Risk Control Strategies: Use the *Construction Consulting* contract format to control risks in Agile projects.

Main Contributing Variables to Risk Control: Appropriate project types, incompetent Agile partners, deteriorated trust between parties, and broken Agile iterations and communication.

Project Outcomes: Two failed executed Agile projects with poorly implemented risk control strategies.

4.4.1.6. Case Study 4.9 - The Washington DC Union Station Amtrak Project

Kone Elevators and Buch Construction worked together on a long list of successful projects and developed a strong business relationship. Most times Buch was the prime contractor and Kone, the elevator subcontractor. But the roles switched on the Washington DC Union Station project in which Kone was the prime contractor leading the

replacement of nineteen existing elevators and escalators while Buch worked as the catch-all subcontractor assisting Kone in the bidding and construction (Figure 4.24).

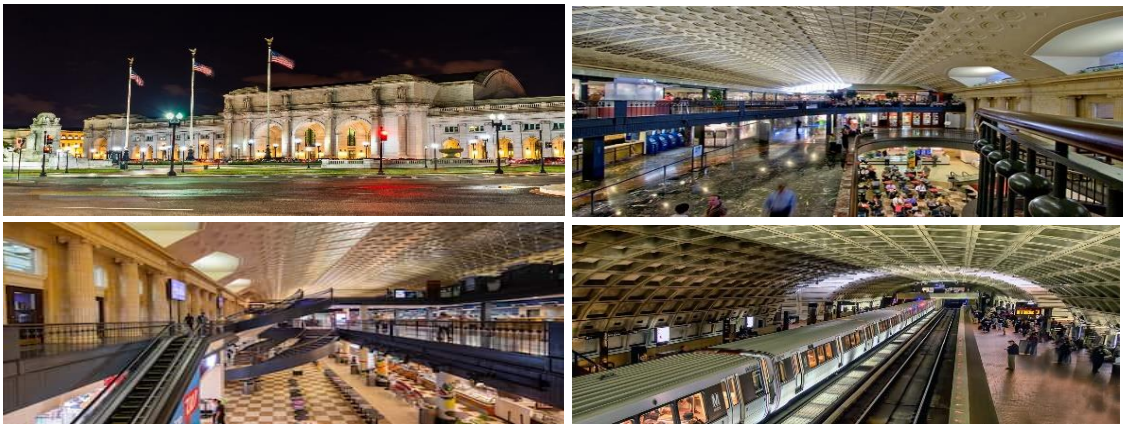

Figure 4.24 - Washington DC Union Station Renovation Project

Kone won a close competition against Otis and Mitsubishi to get this turn-key contract. The scope of work of the elevator/escalator replacement portion was relatively defined, but the existing equipment removals and restorations were far more complex. Buch Company had to overcome dauting challenges to protecting on-going retailers and high-end restaurants, provide safety measures to protect pedestrian traffic around the clock, obtain Amtrak permits and work around busy train and bus schedules, and manage hidden conditions. In order to win the turn-key, Kone and the Buch Company had to take a risk and develop a construction cost estimate with the information available and best judgement. To mitigate the risks, Kone and the Buch Company agreed to share any potential savings or cost overruns.

Kone and the Buch Company entered a conventional *AIA A401 Contract Between General Contractor and Subcontractor* with dollar amount for works that could be well-defined. In the *Supplementary Terms and Conditions,* a clause stipulated that the contract amount would increase with additional scopes mutually agreed by the two parties. At the

completion of the entire project, Kone and the Buch Company would split the difference fifty-fifty between the final actual cost of the construction work and the original estimate developed by the two companies prior.

Agile sprit was at the core in this Union Station project execution. When the teams encountered a challenging issue, they worked together, developed creative solutions, and applied the learned lessons to the next elevator/escalator phase. The solid trust and good faith business dealings were the foundation of the collaboration. With eighteen months of hard work, the team delivered the project on schedule and exceed the owner's expectation.

Project Risk Control Strategy: Use conventional AIA contract to manage commercial risks and a profit-sharing clause to manage financial risks.

Main Contributing Variables to Risk Control: Appropriate project type, established trust, complementary expertise, genuine team chemistry. and supportive project environment.

Project Outcome: A successfully executed Agile project with well-designed risk control strategy.

4.4.1.7. Case Study 4.10 - Two Unsuccessful Agile Projects of Places of Worship

At the request of a long time and important business client, the Buch Company engaged in a project to help a church to develop and build a new church in Maryland. The congregation had divided opinion on the floor layouts and project budget. Because the loosely defined scope and potential major changes, the church and the Buch Company agreed to apply the Agile approach in the project execution and signed a *Construction Consulting* contract. The Buch team participated in numerous meetings with the church

deacons and attempted to help the congregation to develop a project within the budget. It took several months for the congregation to approve a project plan with a long wishful list. The church appointed a committee of six selected church members to work with the Buch Company throughout the project.

After a long wait, the project finally broke ground. During the construction, the church committee were eager to help. The congregation kept making changes and the Buch team put extra efforts to accommodate. Because of these changes, the Buch team had to frequently adjust the course of the construction process and require the Agile partner, the church committee, to provide feedback and make decisions in a timely fashion. The feedback-improve Agile iteration sessions worked well in the beginning, but gradually came to halt because the church bylaws required the committee to get congregation approvals on exceeding a certain amount in spending. Sometimes the Buch team and subcontractors waited for days or weeks to receive directions from the committee. Gradually, the project was behind schedule and over the budget.

Out of the friendship and a sense of obligation, the Buch team helped to minimize the costs, stayed with the church to end, and completed the project. Buch was fairly compensated for the services rendered but suffered opportunity losses by tying up resources with this long project. The long process of getting approvals from the congregation defeated the purpose of exercising the Agile practice.

Another failed Agile project involving worship places facilities was a new synagogue construction project. Similarly, the clients were a trustworthy people who did not have adequate knowledge to participate as an Agile partner. The long process of getting

approvals from the congregation defeated the purpose of exercising the Agile practice. The Buch Company is now selective to take on worship place projects.

Project Risk Control Strategies: Use *Construction Consulting* contract and Agile practice to manage risks associated with the vaguely defined projects.

Main Contributing Variables to Risk Control: Appropriate project types, trusted relationships, enthusiastic but incompetent partner, complex communication process, slow decision making, and broken feedback-improvement cycles.

Project Outcomes: Two failed Agile projects with poorly implemented risk control strategies.

4.4.1.8. Case Study 4.11 - IDIQ Contract and BMSA Agreement Projects

The Indefinite Delivery Indefinite Quantity (IDIQ) contract format was developed by US General Services Administration (GSA) and widely adopted by other government agencies and large corporations. IDIQ contracts provide for an indefinite quantity of services for a fixed time. They are used when the contract legal terms and conditions are clearly defined but the technical scope of work cannot be well determined. Similar to an IDIQ contract, a Blanket Services Agreement (BMSA) is a written instrument of understanding between a facility owner and service provider. BMSA contains contract clauses and uses reference, attachment, or work orders to add future work during its term.

The Buch Company have engaged in both IDIQ and BMSA projects serving government and corporate clients such as Freddie Mac, Fannie Mae, BGE, Kaiser Permanente, Capital One Banks, North Grumman, and more. These clients use IDIQ and BMSA contract formats in their Agile projects to streamline service delivery and control risks. Essentially, the IDIQ or BMSA contract usually contains two segments that

delineates commercial terms and conditions from technical scopes: 1) the commercial segment clearly defines the contractual rights, obligations, and risk boundaries, and 2) the technical segment provides a skeleton to allow applying Agile management and incorporate service in the future.

The balanced structured risk control and flexible technical autonomy, effectively provided by IDIQ and BMSA contract formats, enable the Buch Company and its clients build long-term partnership, streamline service delivery and control risks in many successful facility service projects.

Project Risk Control Strategy: Use IDIQ and BMSA contract formats to contain commercial risks, while allowing project teams to exercise Agile practice and manage undefined scopes and schedules.

Main Contributing Variables to Risk Control: Appropriate project type, trusted partnership and record of reliable and quality service, technical competence, effective feedback-improvement restorations, and embracing environment.

Outcome: Six successful Agile projects with well-designed risk control plans.

4.4.1.9. Case Study 4.12 - May D&C Project Management Software Development

The May Design and Construction division (May D&C) managed all facility related matters for the May Company. In 2002, the new division president of (DP) decided to consolidate its spreadsheet-based project management system into one software platform and synchronize its nationwide network of consultants, contractors, and vendors. Because the scope of software development project could not be well defined, the team intended to adopt the Agile project management approach.

The new DP was a construction veteran and had a strong tendency toward tight control and detail planning. He was aware of the need for an innovative management approach for this software development project, but the level of his understanding and flexibility was insufficient to support the Agile management. The May D&C in-house IT team was excellent at database and hardware maintenance but had little software development experience. After a few months of struggling, a software engineering consulting firm was hired to assist the in-house IT team.

In the beginning the new DP was actively involved in daily feedback-improvement iteration cycles with the IT team and consultants. Later the new DP was distracted by other issues, and the frequency of attending the project meetings dropped from daily to weekly, bi-weekly, then monthly. As the project progressed the technical complexity increased, and the in-house IT team and consultants experimented with alternate ways to solve some technical problems, leading to a series of small mistakes. The DP soon noticed the mistakes and was upset. Losing faith in the Agile management practice. the DP returned to the traditional management style that he was more familiar and more comfortable with. He created a detailed list of what he wanted and when he wanted them. Concerned about job security, amid an impeding corporate layoff in a tough economy, the intimated IT director took the list from the demanding boss and instructed the in-house team and consultants to dogmatically follow it. Afraid of losing the service contract, the consultants stopped making suggestions that might cause any risks. The risk tolerance was reduced to a minimum, and the feedback-improvement iterations became one-way lectures.

After a year of the new DP's micromanagement and more than $1 million investment the new project management was hastily completed. All May D&C project executives and service providers were mandated to use the new platform on the May Company projects. Soon they found the new system was awkwardly overdesigned with some features that the project teams would never use. For instance, the new system indiscriminately distributed correspondences to everyone whose name appeared on the project list, regardless of relevance. A May D&C project executive who often simultaneously oversaw 12-16 projects, each having 30-50 internal and external parties, would receive 400-600 emails generated by the new system daily. Urgent and important issues that merited immediate attention were often buried and got lost in nuisance emails.

The new software system became a burden to the project teams who refused to use the new system or made fake efforts to meet the division requirement. As complaints and resistance mounted, the new DP realized the counterproductive impacts, withdrew the mandatory policy, and replaced the software engineering consultant with a new firm to fix the problems. It was too little and too late. The project already lost its momentum, and the new DP damaged his credentials and lost support from the project teams.

The software development project was expected to be completed in 12 months with a budget of $800,000 but ended with a $1.2 million cost overrun. The project dragged on for 27 months till the merger between the May Company and the Federated took place in 2005. The newly formed Design and Construction group for the combined company elected to use the Federated IT platform and abandoned the May Company's system. The $2 million investment never came to fruition.

Risk Management Strategy: The risk management plan was appropriate in the beginning to manage the uncertainties associated with this Agile project, but the leadership imposed an unsuitable approach.

Main Contributing Variables to Risk Control: Appropriate project type in the beginning, insufficient risk tolerance environment for Agile execution, inconsistent leadership involvement in the feedback-improvement iterations, and intimidating communication and management style.

Project Outcome: An Agile project with a good start but failed later due to low tolerance to risk environment and incompatible rigid leadership.

4.4.1.10. Case Study 4.13 - Target Reverse-Bidding Experiment

Between 2003 and 2005, the Target Corporation implemented a reverse-bidding policy that required all facility service providers and contractors to openly bid against one another. In the typical bidding process, bidders submit their tenders to the project owner, then the owner reviews and picks the winner. In the Target's reverse-bidding process, the project description and schedule were uploaded onto a designated portal, and a list of selected service providers were invited to provide responding quotes. The bidders could see others quotes and decide to either submit more competitive quotes or withdraw from the bidding process.

The Target Corporation expected to generate robust competition through the reverse-bidding and reduce the costs of facility service and construction projects. For these projects that follow routine procedure or have clearly defined scope work, the reverse-bidding delivered moderate results. Most Target facility service projects had medium or

higher levels of condition related uncertainties and managed as Agile projects in the field. The reverse-bidding caused several undesired issues in operation:

1) The vague scope made it difficult to evaluate proposals on an "apple-to-apple" basis.
2) The rigid bidding process forced bidders to play low-ball games where they submit low prices to win the projects then make profits on change orders.
3) The cost-focused new bidding process caused several highly qualified service-minded facility service providers no longer interested in serving Target.
4) To protect profit margins, some bidders rigged the reverse-bidding by submitting, holding up high quotes, and taking turns to win the bids.

The reverse-bidding did not last longer than 2 years. The Target Corporation shut down the unsuccessful experiment. JC Penny had tried a similar reverse-bidding but quickly abandoned it. The May Company observed and studied what Target implemented and decided not to follow.

Risk Management Strategy: Using the reverse-bidding approach to manage project costs and manage financial performance risks.

Main Contributing Variables to Risk Control: Unsuitable management approach applied to Agile projects and damages to established trusted relationship, and lack of team chemistry.

Project Outcome: A unsuccessfully bidding management experiment for facility Agile project management.

4.4.1.11. Case Study 4.14 - Foley's Aurora Distribution Center Project

The merchandise supplies to the Foley's stores in the states of Colorado, Oklahoma, and Arizona were supported by the Foley's distribution center in Houston, Texas. The long-distance fleet operation was financially inefficient. In 2002 the May Company decided to build a new distribution center near the old Denver Airport. Just weeks before the parties were about to sign the real estate contract, the Dillard's Inc announced the plan of closing several stores in the region, along with the distribution center in Aurora, Colorado. The May Company reached out to Dillard's and purchased the facility.

The Dillard's Inc had a vigorous facility management team, and the existing condition of its Aurora distribution center was excellent and only required moderate construction work. The conveyor and processing system was the key to get the distribution center in commission. Early project completion would result in significant cost savings to the company. The Corporate Projects Group (CPG) applied Agile practice to speed up the merchandise processing, and the conveyor system design and installation. CPG engaged in frequent feedback-improvement iterations with DCB Associates and Conveyor Specialists Inc on industrial engineering design and major equipment selection.

Both DCB and Conveyor Specialists had history working on other May Company distribution centers across the country. The May Company signed a *Design-Build* contract with a joint-venture that DCB and Conveyor Specialists formed for this project. The Joint-venture agreed to deliver a complete processing and conveyor system with a specified production efficiency, date, and contract amount. The feedback-improvement interactions served as an efficient communication platforms to exchange the owner's

expectations and consultants' recommendations. The "Design-Build" contract format effectively transferred the project's technical, schedule, and cost risks to the joint-venture.

Risk Management Strategy: Use *Design-Build* contract format to speed up the project delivery and control the risks associated with the fast-paced project development.

Main Contributing Variables to Risk Control: Appropriate project situation, trusted relationship, highly competent Agile partners, transparent communication, and team chemistry among the parties involved.

Project Outcome: A successfully Agile project execution with a well implemented risk control plan.

4.4.1.12. Case Study 4.15 - Under Armour and Lincoln Property Projects

In 2016, the Under Armour Corporation decided to renovate an old, abandoned manufacturing facility into a performance center for athletes to test new sporting products and advertising photo shooting and film making, see Figure 4.25. The Buch Company was selected to work with Under Armour as an Agile partner on this high-profile renovation project. The Under Armour facility management team is made up of professional veterans that understand how to flexibly manage projects with uncertainties and high-volume change orders. Directedly working with the Under Armour facility team, the Buch Company successfully delivered a number of challenging projects.

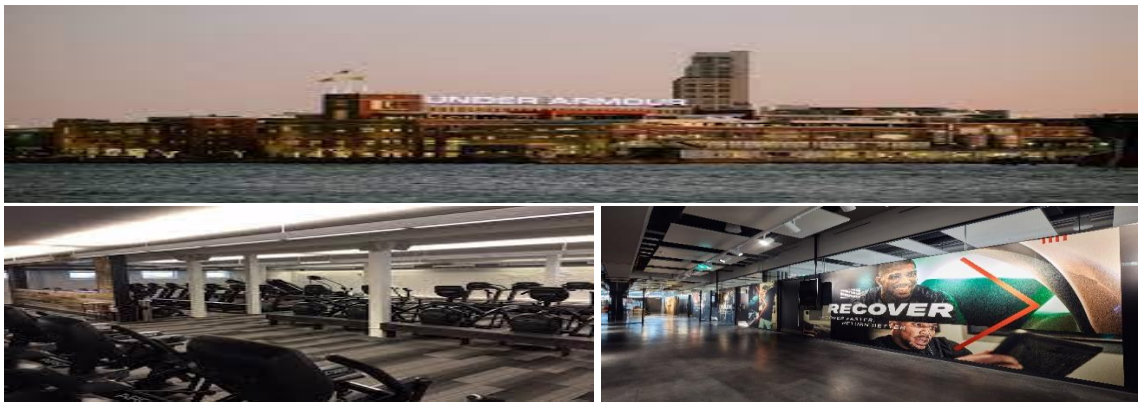

Figure 4.25 - Under Armour Headquarters Performance Center

The performance center project had a significant importance to the Under Armour's corporate product development and business marketing. A consulting firm was hired by Under Armour to coordinate the interdepartmental activities and oversee the facility renovation. The Buch project team had to report to the consultant, instead of the Under Armour facility team as they were used to.

Inserting the consulting firm created an additional project administrative layer that altered the project management structure and Agile management dynamic. Adding the layer of the consulting firm might provide a significant benefit to the Under Armour's corporate strategy, but a disservice to the Agile practice of this facility project management. The consulting firm did not have past working relationship with the Buch team and was new to Under Armour facility management operation. Eager to prove its worth to the Under Armour, the consulting firm took a rigid project management approach in supervising this project and drove hard-nose negotiations on change orders. The uncertainties of the hidden conditions of the abandoned industrial site and constant design revisions generated a high volume of change orders. The consulting firm tried to shift the project's risks unfairly to the Buch Company, but eventually met resistance.

Anticipating the pushbacks from the consulting firm on every change order estimate, the Buch team added a 15% contingency buffer to counterplay and protect reasonable profit margins and absorb potential risks associated. Both the consulting firm and Buch team were trying to serve the Under Armour Corporation, but the conflicts of interest between the two undermined the Agile spirit of the project. The relationship between the consulting firm and the Buch Company deteriorated and became contentious. The project struggled and was delayed, and the Buch Company took a financial loss. Since the Under Armour changed its facility management approach, the Buch Company only participated in projects that were directly managed by Under Armour's facility team.

The Buch Company experienced a similar situation on another project. The Buch teams worked well with Lincoln facility managers and the project management consultants, but the 101 Constitution Ave office upgrading project failed. The office renovation that the Buch Company did for Lincoln Property Group at 101 Constitution Ave in Washington DC had a complex phasing plan to accommodate exiting tenants, see Figure 4.26. The Buch team had to coordinate the work in 25 "phase areas" within constant schedule changes to not inconvenience the tenants and not interfere with Lincoln marketing activities. Project logistic management and schedule related costs were huge challenges to the project team. Based on the trusted relationship, Lincoln invited the Buch Company to be an Agile partner to take on this challenging project.

Figure 4.26 - Lincoln Property Group 101 Constitution Ave Office Building

The Buch Company had served the Lincoln Property Group for many years and worked well with the client's project consultants but failed on the 101 Constitution project. An inexperienced young consultant representative was assigned to the project and tried hard to impress his boss and the client by pushing the Buch team to take undue risks and arbitrarily slash the cost estimates. These pushovers soon met resistance and backfires from the Buch team. The relationship with the young representative deteriorated, tension elevated, and inevitably confrontation occurred. The situation went from bad to worse, and Lincoln facility management had to intervene and replace the young consultant, but it was too late. The project suffered a significant cost overrun and major delay.

Project Risk Control Strategies: Using the Agile method to manage projects with high levels of uncertainties of scopes, schedules, or logistics.

Main Contributing Variables to Risk Control: Appropriate project types. The Agile spirits in abovementioned projects were undermined by either a consulting firm or an individual who violated the presumed obligation of fair business dealing and imposed undue risks to other Agile partners.

Project Outcome: Two unsuccessful projects resulted from deteriorated project environments that no longer support the Agile practices.

4.4.1.13. Case Study 4.16 - The Sprinkle System Erosion Management Program

In the early 2000's after receiving reports that a series of fire sprinkler pipes bursts and flooded several stores, the CPG team deployed consultants to investigate the pipe failures. The consultants discovered aggressive erosions caused by metal-eating microbes in the fire suppressant fluid that was injected into the pipe systems. They also

noticed these problems only occurred in the systems installed between late 1970's and early 1980's.

The CPG team mobilized mechanical engineers to all stores with sprinkler systems that were installed between 1975 and 1985 and collected fluid samples and pipe segments for lab tests. Based on lab reports and engineers' recommendations, the CPG team developed five levels of corrosion and solicited three mechanical subcontractors in each branch region to submit RFPs. The subcontractors were required to prepare RFPs with the weekly costs of general conditions, as well as unit costs to repair the system based on different levels of corrosion. The May Company entered *General Condition plus Unit Prices* contracts with winning subcontractors. The CPG team hired consulting firms to administrate the project implementation and assist CPG on-site representatives making decisions on technical issues. The parties applied Agile feedback-improvement iterations throughout the projects, creatively solved unforeseen challenges, and completed the project within the expected timeframe and budget.

Project Risk Control Strategy: Apply *Weekly General Condition Cost and Unit Prices* contract format in commercial risk control and Agile practice in change management.

Main Contributing Variables to Risk Control: Appropriate project type, adequate trust on normal business level, professional Agile partners, effective communication and feedback-improvement iterations, and tolerant corporate policies.

Project Outcome: A successful Agile project execution with a prudent risk control.

4.4.1.14. Case Study 4.17 - The May Company ADA Barrier Removal Program

To respond to the court orders and to minimize legal exposure to further lawsuits on the grounds of the Americans with Disabilities Act (ADA), the May Company

budgeted $32 million over four years, between 2001 and 2005, to correct the items required by the courts and remove existing handicap barriers in its facilities built prior to the year 1996.

More than 350 stores, distribution centers, and offices were included in the ADA Barrier Removal program. These facilities were in different lifecycle stages and scattered across the country. The CPG team assigned a director to lead a group of eight on site representatives to identify ADA issues, administrate the barriers removal processes, and ensure the project quality. In each region, three to four contactors who had long business working relationship with the May Company were selected to participate in the program.

Due to concealed conditions and schedule uncertainties resulting from frequent changes of store sales promotion plans, it was difficult for contractors to provide meaningful estimates. It was not fair or practical to ask contractors to bid against others, travel long distances to visit stores, discover hidden conditions, and prepare RFPs for a small number of projects that the CPG team would dispatch on waves. The May Company was responsible for supplying most of the architectural finish materials, showcase, and equipment. The availabilities and delivery of long lead time items also posed tough challenges to the CPG teams and contractors in defining a meaningful scope of the projects.

To manage the elevated levels of uncertainties and logistical challenges, the CPG team and contractors agreed to use Time and Material Contracts and Agile practice in project executions. To control the risks within corporate tolerance, the CPG team only assigned a limited number of projects one time to the contractors. Based on the evaluation of the completed projects, the CPG team awarded the contractors who outperformed competitors with more projects and reduced or replaced the underperformers. The Time

and Material contract format, flexible Agile management, and prudent risk management were instrumental in creating a balanced project model for this high-profile program in shielding the May Company against malicious legal claims and attacks.

Project Risk Control Strategy: Using *Time and Materials* contract format to define commercial obligations, break the scope of work into small groups and award them to the contractors based on evaluation of the projects previously delivered.

Main Contributing Variables to Risk Control: Appropriate project type, sizable pools of qualified and trusted contractors, frequent feedback-improvement Agile iterations, supporting corporate policies, and effective evaluation and correction mechanism throughout the program to limit risk exposure and resolve issues.

Project Outcome: A successfully executed Agile program with a well-designed risk control plan and implementation.

4.4.2. QCA Research on Proposition #2

Twenty-three Agile projects were studied to investigate the key risk variables and their impacts to the project outcomes. *QCA* method is employed to analyze the collected empirical information to examine Proposition #3.

- Condense and conceptualize empirical information in case study discussions.
- Select six key risk variables factors (conditions) to the project performance.
- Repeat the same process with all 23 sample Agile projects and produce six condition sets and one outcome data set.
- Code and the condition and outcome data sets and construct a *Truth Table*.
- Analyze the *Truth Table*, identify connections between condition and outcomes sets.

- Analyze the relationship between the *Truth Table* findings and the proposition statement and determine whether the *QCA* research results support Proposition #3.

4.4.2.1. Condense and Conceptualize Empirical Information from Case Studies

The concepts and ideas discussed in the Case Study 4.4 - Case Study 4.17 are collected and summarized in Table 4.29 below.

Table 4.29 - Risk Control Concepts Collected from Case Studies

Project #	Case Study #	Risk Control Concept	Project Performance Outcome
1	4.4	Using the Agile practice to manage vaguely defined scope, incrementally taking bigger risks as trust level progressively elevates, maintaining effective communication and feedback-improvement iterations, and collaborating in risk tolerant and Agile supportive environment.	Successful
2	4.5	Using the Agile practice to manage a complex overseas powerplant project, breaking the overwhelming ambiguous scope into smaller packages that hidden risks can be reasonably identified and contained, then using assignment provision to integrate small packages into a single turnkey prime contract to consolidate and transfer the risks, incrementally taking bigger risks as trust level progressively elevates with key stakeholders, maintaining effective communication and feedback-improvement iterations, and having sufficient autonomy and support from a risk tolerant corporate headquarters. Due to the cultural gaps, language barriers, and technical practice difference, the feedback-improvement restorations were not highly effective, but functionally served the purpose.	Successful

3	4.6	Applying the Agile practice to manage a petrochemical refinery refurbishing project with a high level of uncertainties due to decades of erosion and weathering, using a *Maximum Not-to-Exceed* contract format retain the risk exposures within corporate tolerance while allowing project teams sufficient autonomy to apply the Agile practice in field execution, working with a trusted and competent contractor, maintaining effective communication and feedback-improvement iterations, and having a supportive Agile project environment.	Successful
4	4.7 (1)	Applying Agile practice to manage vaguely defined annual renovation programs for two iconic retail destinations in NYC, using a *Consulting Service Only* Contract format to control commercial and legal risks while allowing the teams to exercise the Agile practice, working with highly competent and trusted partners, maintaining effective communication and feedback-improvement iterations, and having a supportive Agile project environment and risk tolerant corporate policies.	Successful
5	4.7 (2)		Successful
6	4.8 (1)	Applying Agile practice to manage two vaguely defined projects: a senior adult daycare center and an international language institute, using *Consulting Service Only* Contract format to shield risks from project uncertainties and unfamiliar owners, trust was never established and quickly broke down soon after projects started, feedback-improvement meetings were dysfunctional, and project environments were confrontational. The owner in Project 4.8 (1) was moderately capable in project management but unwilling to contribute due to the distrust between the parties. Partners competence was a nonfactor in 4.8 (1) project. The owner in Project 4.8 (2) was incompetent and demanding.	Failed
7	4.8 (2)		Failed

8	4.9	Applying Agile practice to manage a high-risk Union Station Amtrak project, using a conventional *AIA 401 Subcontractor Agreement* contract to manage commercial risks with an open-book profit/loss sharing clause to manage financial risks, engaged collaboration between two highly rusted professional Agile partners, frequent and effective feedback-improvement iterations through timely and transparent communication, and maintaining a supportive environment throughout the project.	Successful
9	4.10 (1)	Applying Agile approach to manage two "place of worship" projects that the scopes of work were poorly defined and arguably unsuitable for Agile practice, the *Consulting Service Only* Contracts used in the projects were insufficient to manage the risks encountered later in the execution of neither of the two projects, the levels of trust were high in both projects, owners were eager to contribute in feedback-improvement iterations but did have the require technical expertise, the long approval processes through the congregations defeated the effectiveness of the Agile circles, and both owners and representatives teams were supportive and accommodating.	Failed
10	4.10 (2)		Failed
11	4.11 (1)	Applying Agile practices to manage high volume work orders with yet-to-be-defined scopes, using *IDIQ or BMSA* contract formats to establish boundaries of legal and commercial risk while allowing project teams to nimbly manage project scopes and schedules, established trust between competent owner teams and the skilled service providers, well-organized and frequent feedback-improvement iterations, and adequate risk tolerance and supportive corporate policies for Agile practices.	Successful
12	4.11 (2)		Successful
13	4.11 (3)		Successful
14	4.11 (4)		Successful
15	4.11 (5)		Successful
16	4.11 (6)		Successful

17	4.12	Applying the Agile practice to manage IT development project started from a scratch with a concept, no formal risk control plan, average technical competences, and the risk tolerance was short-lived and soon this Agile project turned into a conventional water-fall management. Trust broke down and work ethics deteriorated, under the pressure from a demanding leader, not to a sabotage level. Team members stopped taking risks in finding creative solution or disagreeing with the leader. The feedback-improvement reiterations were effective in the beginning, but soon the leader changed the sessions into one-way lectures.	Failed
18	4.13	Applying inappropriate approach in managing facility projects suitable for Agile practice, not a pragmatic solution of controlling cost overrun risks, tearing established trust with quality service providers, and creating an unsupportive environment for Agile practice. Owner and service providers' competence and feedback-improve iterations became non-factors in this case project.	Failed
19	4.14	Applying Agile practice to manage a strategically important distribution center development project with a minimum conceptual plan and urgent schedule, using a *Design-Build* contract to speed up project delivery and control the risks associated with the fast-paced development, working with highly competent and trusted partners, maintaining effective communication and feedback-improvement iterations, and having a supportive Agile project environment.	Successful
20	4.15 (1)	Appropriately applying Agile practice to manage two vaguely defined corporate projects: 1) turning an abandoned facility with hidden conditions to a high tech sporting product testing and marketing center, and 2) upgrading a trophy class office building with complex phasing plan and logistical challenges, using *Construction Consultant at Risk* contract in both projects to control commercial and legal risks while allowing the teams negotiate and exercise the Agile practice in the field, the established trust between the service provide and the owners were damaged by inserting a layer	Failed

21	4.15 (2)	of third party owner representatives, the owner's representatives in Case project 4.15 (1) were competent but confrontational, the owner's representatives in Case project 4.15 (2) were incompetent and demanding, the feedback-improvement iterations were effective in the beginning but turned into dysfunctional as the projects struggled, the clients corporate risk policies were tolerant but the embedded interest conflicts between representatives and service provider damaged the Agile project environment in both projects.	Failed
22	4.16	Applying Agile practice to manage sprinkler system erosion management program with complex uncertainties and logistical challenges, using a W*eekly General Condition Plus Unit Cost* contract to control commercial risks while allowing Agile practice in program execution, solid trust between owner and contractors, frequent and effective feedback-improvement iterations, and supportive Agile project environment and corporate policies.	Successful
23	4.17	Applying Agile practice to manage a nationwide $32 million multiple year facility ADA barrier removal program in responding to a series of court orders with vaguely defined scopes and logistical challenges, awarding small batches of projects and follow up project audits to limit risk exposures, incrementally increasing the batch size to outperforming contractors and recycling the underperforming ones, and working with qualified Agile partners with established trust. Conducting periodic feedback-improvement iterations effective enough to manage the program. Due to the legal complication with the court order, the corporate risk tolerance on this program was properly balanced and managed. These two risk variables were not key contributors to the project performance outcomes.	Successful

4.4.2.2. Select and Code Conditions and Outcomes

Six key risk variables are identified in the case study summary Table 4.29:

1) Project Type Suitability: project scope assessments, management team compatibility,

and executive decision-making, 2) Risk Control Strategy: experience and judgement in identifying and managing risks, 3) Trust Level Among Agile Partners: commitments, obligations, and fair business dealing, 4) Competence of Agile Team: technical expertise, people skills, and Agile management knowledge, 5) Agile Iterations and Communication: effectiveness and efficiency of the Agile cycles and communication channels, 6) Agile Project Environment: corporate risk tolerance policies and team engagement. The six key risk variables are categorized and coded in Table 4.30 below.

Table 4.30 - Categories and Codes of Key Risk Variables

No.	Key Risk Variable	Contribution Code	
		Positive	Negative
Variables 1	Project Type Suitability	1	0
Variables 2	Risk Control Strategy	1	0
Variables 3	Trust Level Among Agile Partners	1	0
Variables 4	Competence of Agile Team	1	0
Variables 5	Agile Iterations and Communication	1	0
Variables 6	Agile Project Risk Tolerance	1	0

Project outcomes are categorized and coded in Table 4.31 below.

Table 4.31 - Categories and Code of Project Outcomes

Project Outcome	
Successful	Failed
1	0

4.4.2.3. Truth Table Analysis

The codes prepared above are compiled into a *Truth Table* in Table 4.32.

Table 4.32 - Schneider and Wagemann Truth Table

No.	Case Study	Key Risk Variable Contribution						Project Performance Outcome
		#1	#2	#3	#4	#5	#6	
1	4.4	1	1	1	1	1	1	1
2	4.5	1	1	1	1		1	1
3	4.6	1	1	1	1	1	1	1
4	4.7 (1)	1	1	1	1	1	1	1
5	4.7 (2)	1	1	1	1	1	1	1
6	4.8 (1)	1	1	0		0	0	0
7	4.8 (2)	1	1	0	0	0	0	0
8	4.9	1	1	1	1	1	1	1
9	4.10 (1)	0	0	1	0	0	1	0
10	4.10 (2)	0	0	1	0	0	1	0
11	4.11 (1)	1	1	1	1	1	1	1
12	4.11 (2)	1	1	1	1	1	1	1
13	4.11 (3)	1	1	1	1	1	1	1
14	4.11 (4)	1	1	1	1	1	1	1
15	4.11 (5)	1	1	1	1	1	1	1
16	4.11 (6)	1	1	1	1	1	1	1
17	4.12	1	0	0			0	0
18	4.13	0	0	0			0	0
19	4.14	1	1	1	1	1	1	1
20	4.15 (1)	1	1	0	1	1	0	0
21	4.15 (2)	1	1	0	0	1	0	0
22	4.16	1	1	1		1	1	1
23	4.17	1	1	1	1			1

Note: Blank cells indicate these risk variables have insignificant impact or are irrelevant to the project outcomes.

The projects in Table 4.32 are rearranged by project outcomes, Successful and Failed. See the rearranged *Truth Table* in Table 4.33 below.

Table 4.33 - Rearranged Truth Table Analysis of Table 4.32

Project No	Case Study	Key Risk Variable Contribution						Project Performance Outcome
		#1	#2	#3	#4	#5	#6	
1	4.4	1	1	1	1	1	1	1
2	4.6	1	1	1	1	1	1	1
3	4.7 (1)	1	1	1	1	1	1	1
4	4.7 (2)	1	1	1	1	1	1	1
5	4.9	1	1	1	1	1	1	1
6	4.11 (1)	1	1	1	1	1	1	1
7	4.11 (2)	1	1	1	1	1	1	1
8	4.11 (3)	1	1	1	1	1	1	1
9	4.11 (4)	1	1	1	1	1	1	1
10	4.11 (5)	1	1	1	1	1	1	1
11	4.11 (6)	1	1	1	1	1	1	1
12	4.14	1	1	1	1	1	1	1
13	4.5	1	1	1	1		1	1
14	4.16	1	1	1		1	1	1
15	4.17	1	1	1	1			1
16	4.8 (1)	1	1	0		0	0	0
17	4.8 (2)	1	1	0	0	0	0	0
18	4.10 (1)	0	0	1	0	0	1	0
19	4.10 (2)	0	0	1	0	0	1	0
20	4.12	1	0	0			0	0
21	4.13	0	0	0			0	0
22	4.15 (1)	1	1	0	1	1	0	0
23	4.15 (2)	1	1	0	0	1	0	0

The following relations, among the key risk variables and organization performances, are observed in Table 4.33:

1) The first twelve projects, Project #1 to #12, have successful outcomes, positive contributions from all key risk variables, and no negative contribution from any key risk variables.

2) Next three projects, Project #13 to #15, have successful outcomes, positive contributions only from some of key risk variables, and no negative contribution from any key risk variables.
3) The last eight projects, Project #16 to #23, have failed outcomes, mixed positive and negative contributions from key risk variables, and at least one negative contribution from the key risk variables.

The connections observed in Table 4.33 and their relations to Proposition #3 are further generalized in Table 4.34 below.

Table 4.34 - The Observed Relations and Proposition #3

		Project Performance Outcome		Supporting Proposition #3
		Successful	Failed	
Contributions from Key Risk Variables	All positive	12		Yes
	Some positive. No negative	3		Yes
	At least one negative		8	Yes

In conclusion, the case studies and *Grounded Theory* analysis conducted in this section support that Proposition #3 *"Pragmatic management of key risk variables is prerequisite for successful applications of adopted practices in facility project execution"* generally holds true in the facility project management practices. Not all the contributions of the risk variables need be positive, but none can be negative.

4.5. Chapter Summary

The facility management industry has experienced a stable growth in the past decades. To meet the challenges of the fast expansion of market size and increasing complexity in service scope, the facility industry needs to learn and adopt modern management methods and new practices. This chapter discussed two corporations, the May Company and Buch Company, about how they learned and adopted innovative practices that fit their needs for new management methods to improve their facility portfolio operation and corporate financial performance. The May Company case demonstrated that the adoption of *P3M/PMO* practices had a significantly impact in reducing facility portfolio operation cost. The Buch Company case showed that the adoption of *APP*/*OPM3* played a critical role in lowering derivative project ratios and increasing company marketing and operation revenues. *Grounded Theory* was employed to analyze the data collected from the case studies. The research results support Proposition #1 "*Cross-industry learning and adoption can effectively meet the increasing demands for innovative modern facility management methods.*" Also, *Pre-Post* comparison was used as a supplementary analysis method to study the cases, verify the *Grounded Theory* research outcome, and augment the support to Proposition #1.

Besides discussing the needs of modern management methods, this chapter tackled two practical: 1) What it takes to successfully implement a new management method adoption, and 2) what are the risks associated with new practice adoption and how to manage them in project execution? Case study 4.3 discussed the successes and failures of 13 subcontracting companies and their attempts and adoptions of the *APP*/*OPM3* practices. *QCA* and case study methods were employed to investigate conditions that

necessary to produce positive adoption outcomes. The research concluded that willingness, knowledge, financial strength, technical readiness, and persistence are preconditions to a successful adoption. The case study and *QCA* research results support Proposition #2: "*Assuring positive contributions from key factors is a precondition for successful new practice adoption*."

Case study 4.4 used Agile method adoption as an example to discuss risks associated with new practice adoptions. *QCA* and case study research methods were applied to investigate the six key risk variables and their impacts on project performance. To build sufficient data sets to produce quality research outcome, 23 Agile projects were selected and discussed. The empirical data collected from these projects was conceptualized, categorized, and coded. *Truth Table* was used to analyzed to identify causal connections between the condition and outcome data sets. The research concluded that project type, risk strategy, trust, competence, communication, and risk tolerance are six essential variables to risk control in project execution. The case study and *QCA* research results support Proposition #3: "*Pragmatic management of key risk variables is prerequisite for successful applications of adopted practices in facility project execution*."

5. Facility Sustainability Development Practices and Challenges

This chapter discuss the impacts of government and corporation involvement in facility sustainability development, the challenges currently encountered in sustainable facility practice, and explore potential solutions.

5.1. Data and Methodology

Survey questions, case studies, interviews, and content research are used to collect data and gain a broad understanding of sustainable facility management.

5.1.1. Case Studies

The May Company, Buch Construction, and Jones Lang LaSalle are the primary sources of the case studies. The case studies are the following:

The May Company

Case Study 5.1 - After Hours Drycleaner Site Cleanups

Case Study 5.4 - The Montgomery Ward UST Contamination Remediations

Case Study 5.6 - The May Company's Sustainable Management Practices

Buch Construction

Case Study 5.2 - The Bay Saver Projects

Case Study 5.3 - The AstraZeneca Combine Power & Heat Cogen Projects

Case Study 5.7 - Energy Efficiency vs. Fresh Air Ventilation

Case Study 5.8 - A BIM Implementation Failure, The Vine Apt. Project

Case Study 5.9 - Ballston Common Shopping Mall Redevelopment

Jones Lang LaSalle Company

Case Study 5.5 - Jones Lang LaSalle Corporate Sustainability Policies

5.1.2. Surveys

The survey consisted of fifteen questions related to government regulations, corporate sustainability policies, industry practice standards, and solutions to current challenges in sustainable facility management. Eleven of the fifteen survey questions were used in this dissertation. 628 out of a total of 853 invitees responded to the survey, a response rate of 73%. It was judged that a random selection of people from other industries who may or may not have the knowledge or understanding of the survey subjects would skew the results and undermine the research quality with misleading answers.

The survey invited a diverse group of professional industry practitioners with adequate experience and knowledge to provide meaningful answers to the survey questions. The 586 respondents, who provided their profession information, comprise 12.29% facility managers, 7.68% property owners, 5.46% corporate executives, 6.31% real estate developers, 5.63% architects, 8.02% engineers, 24.40% contractors, 27.65% subcontractors, and 2.56% attorneys. The research focused on facility sustainability practices and the participant selection was designed to suit the research goals.

Biases inevitably exist, but the extremely high response rate provided a confidence sufficient to serve the purpose of the practice-based research objectives.

Survey demographics are summarized in Table 5.1, Table 5.2, and Table 5.3. Answering demographic questions was optional and voluntary and all results were anonymized. Survey questions addressed strictly professional opinions only.

Table 5.1 - Survey Age Demographic

Age	< 18	18-29	30-44	45-60	>60	Total
Respondents Provided Information	0	99	105	142	36	382
Percentage	0	25.92%	27.48%	37.17%	9.42%	100%

Table 5.2 - Survey Gender Demographic

Gender	Female	Male	Total
Respondents Provided Information	62	322	384
Percentage	16.15%	83.85%	100%

Table 5.3 - Survey Profession Demographic

Profession	Facility Manager	Property Owner	Corporation Executive	Real Estate Developer	Architect	Engineer	Contractor	Subcontractor	Attorney	Total
Respondents Provided Information	72	45	32	37	33	47	143	162	15	586
Percentage	12.29%	7.68%	5.46%	6.31%	5.63%	8.02%	24.40%	27.65%	2.56%	100%

5.1.3. Online Interviews with Chinese Industry Veterans and Government Officials

Online interviews were conducted with Chinese industry veterans and government officials to solicit their opinions on current BIM application and future perspectives. All fifteen interviewees live and work in China. They comprise 3 facility owners, 2 management consultants, 3 real estate developers, 1 software engineer, 2 contractors, 2 engineers, and 2 government officials. They were chosen based on their rank in organizations, decades of in-depth experience, and diversified representation of government and private business practices. The interviewees profession demographics are summarized in Table 5.4. Answering demographic questions was optional and voluntary and all results were anonymized. Survey questions addressed strictly professional opinions only.

The smaller samples were subject to possible biases from the interviewees; therefore, the interviews were used as supplemental research, along with case studies and literature analysis to verify survey results from different angles, and to test whether they were

consistent with real-world experience. Mixed-use of multiple research methodologies was applied to offset potential biases when developing the propositions.

Table 5.4 - Interview Profession Demographic

Profession	Facility Owner Operator	Supervising Consultant	Real Estate Developer	Software Developer	Contractor	Engineer	Government Official	Total
Respondents Provided Information	3	2	3	1	2	2	2	15
Percentage	20%	13.33%	20.00%	6.67%	13.33%	13.33%	13.33%	100.00%

5.1.4. Research Methodology

Chapter 5 uses mixed uses survey, case study, interview, and special topic content analysis to examine three sustainability related propositions.

5.1.4.1. Types of Qualitative Data Analysis Methodologies

Narrative, content, discourse, thematic, *Grounded Theory*, and interpretive phenomenology analysis (IPA) are the six most popular qualitative data analysis methods that Warren discussed in her article *Qualitative Data Analysis Methods 101: The "Big 6" Methods + Examples* (2020). Four of the six research methods are applied in Chapter 5.

Thematic analysis studies bodies of collected information, categorizes and processes data according to similarities, and derives meanings out of the content. Survey is an efficient and effective thematic analysis for studying people's insights and opinions. Narrative is another commonly used qualitative analysis method for evaluating stories of event or projects and interpreting inherent meaning. As Warrant said, "Since stories serve a functional purpose of helping us make sense of the world, we can gain insights into the

ways that people deal with and make sense of reality by analyzing their stories (2020)." Case study adds an important dimension to support the propositions in Chapter 5. Interview is typical IPA approach that collects and analyzes personal experience and/or opinions on subjects, events, or projects. Content analysis studies words, reports, memos, or articles and seeks for relationships and patterns within the pieces of information collected.

It is often difficult to clearly delineate one of six methodologies from another. One research could be simultaneously fitted into more than one classification. For example, case study is typically a narrative analysis, but if the presenter is discussing personal experience, then the case study is also an IPA. Like all analysis methods, qualitative data analysis approach has its strengths, weaknesses, and limitations. The main critics to qualitative analysis approach are i) relatively small sample sizes, ii) difficulty to reproduce representative cases in subsequent research, and iii) researcher's bias. Be aware of these limitations, qualitative data analysis can be a powerful tool for research studies in complicated social and project management areas and guiding real world practices.

5.1.4.2. Mixed Use of Analysis Approaches

Applying multiple qualitative methods in single research can provide additional analysis angles, reduce biases, and produce more balanced outcomes. Mixed uses of thematic surveys, narrative case studies, special content analysis, and IPA interviews are applied in this chapter to examine sustainability related propositions and enhance the outcomes. The mix-use research is designed with the following steps:

1) Start with asking one or more survey questions to solicit opinions from industry practitioners on a particular research topic.

2) Use survey software to process and organize the collected responses.
3) Analyze survey results and examine statements of the topics.
4) Conduct case studies to demonstrate the concept of the research topic and analyze the information collected to provide a supplementary examination to the research topic.
5) For selected topics, conduct additional interviews and special subject research to deepen the examination and support the main aims of the research.

Semantic differential, Likert rating, and other numerical scale are employed in survey questions design and result processing to strengthen the research arguments with a level of quantitative intensity.

5.2. Government Involvement is the Backbone of the Sustainability Movement

This section uses survey questions and case studies to demonstrate and analyze the impact of government involvements on sustainability development and examine Proposition #4.

5.2.1. Government Involvement and Effectiveness

The survey results and case studies in this section revealed that government regulation compliance is an effective extrinsic motivator and has a predominant impact on sustainability development. The findings echo to the research conducted by Kwawu and Elmualim in 2011 and the global the online survey conducted by Dodge Data and Analytics in 2018, both having ranked *Government Regulation Compliance* the top one driver behind facility sustainability development.

5.2.1.1. Survey Question and Analysis

Survey Question #1 solicited opinions from respondents on the effectiveness of government involvement in advancing sustainability management.

Table 5.5 - Result of Survey Question #1

Survey Question #1: Using a number from 1 to 10, where 1 is not effective at all and 10 is extremely effective, to rate the impact of government environmental regulations on facility sustainability management.

	10	9	8	7	6	5	4	3	2	1	TOTAL
Goverment Regulation Impact to Facility Sustainibility Management	10.38% 65	10.70% 67	17.09% 107	19.81% 124	11.98% 75	11.66% 73	6.07% 38	4.31% 27	2.24% 14	5.75% 36	626

The survey result in Table 5.5 shows that about 70% of respondents gave scores greater than 5 and 30% gave scores 5 or less. On federal, state, and municipal levels, governments are involved in sustainability development through regulations and incentive programs. Case Study 5.1 uses drycleaner site remediation as an example to demonstrate and discuss government involvements in sustainability development.

5.2.1.2. Case Study 5.1 - After Hours Drycleaner Site Cleanups

Perchloroethylene (PERC) was widely used in the dry-cleaning process before being banned by the *Resource Conservation and Recovery Act (RCRA)* in 1976. PERC contaminated sites pose major human health threats to underground drinking water sources. Besides RCRA, the U.S. Congress enacted the Safe Drinking Water Act (SDWA) and Toxic Substances Control Act (TSCA) to authorize the EPA to collect data and monitor

and enforce compliance. State Drycleaner Cleanup Superfunds were developed to support remediations.

To enter the promising tuxedo market, the May Company purchased David's Bridal, Modern Tuxedo, Gary's Tux, Priscilla, Tyndall's, Desmond's, and Gingiss. Later 330 After Hours Formalwear stores were added to the portfolio in 2002. Through the acquisitions, the May Company inherited two PERC contaminated drycleaner sites in Atlanta and Charlotte. Per state regulations the previous owner installed systems injecting potassium permanganate solvent to remediate underground water pollution, but the monitoring reports showed frequent high spikes above EPA standards. At the time of the ownership transition, PERC plumes in both sites were moving down-gradient toward neighboring parcels, which pose as costly liabilities and legal complications once the plumes move across the boundaries. A consulting firm was deployed to investigate the situation and found that the existing systems on site were not working properly due to the crystal casings developed around the injection wells from chemical reaction between potassium permanganate and PERC. The consultant and May team decided to install a new advanced hydron-release compound (HRC)[1] system that automatically controls releasing intervals of "PERC-eating" microbes, breaks PERCs down to ethane, and prevents clogging. The May team submitted the new remediation plans and obtained approvals from the states of Georgia and North Carolina. Also, the HRC biotechnology technology qualified the remediation designs for Drycleaner Cleanup Superfunds in both states.

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[1] HRC is a mix of dextrose, ethyl lactate, molasses, sodium lactate, ethanol, and potassium lactate. The compound works with time-controlled releases and biotechnology design to have lasting remedy effects.

New HRC injection wells were installed 1) around the underground water plumes to target treat the pollution sources, 2) in the down gradient of plumes movement to intercept escaped plumes, and 3) along the neighboring boundaries to create deep defense lines preventing pollutants from migrating into adjacent properties. The HRC systems effectively lowered PERC concentrations on both sites, eventually kept PERC levels below the EPA standards for six consecutive quarters and received Remediation Completion Certificates from both states respectively.

5.2.2. Government Incentive Programs for Sustainability Development

Besides regulations and enforcement, governments on all levels offer performance-based incentive programs to advance sustainability development. As Rademaekers et. al. stated in their research report they prepared for the European Commission (2012),

> When regulations are effectively enforced, they force an organization to achieve minimum levels of environmental performance. Economic incentives are relevant to all firms and offer a large range of possibilities to effectively enhance drivers and reduce barriers to improved environmental performance.

5.2.2.1. Survey Question and Analysis

Survey Question #6 Table 5.5solicited opinions from facility industry practitioners on the impacts of government incentive programs on sustainable facility management.

Table 5.6 - Results of Survey Question #6

Survey Question #6: How would you describe the actual impacts of government financial incentive programs on sustainable facility management?

ANSWER CHOICES	RESPONSES	
Direct and effective	14.97%	94
Indirect but effective	29.78%	187
Fairly effective	38.54%	242
Not effective	16.72%	105
TOTAL		628

The survey result in Table 5.5 shows that about 83% of the respondents believed that government incentive programs were *Direct and Effective, Indirect but Effective*, or *Fairly Effective* while only 17% believed them to be *Not Effective*. The survey result suggests that government incentives have significant impacts on sustainable facility management. Most government sustainability incentive programs are administrated at state and municipal levels in terms of tax credit, discounts, rebates, subsidies, and grants. Case Study 5.2 and Case Study 5.3 use two sustainable facility projects to demonstrate and discuss incentive programs offered by the State of Maryland for Chesapeake Bay ecosystem protection and High-efficient power generation.

5.2.2.2. Case Study 5.2 - The Bay Saver Projects

The Clean Water Act was enacted to prevent surface stormwater runoff from carrying hazardous pollutants into public infrastructure that eventually leads into rivers, lakes, and oceans. In the mid-1980's, many state and municipal governments developed incentive programs to protect public bodies of water and surrounding ecosystems.

According to Polluted Runoff Chesapeake Bay Foundation Report, "one inch of rain fall on an acre of a hard surface can produce 27,000 gallons of stormwater runoff, flushing fertilizer, pesticides, oil, and sediment into public waterways with huge

ecological significance to the inhabitants that live around the shore (2014)." The Maryland General Assembly established the Chesapeake Bay Critical Area Protection Program in 1983 to safeguard the ecosystem from the alarmingly increasing runoff pollution surrounding the bay. The program offers grants and tax rebates to encourage property owners to install large capacity bay-saver systems to treat high volume stormwater and before it discharges into public sewage. The bay-saver systems are designed to capture 80% of hydrocarbon, trash, sediment, metal pieces, dissolved nitrogen, and other pollutants.

In 2008 The Buch Company completed two bay-saver projects in Montgomery County, a 10K system for the Westfield Wheaton Shopping Plaza redevelopment and a 15K system for Trammell Crow's Milestone Business Park construction (Figure 5.1). Both projects qualified and received subsidies from Maryland Chesapeake Bay Critical Area Protection Program and property tax discounts from Montgomery County. Government financial incentives were an effective motivator to the project owners to invest in technologies and protect local ecosystems.

Figure 5.1 - Milestone Business Park

5.2.2.3. Case Study 5.3 - The AstraZeneca Combine Power & Heat Cogen Projects

To reduce energy consumption and emission, AstraZeneca awarded Buch Company the contract in 2015 to install a high-efficiency combined power heat (CHP) system to support its biopharmaceutical research campus in Gaithersburg, see Figure 5.2.

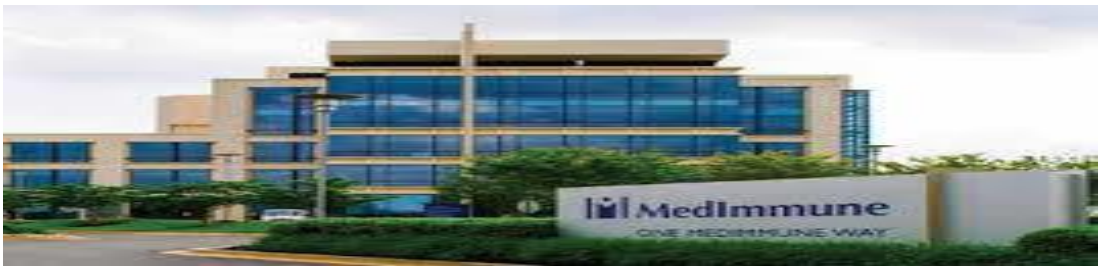

Figure 5.2 - The Medimmune Campus

A CPH unit produces electricity while reclaiming the heat generated from its engine and uses the heat to supply steam and hot water for the campus operation. This dual-function achieves great efficiency and reduces energy consumption. The CHP unit installed on the AstraZeneca campus was a natural gas-fired reciprocating internal combustion 2.5-megawatt Alban CAT unit (Figure 5.2Figure 5.3) with the following highlighted features: 1) generates 32,000 MWH electricity and 80,000 MBTU heat annually, 2) achieves 75% combustion heat transfer efficiency [2], 3) provides 98% power reliability redundancy which is critical to biochemical laboratories, 4) 30% reduction of greenhouse emissions, 5) 7.2 million kw-hours electricity consumption reduction per year, 6) $450K savings in electricity purchase per year, and 7) $275K savings in operational costs per year.

[2] Typical power generator efficiency is approximately 30-40%. With heat reclamation, the CHP achieved 75% system fuel efficiency.

Figure 5.3 - Medimmune Combined Power and Heat Unit Project

The project received the following financial assistance from state, county, and local utility company: 1) $120K tax credit from the Maryland Energy Administration's Combined Heat and Power Grant Program, 2) $800K low-interest loan from the Maryland Lawton Loan Program, 3) $200K low-interest loan from the Maryland Clean Energy Capital programs, and 4) discounted electricity/gas rates from local provider PEPCO. With these incentives, the project financially broke even in seven years.

5.2.3. Government Regulations and Self-Corrections

In the 1980's, the US Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) to curb the alarming nationwide hazardous contamination. The strict and effective regulations aimed to hold responsible large petrochemical corporations financially liable to clean up the contaminations they caused. The undiscriminating regulation also placed unintended burdens on small businesses in the older industrial or struggling inner city areas. In the rusty industrial and urban commercial districts, virtually every facility has, or is suspected to have, some kind of contamination from previous uses. The legal liabilities and financial uncertainties

imposed by CERCLA push existing businesses to exit and scare off potential investors from moving in. “The problem of urban blight largely arose because of the unintended chilling effect of the CERCLA and its state-law analogues (Eisen 2002).” The undesired impacts defeated the purpose of protecting environment and promoting sustainable growth.

5.2.3.1. Survey Question and Analysis

Survey Question #2 solicited opinions from respondents on whether government environmental regulations are too harsh and place unintended burdens on small business owners and developers.

Table 5.7 - Result of Survey Question #2

Survey Question #2: In general, do you believe government environmental regulations are too harsh and place financial and liability burdens onto small facility owners and developers?

ANSWER CHOICES	RESPONSES	
Too harsh	19.43%	122
Strong and effective	26.27%	165
Fairly managed	36.78%	231
Soft and ineffective	17.52%	110
TOTAL		628

The survey result in Table 5.7 shows that slightly less than 20% of the 628 respondents believed some regulations were *Too Harsh* on small businesses, while 63% believe most government regulations are *Strong and Effective* or *Fairly Managed*. Self-correction is one of the main reasons for high approval of government regulations. One of the most impactful government regulation self-correction was the Brownfields

Revitalization Act. As Eisen stated "the brownfield program aims directly at modifying previous environmental laws thought to be most responsible for stifling urban development (Eisen 2002)." The main purpose of the Brownfields Revitalization Act is to lessen the liabilities and financial burdens the previous regulations placed on property owners and promote investments in declining or abandoned properties in blight inner cities or industrial areas. Case Study 5.4 uses four projects as an example to demonstrate and discuss how the State of Missouri Brownfield program helped sustainability development in declining business communities.

5.2.3.2. Case Study 5.4 - The Montgomery Ward UST Contamination Remediations

Before going bankrupt in 2000, the retail giant Montgomery Ward sold twelve properties in Missouri to the May Company. Four sites in Joplin, Cape Girardeau, Springfield, and St. Louis were contaminated by underground storage tank (UGT) leaks. Montgomery Ward registered the sites with the Missouri Voluntary Cleanup Program, replaced the old UGTs with double-liner leak-proof above ground tanks, and hauled off contaminated soil for ex-situ treatment, and installed emitters to monitor volatile organic compounds concentration levels.

Despite Montgomery Ward's remediations complying to federal and state regulations, the environmental liabilities tied to the sites were major risk concerns to potential investors. Without the Brownfield Act, the May Company or others would not have been interested in taking over the four contaminated sites from the struggling Montgomery Ward. These facilities would likely have been abandoned and left to deteriorate and become lingering environmental and social problems to the local communities. Owing to the "innocent owner" liability waiver clause in the Brownfield Act, the May Company

purchased these strategically important properties and obtained "non-responsible party" certifications from the state EPA. In the ensuing years, the May Company completed remediations respectively and received the No Further Remediation letters from the State of Missouri.

The Missouri Brownfield programs enabled the May Company to save these contaminated sites, turn the declining properties into local shopping destinations, and contribute to the revitalization of the neighboring communities.

5.3. Corporate Sustainability Policies and Practices

This section uses case studies and survey questions to demonstrate and analyze the important role that corporate sustainability policies play in converting government's efforts into practical results and examines Proposition #5.

5.3.1. Corporate Sustainability Policies

Without business organizations' engagement, government regulations and incentives would not come to fruition. As Bell stated, "it has become increasingly evident that governments acting alone cannot achieve the far-reaching social and economic changes that sustainability will require. Only business and industry can lead quick and effective efforts to move beyond the rhetoric of sustainability (2002)." Corporate sustainability policies and practices play a critical role in converting government efforts into results.

Sustainability management has become one of the new engines for global economy growth and a necessity for enterprises to achieve long-term successes. A well-developed corporate sustainability policy internalizes environmental and social responsibilities

into a core strategy, captures business opportunities, and delivers long-lasting benefits to current and future generations of stakeholders.

5.3.2. Motivations Behind Corporate Sustainability Statements and Policies

Many organizations have come to realize the importance of sustainability and are intrinsically motivated to strive to operate green and invest in their future. As Kwawu and Elmualim stated, "the perception of sustainability, as benevolence with no direct impact on organizational core business strategies, has changed over the years as organizations actively incorporate sustainability principles into their core business strategies (2011)." Some organizations may still see sustainability practices as a financial burden and publish corporate sustainability statements and polices under the pressures from government regulation compliance and social media.

5.3.2.1. Survey Question and Analysis

Survey Question #5 asked respondents to rate five motivators behind corporation publishing sustainability statements and policies.

Table 5.8 - Result of Survey Question #5

Survey Question #5: Please rank five motivations behind corporation publishing their sustainability statements and practice policies, where 1 is the most important and 5 is the least important.

	1	2	3	4	5	TOTAL	SCORE
To avoid legal complications and penalty	34.61% 217	26.63% 167	17.38% 109	10.53% 66	10.85% 68	627	3.64
To improve company public image and marketing	25.20% 158	24.56% 154	22.49% 141	18.50% 116	9.25% 58	627	3.38
To take financial benefits from the sustainability incentives offered by governments	16.91% 106	25.04% 157	34.61% 217	15.15% 95	8.29% 52	627	3.27
To reduce operating costs	8.76% 55	12.42% 78	18.79% 118	39.17% 246	20.86% 131	628	2.49
To contribute to global sustainability growth	14.65% 92	11.31% 71	6.85% 43	16.56% 104	50.64% 318	628	2.23

The survey result in Table 5.8 shows that *To avoid legal complication or penalties* was ranked as the #1 motivator followed by *To improve company public image and marketing* in second. It is worthy notice that *To contribute to the global sustainability growth* was ranked #5, the very last. Based on the survey results, most corporations are not intrinsically motivated to take initiatives to go green, and government regulations and marketing demands currently remain the most powerful motivators.

5.3.3. Case Studies and Discussions

Among five corporations used in this section, Jones Lang LaSalle was selected to demonstrate its corporate sustainability policy in Case Study 5.5; the May Company was selected to discuss technical and procedural aspects of corporate sustainability practices in Case Study 5.6; and PNC Banks, Starbucks, and CBRE Europe were selected to compare and analyze their corporate sustainability goals.

5.3.3.1. Case Study 5.5 - Jones Lang LaSalle Corporate Sustainability Policies

Jones Lang LaSalle Incorporated (JLL), the world's second-largest real estate brokerage firm, provides asset investment, sales and leasing, property development, and facility management services. JLL has developed a comprehensive policies to guide corporate global sustainability practices.

The JLL corporate sustainability policies includes the following aspects: 1) a dedicated Global Chief Corporate Responsibility Officer to spearhead the corporate global sustainability efforts, 2) a global sustainability board committee to govern corporate sustainability policies and implementations, 3) *JLL Global Sustainability Teams* to oversee daily practices, 4) a corporate *Global Sustainability Mission Statement* on the company's website, and 5) annual *Global Sustainability Reports* accessible to the public.

5.3.3.2. Case Study 5.6 - The May Company's Sustainable Management Practices

The May Company assisted the USGBC in developing the first version of LEED by providing historical data on retail facility operation. The company developed a result-oriented corporate sustainability policy with specific operation procedures and details as listed in Table 5.9.

Table 5.9 - The May Company Corporate Sustainability Practices

Sustainability Practices	Description
Energy Consumption Reduction	Installing reflective roofs, solar panels, tanned glazing, LED lighting, variable-speed motors, and automatic power shut-downs.
Water Efficiency	Using waterless fixtures, water reuse, and stormwater harvesting technology.
Indoor Air Quality	Preventing sick-buildings through asbestos abatements, lead-paint removal, mold prevention, and HEPA filters.
Waste Management	Going paperless, recycling, and legal disposal of fluorescent bulbs, used batteries, and copier cartridges.

Transportation Management	Mandating third-party fleets using lean fuels.
Sustainable Procurement	Encouraging merchandise suppliers, vendors, and contractors to use renewable materials and environmentally friendly products.
Greenhouse Emission Reduction	Eliminating aerosol usage, replacing oil-based paint with water-based agents, prohibiting volatile organic compound chemicals, and reducing and eliminating ozone emission.
Environmental Protection	Replacing oil-hydraulic elevators and USTs to eliminate leaks and underground contamination.
Information-based Facility Performance Integration	Using information-based building integration to systematically improve facility sustainability performance.

Ozone (O_3) layer absorbs and prevents ultraviolet radiation rays from harming living organisms. Chlorofluorocarbons (CFC), also known as chlorofluorocarbon was widely used in refrigerant from the 1930's to the 1980's., are lasting chemical compounds that eventually rise up to the upper atmosphere, obliterate the ozone layer, and create ozone holes. CFC released from air-conditioning systems is one of the chief causes of ozone depletion. The following is an example demonstrating how the May Company achieved the corporate sustainability goals of ozone depleting emission reduction and elimination.

Chillers installed in the May Company stores prior to the 1980's mostly operated with CFC refrigerants (Figure 5.4). The CFC releases resulting from repair purges, system failures, or decommissions posed a serious greenhouse emission issue.

Figure 5.4 - Typical York Chiller Installed in the 1970's

In 1994, a chiller management program was developed to retrofit 312 older chillers to phase out CFC refrigerants (R-11 and R-12) with environmentally friendly HCHC products (R-22[3], also known as freon). In early 2000, all 2,340 chillers in the corporate facility portfolio operated with HCHC R-22 that reduced ozone emission by 82%. In 2003 the program started a 10-year phasing plan to replace R-22 with the zero-ozone emission refrigerant product HFC -410A[4]. The accomplishment was a direct result from the May Company's commitment to achieving the goals set in its corporate sustainability statement and policy.

5.3.4. Genuineness and Effectiveness of Corporate Sustainability Practice Policies

This section uses survey question and three sample organizations, PNC Banks, Starbucks, and CBRE Europe to discuss and analyze the genuineness and effectiveness, of corporate sustainability policies.

5.3.4.1. Survey Question and Analysis

Survey Question #4 asked respondents to rate the genuineness and effectiveness of corporate mission statements and sustainability policies.

Table 5.10 - Results of Survey Question #4

Survey Question #4: Using a number from 1 to 10, where 1is "Genuine and Effective" and 10 is Superficial and Ineffective, to rate corporation's sustainability mission statements and practice policies.

[3] HCHC R-22 and HCHC R-134a are chlorodifluoromethane and hydrochlorofluorocarbon respectively. R-22 is widely used for air conditioners and R-134a for portable equipment and refrigerators.
[4] HCH R-410A is a near-azeotropic mixture of hydrofluorocarbons difluoromethane and pentafluoroethane that has zero depleting effect to ozone.

	10	9	8	7	6	5	4	3	2	1	TOTAL
Corporation Mission Statements and Policies	13.60% 85	5.76% 36	16.32% 102	19.68% 123	14.72% 92	14.88% 93	6.56% 41	5.44% 34	1.28% 8	1.76% 11	625

The survey result in Table 5.10 shows that about 15% of respondents rated corporate sustainability mission statements and practice policies as *Genuine and Effective* (scores between 1 and 4); 55%, rated them *Superficial and Ineffective* (scores between 7 and 10); and the remaining 30% were in the middle (scores between 5 and 6). Based on the survey results, this indicates that corporate mission statements and the facility management industry practitioners currently have a credibility issue with the public. The survey result echoes to early discussions that some businesses view sustainability development as added costs, only do the bear minimum to comply with regulations, and publish grandiose sustainability statements and policies to improve their public image. PNC Banks, Starbucks, and CBRE were selected to compare and study some of the ambitious goals noticed in their sustainability mission statement and corporate policies.

Table 5.11 - Emission Reduction Goals

Company Name	Corporate Sustainability Policy Goals
PNC Banks	Reduce 75% carbon emission, 50% water consumption by 2035, and 100% renewable energy by 2025.
Starbucks	Reduce 50% carbon emission, 50% water consumption, and 50% landfill waste by 2030.
CBRE European	Zero carbon emission by 2025 and zero Group #3 emission by 2030.

Due to a lack of science-based evidence data support and rigorous formal external audits, strikingly encouraging goals like those summarized in Table 5.11 draw credibility questions from the public. Kwawu and Elmualim stated, “Lack of consensus on key

sustainability policy issues and responsibilities have created a concern for facility management (2011)." Some organizations may simply publish lofty goals and superficial policies for the sake of having them, to avoid liabilities, or to impress the public with far-stretched dates and information that cannot be feasibly verified.

Grandiose sustainability mission statements or corporate policies that cannot be reasonably verified pose potential legal liabilities to organizations. In the eyes of the law, corporate sustainability mission statements and self-audited reports are integral materials that have an influence on investors decisions.

5.4. Public-Private Collaboration and Current Challenges

This section uses LEED and BIM as primary examples to demonstrate and discuss challenges currently encountered in sustainability practices, investigate underlying causes, explore potential solutions, and examine Proposition #6.

5.4.1. Industry Professional Associations and Sustainability Development

Facility management associations provide professional guidance and technical standards to assist members, solve emerging challenges in practices, and promote the industry. For instance, the LEED developed by the USGBC is the most widely used green building rating system in the facility industry providing design standards for healthy, efficient, and high-performing buildings.

5.4.1.1. Survey Questions and Analyses

Survey Question #7 solicited respondents' opinions on the effectiveness of facility industry associations in assisting sustainability development.

Table 5.12 - Result of Survey Question #7

Survey Question #7: In your opinion, how well do professional associations assist the facility industry in improving sustainable facility management?

ANSWER CHOICES	RESPONSES	
Helpful and effective	14.65%	92
Fairly effective, but with much room for improvement	53.50%	336
Not effective	31.85%	200
TOTAL		628

The survey result in Table 5.12 shows that only 15% of the total respondents believed professional associations assistance was *Helpful and effective;* about 32% believed it was *Not Effective;* 53% believed it was *Fairly effective but with much room for improvement.* The survey result suggests that facility management professional associations have met the industry expectation in assisting the facility sustainability development. The following section discusses some challenges caused by confusing LEED requirements.

5.4.2. LEED Standard and Challenges in Practice

LEED was adopted by the USGBC in 1998 and became a comprehensive standard covering all aspects of the development and construction process. LEED was developed to establish a common standard for sustainable buildings, to promote integrated green building design, to raise consumer awareness of green building benefits, and to transform the building market.

5.4.2.1. Survey Question and Analysis

Survey Question #8 solicited general opinions from respondents on current LEED standards.

Table 5.13 - Result of Survey Question #8

Survey Question #8: What is your opinion on the current LEED standards?

ANSWER CHOICES	RESPONSES	
Well developed	24.20%	152
Well developed, but with some contridicting design requirments	57.96%	364
Poor	17.83%	112
TOTAL		628

The survey result in Table 5.13 shows that 24% of the respondents believed the LEED standards were *Well developed*; 58%, *Well developed, but with contradicting design requirements*; and less than 18%, *Poor*. LEED standards play a critical role in advancing facility sustainability development and receive a solid approval from the industry, though about 76% of the survey respondents believe there is much room for improvement. As an example, confusing LEED design requirement will be discussed in Case Study 5.7.

5.4.2.2. Case Study 5.7 - Energy Efficiency vs. Fresh Air Ventilation

Sick buildings pose serious issues such as employee health, productivity loss, and legal complications to business organizations. Research has shown that "approximately 3.8 million people around the world die every year as a result of indoor air pollution. It is estimated that the poor indoor air quality affects 33% to 50% of commercial buildings in the U.S. and is responsible for over 10 million lost workdays per year (Davies 2019)."

The main causes of sick buildings are mold, asbestos, lead, carbon dioxide, radon, and volatile organic compounds. Mold fungi grow in damp areas with stagnant air and moisture and people get sick from excessive exposure to airborne fungi. Eliminating

water leaks and maintaining adequate fresh air flows are the two most effective measures to prevent a mold sick building. The current LEED energy efficiency design requirement encourages air-recycling and tight-sealed building envelopes that contradicts with indoor fresh air ventilation design.

In 2016, the Buch Company completed the New Technology Training Center project for the Plumbers and Gasfitters Union (Figure 5.5), a Silver LEED project with state-of-the-art building automation systems. Advanced building sealing technologies, double-pane windows, and pre-treated air recycling systems were installed to achieve more LEED energy efficiency points.

Figure 5.5 - The Plumbers and Gasfitters Union New Technology Training Center

Two years after moving-in, several employees reported breathing difficulties and headaches, typical symptoms of sick-building. An occupational health consulting firm was deployed to investigate the reoccurring problems and the lab results revealed 1) high mold concentrations in the building, 2) damp areas in the attics and crawl spaces with no fresh air circulation, and 3) the high-efficient air recycling system blew the fungi into working spaces. ported. An engineering firm was hired to redesign the air circulation

systems bringing significant fresh make-up air into the building and lowering the capacity of the high-efficiency air recycling automation.

To earn maximum LEED points, the design was heavily favored the energy efficiency aspects, due to the current LEED rating structure, where Energy Efficiency counts for 35 points while indoor air quality only counts for 15. LEED awards more points for building automation energy saving efficiency designs such as sealing the building envelops, using double-pane windows, and recycling cooled or heated air, but these designs often contradict with LEED indoor air quality requirements. Overdesigns of energy efficiency compromise indoor air quality and cause sick buildings.

5.4.3. BIM and Challenges in Practice

Beyond 3D visualization, BIM provides a useful tool and a philosophy of how facility teams manage their projects. Mason stated in his article *It's Not a Tool, It's a Process*, "BIM is not something that can be used as it is not a specific tool nor a piece of software, it is not an object. Building Information Modelling is a collaborative way of working underpinned by digital technologies (2016)."

This section uses four survey questions and one case study to discuss BIM application and investigate the challenges encountered in practice.

5.4.3.1. Survey Questions and Analyses

Survey Question #9 solicited opinions from respondents on whether they believe BIM can significantly improve facility sustainability management.

Table 5.14 - Result of Survey Question #9

Survey Question #9: Do you believe BIM (Building Information Modeling) can significantly improve facility sustainability management?

ANSWER CHOICES	RESPONSES	
Strongly believe	19.75%	124
Believe	48.89%	307
Do not believe	28.03%	176
Strongly do not believe	3.34%	21
TOTAL		628

The survey result in Table 5.14 shows that about 69% of respondents *Believe* or *Strongly Believe* BIM can significantly improve facility sustainability management, while the other 31% do not. The result indicates that BIM is an impactful tool and innovative management approach, yet there are obstacles in the practice preventing the BIM application from delivering its full capacity. The majority of the respondents are industry veterans and observations, and experiences reflect the reality of BIM application in practice. Survey Question #13 solicited opinions on whether the benefits of BIM application are overhyped.

Table 5.15 - Result of Survey Question #13

Survey Question #13: Do you believe that BIM benefits are "overhyped", and the full capacity of BIM has not been realized yet?

ANSWER CHOICES	RESPONSES	
Strongly believe	16.56%	104
Believe	54.94%	345
Do not believe	24.52%	154
Strongly do not believe	3.98%	25
TOTAL		628

The survey result in Table 5.15 shows that about 71% of respondents *Believe* or *Strongly Believe* that the BIM benefits are overhyped, and the capacity has not been fully realized.

The benefits of BIM application have been studied and touted in copious academic and professional publications. Apparently, the industry veterans and respondents who participated in this survey do not necessarily agree with the rosy perspectives. As facility industry expert Rogers stated in his article *BIM is "Overhyped", Says Survey*, "40% said the benefit of using BIM has been exaggerated, an increase on the 34% last year while the number of people admitting they did not derive any benefits from BIM edging up from 10% last time to 12% (Rogers 2017)." BIM is a sophisticated management tool and approach, but what are the underlying reasons of BIM application not reaching its full capacity in the facility management industry? Survey Question #12 asked respondents to rank six possible reasons that may cause the facility management industry to lag in BIM application.

Table 5.16 - Result of Survey Question #12

Survey Question #12: Using the arrow boxes, where 1 is "The Most Important" and 5 is "The Least Important", to rank the six (6) possible reasons that may cause the facility management lagging behind in BIM application.

	1	2	3	4	5	6	TOTAL	SCORE
The industry composition are largely small or medium subcontractors who are "not-BIM-ready"	29.51% 185	25.52% 160	18.34% 115	10.37% 65	5.10% 32	11.16% 70	627	4.30
Most of facility managers and frontline teams are much less digitalized than peer industries	24.72% 155	21.69% 136	14.19% 89	13.08% 82	15.47% 97	10.85% 68	627	3.95
The additional cost to the projects discourage facility owners from implementing BIM pratice	27.59% 173	24.88% 156	29.67% 186	9.57% 60	4.78% 30	3.51% 22	627	4.50
Current BIM practices are confusing and lack of industry standards	8.61% 54	15.47% 97	17.38% 109	32.85% 206	16.59% 104	9.09% 57	627	3.39
Disconnections between/among phases (design - construction - operation)	5.90% 37	5.74% 36	12.28% 77	21.21% 133	36.68% 230	18.18% 114	627	2.68
Incompability among design disciplines (architectual and multiple engineering)	3.66% 23	6.85% 43	8.12% 51	12.90% 81	21.34% 134	47.13% 296	628	2.17

The ranking in Table 5.16 is summarized and rearranged in Table 5.17 based on the scores.

Table 5.17 - Rank of Underlying Reasons

	Description of Reasons	Score
1	Additional cost to implementation	4.5
2	Industry trade composition	4.3

3	Lacking digital skills and training	3.95
4	Confusing BIM practice standards	3.39
5	Disconnection between design, construction, and operation	2.68
6	Incompatibility among design disciplines	2.17

The ranking in Table 5.17 indicates that the facility industry currently is not ready to support BIM application to reach its full capacity. As Rogers stated, "the BIM fatigue is real, and some people are losing patience and confidence in BIM (2017)." Government agencies and industry associations need to join forces and step in to help before BIM losses its momentum. Section 5.4.4 revisits these challenges and explores possible solutions.

5.4.3.2. Case Study 5.8 - A BIM Implementation Failure, The Vine Apt. Project

The Buch Company started the development of a 238-unit luxury apartment complex The Vine in 2015 (Figure 5.6) and needed to obtain a $57 million low interest loan from the US. Department of Housing and Urban Development (HUD) to finance this project. Applying BIM technology was required for HUD loan application. A BIM firm was hired to manage the BIM application throughout the design, construction, and operation phases.

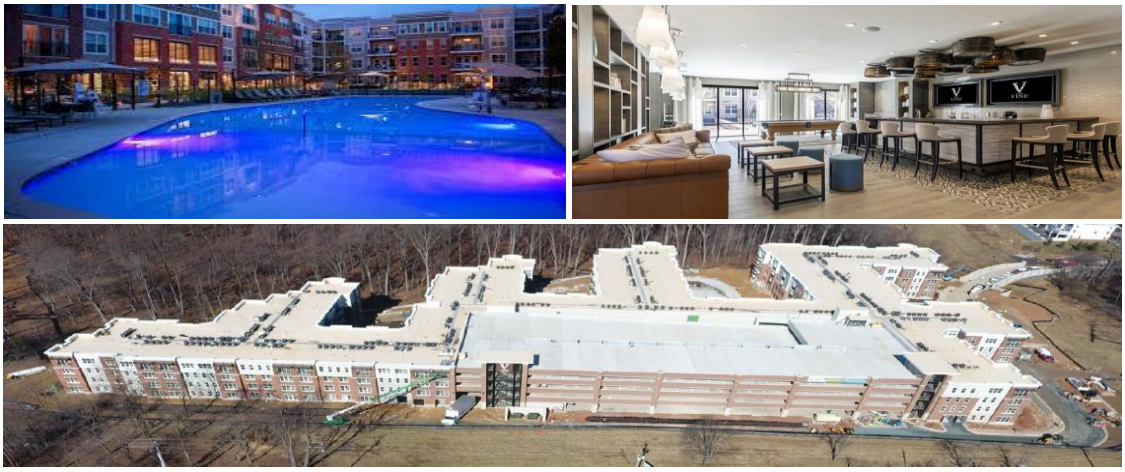

Figure 5.6 - The Vine Apartments

In the design phase architects, engineers, and subconsultants used AutoCAD, Mcintosh, and special software developed for their disciplines. The interdisciplinary incompatibilities presented a daunting challenge, and it would take 6-8 weeks for the consultant to painstakingly to prepare a high-quality BIM package. Under the pressure of the loan application deadline, the Buch team instructed the BIM consultant to quickly compile a bare minimum package to satisfy HUD requirements. The BIM package was assembled within two weeks and submitted. HUD officials checked the consultant's seal, approved the package, and awarded BIM points. HUD did not have the capacity to verify the BIM package, and there were no regulations or enforceable industry standards to hold the consultant responsible to a defined or generally accepted level of professionalism or service.

In the construction phase, other than a handful of large corporations, the subcontractors and vendors that won contracts through competitive bidding were medium or small companies. It was unrealistic to ask these subcontractors, who had zero or limited computer training, to track and convert changes into BIM as-builts. If the process only allowed BIM-ready subcontractors to bid on the project, then that would have significantly

lowered the competition, increased construction cost, and made this development financial infeasible. HUD did not have the auditing capacity, and the Buch team did not enforce BIM compliance. Because there was no solid base of "commonly acceptable industry customary BIM practices", strict enforcement could lead to confrontation and potential legal complications.

In the facility operation phase, the compromised BIM package handed over to the owner facility teams was of little use. Frustrated with the discrepancies and misleading information, the facility team gave up on the BIM package.

The Vine development project was a huge financial success but a major BIM failure. The BIM challenges encountered in this project are not isolated but are industry-wide issues beyond a single company's capacity to fix.

5.4.4. Potential Solutions

As discussed in Case Study 5.8, the current challenges encountered in today's facility sustainability development cannot be overcome by a single organization or a single industry sector. It requires a coalition of government, industry associations, and corporations to remove barriers and create a holistic supporting infrastructure to advance sustainable facility growth.

5.4.4.1. The Public-Private Collaboration

The public-private collaboration is the sensible solution to resolving the aforementioned issues in facility sustainability management. Government involvement is needed to establish fundamental principles, provide regulatory guidance, and enforce compliance. Besides regulations, governments use incentive programs to effectively

foster public-private collaboration, as AIA report (2008) stated, “incentives work best when they are based on a sound methodology combined with robust advocacy efforts and strong support from the public.” Case Study 5.9 provides an example of successful PIP collaboration in a sustainability development project.

5.4.4.2. Case Study 5.9 - Ballston Common Shopping Mall Redevelopment

In 2012, the Buch Company teamed with Forest City Realty Trust (FCRT) in the Ballston Common Shopping Mall urban mix-use redevelopment (Figure 5.7). FCRT developed an 18-story luxury condominium at the south end and reconfigured the existing 4-level shopping concourses in the middle section. The Buch company developed a 15-story class-A office building at the north end (Figure 5.8).

Figure 5.7 - Ballston Common Redevelopment Wilson Street Elevation

The 15-story Buch office building consists of 3 existing floors on top of Macy’s store plus 12 new floors with a typical floor of 45,000 sf. The total proposed project area was 675,000 sf. Buch had 293,000 sf FAR (floor area ratio) already approved by the Arlington County and needed additional 382,000 sf to make the project financially feasible.

To obtain the additional 382,000 sf, the Buch team applied for the LEED-based bonus density program offered by the Arlington Economic Council: 25% bonus density for projects achieving Platinum LEED certification, 20% for Gold, and 15% for Silver. Buch committed and applied for Silver LEED and the Arlington granted the additional

101,250 sf FAR. Based on the prevailing density rate of $75/sf on the real estate market, the value of the bonus density was about $7.6 million in. This substantial non-cash financing from the County was critical to the project. With the bonus density, Buch was still short of 280,750 sf. The Arlington Economic Council creatively structured a sustainability credit swap plan allowing Buch to contribute $18.2 million and sponsor a green urban parks program in the county for an exchange of 280,750 sf FAR for the project.

Figure 5.8 - Ballston Common Redevelopment

This Ballston redevelopment project was a public-private collaboration success. The Arlington County Government used the industry standard LEED incentive program and a creative sustainability credit swap plan to support a private redevelopment. In return, the Buch Company contributed $18.2 million to enable the County to fund its eco-green urban park projects.

5.4.4.3. Adopt Successful Government Practices from Other Countries

As discussed earlier in this chapter, government involvement has been the driving force behind sustainability development. Government regulations, enforcement, and collaboration with private enterprises are critical to help the facility industry to overcome the

current challenges. The United States government can learn from their counterparts in other countries.

5.4.4.4. Survey Question and Analysis

Survey Question #15 solicited insights from respondents on whether the United States government should make BIM a mandatory practice on certain projects like their counterparts do in other countries.

Table 5.18 - Result of Survey Question #15

Survey Question #15: Do you believe that government should make BIM a mandatory practice for certain projects, like what their counterparts do in other countries?

ANSWER CHOICES	RESPONSES	
Strongly believe	18.95%	119
Believe	53.82%	338
Do not believe	20.70%	130
Strongly do not believe	6.53%	41
TOTAL		628

Survey result in Table 5.18 shows that about 73% of the respondents *Believe* or *Strongly believe* that governments should learn from their counterparts in other countries and make BIM a mandatory practice on certain projects, while 27% either *Do not believe* or *Strongly do not believe* so. The facility industry needs the assistance from government to push BIM application go through bottlenecks. The US governments needs to step out of the box and learn pragmatic practices from their counterparts in other countries.

5.4.4.5. Online Interviews and Analysis

Online interviews were conducted with fifteen Chinese government officials, senior executives of state-run corporations, and owners of private enterprises to understand

Chinese governments involvement and interactions with private enterprises. The main topics of interview discussions are summarized in Table 5.19.

Table 5.19 - Main Topics of Online Interview Discussions

	Interview Topics
1	How are the current BIM application and sustainability development in China?
2	How mature are the BIM software products in China?
3	Should governments intervene and mandate BIM application on certain projects?
4	How private owners and developers view the additional BIM costs to their projects?
5	Are facility service providers in China technically ready to provide BIM service?
6	How to monitor, audit, and enforce BIM application?

Topic #1: Fifteen interviewees shared similar views, i) the BIM application is in its infancy in China and still needs protection and guidance from governments; ii) compared to what China had ten years ago, this country has made significant strides in sustainability development and is exploring innovative ways to accomplish more; and iii) the BIM practice is far from being used to its full capacity.

Mr. Lin He, a senior executive of Xiaman Engineering Consultant Company representing owners on project sites, said "in reality, BIM is mostly used now in engineering design to avoid equipment and pipeline spacing conflicts." He firmly believed that the situation would change soon in the next few years.

Topic #2: The Hubei Province United Engineering Software Development Ltd provides BIM software development and consulting service to Wuhan City and adjacent governments and private clients. Owner of the company, Mr. Bo Gao, confidently stated, "as a soft engineering veteran serving the facility and construction industry for more than two decades, I can assure that the BIM software developed in China is as good as anywhere else and years ahead of the application in practice."

China and the United States are facing the same situation that the BIM software development is not one of the bottlenecks, but the government, industry, and market supports are. The difference is that Chinese governments are stepping in to change the stalemate, but the United States governments are not yet.

Topic #3: Both Dr. Ning Sun and Mr. Zhou are government officials. Dr. Sun works for the Highspeed Railways Bureau of China Ministry of Railways. Mr. Zhou was Director of the Beijing Construction Committee for years prior to being transferred to the Beijing Construction Engineering Corporation.

Dr. Sun and Mr. Zhou strongly believed that without the government directly intervening, BIM would have no chance at success in China. Dr. Sun said, "only government regulations and enforcement can set out the message to the business society that the sustainability is the future, and everyone has to jump on the wagon." Mr. Zhou pointed out, "to me only the governments can level the playground for BIM practice, so that all developers and constructor in the same classification compete against each other on the same BIM standards. Otherwise, no company would voluntarily absorb the added BIM costs and put oneself in a competitive disadvantage."

Topic #4: Mr. Cangyan Wu owns a private real estate real estate company in Fuzhou, Fujian Providence. He shared insights, "BIM application is an additional cost to owners, and we try to find excuses not to do it as much as possible. The situation may change in the next couple year as provincial and municipal government are rolling out BIM regulations on larger public projects, and private commercial development will be regulated soon." Mr. Chengfu Pan, owner of a private construction company, added, "I

do not see how BIM application would affect our business, once we all follow the same regulations, the market will pass down the additional BIM costs to the end-users."

Topic #5: Mr. Jinsong Chen, founder of the well-known Chinese full property service conglomerate Shenzhen World Union Properties Consultancy Co. Ltd, offered his thoughts, "Whether the facility is BIM technically ready or not is a pseudo question. In essence, this is an economic question. Colleges in China produce more degreed workforce than the market can take. It is really about how much we are willing to pay them and how to convince the market to absorb the costs. In general, the current China market does not support a full-scale BIM rollout, but we can start to pilot experiments making BIM application mandatory in the public and high-end private submarkets."

Topic #6: Mr. Zhenhua Xi, owner of a private engineering design firm in Shenzhen, Guangdong and Mr. Lixue Tang, CEO of private real estate developer operating in both Wuhan and Beijing discussed and provided detailed information of BIM regulations and compliance enforcement recently announced by some municipal governments. Table 5.20 highlights the timeline of BIM requirements published by the ShenZhen municipal government, *Notification from the Housing and Construction Bureau of Shenzhen Municipality (No. 103, December 7, 2021) on Accelerating BIM Technology Application.*

Table 5.20 - Timeline of Shenzhen Municipal Government BIM Application Rollout

	Target Date	Rollout Scope
1	1/1/2022	Any new project financed by state or municipal governments, any project is of significance to the municipality, and any project in the special development zones are required to fully implement BIM application.
2	6/1/2022	Referenced projects must submit BIM package in the process of zoning review, construction permitting, and final occupancy certification.

		Municipal government to provide a public BIM bidding portal for all state or municipality financed projects.
3	12/21/2022	The municipal government is to build a multi-function portal to manage BIM application, approval, and inspection, synchronize the new portal with the existing Smart City Digital platform, and require 50% of the total new projects in the municipal jurisdiction to implement BIM application.
4	1/1/2023	Any public or private project > 10,000 m^2 or cost > ¥10 million must implement BIM application.
5	12/31/2025	The municipal government is to develop a comprehensive BIM database, support information-based intelligent (CM1) system, and achieve a fully digitized city management network.

China central government considers the digital economy as one of the new engines to keep up the GDP growth. BIM has received recognition as a powerful tool to support national strategies of intelligent infrastructure and smart city managements. As Tang said, "BIM application is still in the early experimenting stage in China, With the supports from our authoritarian government, advanced IT infrastructure, surplus of educated workforce, vast market, and national wealth, BIM application will grow and mature quickly and deliver strong impacts and transform the facility and construction industry in China."

5.4.4.6. BIM Application in European Countries

European countries have been the leaders in building digital automation and BIM application. Not all European countries are following the same timeline or methods in BIM adoption. While the early adopters are reaping the benefits of their established BIM programs, other countries remain in an exploratory phase. Austria and some Scandinavian counties have already established comprehensive standards and mandate BIM application. UK, France, and Italy have established basic BIM mandates and have various schedules for moving to higher levels. Germany and Spain introduced BIM standards and

have plans to eventually mandate BIM application. Portugal, Switzerland, and Belgium have active BIM organizations and initiatives, but no plans to mandate BIM application. The aforementioned information was collected from Petri Luomala's article *The Different Phases of BIM Adoption in Europe* (2020).

5.4.4.7. Suggestion to BIM Application in the United States

Both interviews with Chinese government officials and industry veterans and research on BIM application practices in European countries indicate that government intervention and mandates play a critical role in advancing BIM application. Due to cultural and political differences, these proven effective measures in China or Europe may not work in the United States. It is no doubt that the United State government can learn some inspirations and lessons and find inspiration from their overseas counterparts.

5.5. Chapter Summary

Analyses on survey results of Question #1 and #6 indicated that government regulations and incentive programs were highly effective in advancing facility sustainability management. Case Studies #1, #2, and #3 provided three examples demonstrating how the state government incentive programs encouraged and assisted corporations in contamination cleanup, local ecosystem protection, and high-efficiency power generation projects. Analysis on the survey results of Question #2 indicated that some government regulations were harsh for facility owners. Case Study 5.4 demonstrated how the government agencies used the Brownfield Act to adjust and relieve unintended burdens previously placed on innocent property owners.

Analysis of the survey results of Question #5 revealed that regulation compliance and an organization's public image are the top two motivators behind corporate sustainability policies. Case Study 5.5 and 5.6 demonstrated the corporate sustainability policies of two S&P500 corporations. Analysis on the survey results of Question #4 suggested that the public has credibility concerns with corporate sustainability statements and policies. An investigation on three large corporations' ambitious sustainability goals indicated a lack of third-party audits or no technical feasibility of verification.

LEED and BIM applications were used as examples to demonstrate current challenges encountered in sustainable facility practices. Analyses on the survey results of Question #7 and #8 indicated that although industry professional associations and LEED standards play critical roles in sustainable facility management, there is room for improvement. Case Study 5.7 provided an example of contradicting LEED requirements. Analyses on the survey results of Question #9 and #13 showed that BIM has potential,

but its benefits have not been fully realized. Analysis of survey results of Question #12 revealed reasons for industry-wide struggles in sustainable facility practice. Case Study 5.8 provided an example of an aborted BIM application project and investigated the causes behind the failure. Case Study 5.9 provided a successful public-private collaboration for an urban redevelopment project. The case study analyses showed that public-private collaboration is a pragmatic solution to the current challenges encountered in the sustainability management practice.

Analysis on the survey results of Question #15 showed that United States governments agencies should learn from their overseas counterparts and make BIM a mandate on certain projects. Analysis on interview outcomes with Chinese government officials and industry executives suggested that the United States government agencies would benefit from adopting practices that have been shown to be successful in China. Research conducted on BIM application in European countries also suggested that direct government involvements are effective and necessary in advancing BIM application.

Overall, the survey results, case studies, interviews, and content research on special topics conducted in Chapter 5 have established case-based reasonings to support the conclusion that Propositions #4, #5, and #6 generally hold true.

6. Conclusions

The facility industry has experienced a steady growth of 7% a year in past two decades. To meet this growth, the industry is in need of innovative management methods and solutions to the challenges currently encountered in sustainability practices. Modern management methods that have been shown to be successful in other industries were discussed in Chapter 2 and Chapter 5.

6.1. Proposition #1

Case Studies 4.1 and 4.2 and *Pre-Post* analysis were employed to examine Proposition #1 using a *Grounded Theory* approach. Corporate facility portfolio maintenance cost records between 1992 and 2005 were used to structure a series of *Pre-Post* comparisons to demonstrate the impact of the *PM3/PMO* adoptions on the cost reduction of the May Company corporate facility portfolio operation over the 14 years. Record of ratio of derivative project and company financial statements between 2006 – 2019 were used to prepare a series of *Pre-Post* comparisons to demonstrate the impact of *APP/OPM*3 adoptions on the improvement of the Buch Company financial performance. Together, the case studies and *Pre-Post* analyses provided a case-based reasoning to support Proposition #1 "*Cross-industry learning and adoption can effectively meet the increasing demands for innovative modern facility management methods*."

The research started with the idea that the cross-industry learning and adoption has a significant impact to facility management. It was a struggle to find an appropriate methodology to process the large amounts of empirical case information and of historical data available and define the research directions. The Grounded Theory provided a fitting

approach suitable for the research needs. The Proposition has been adjusted throughout the research as new concepts became clearer and supporting information emerged. The improvised research approach caused the Proposition to develop out of the ground information and come into form. The *Pre-Post* comparison provided a stronger than expected supplemental support to confirm the results of Grounded Theory research.

6.2. Proposition #2

A cross-sectional case study and the *QCA* approach were used to examine Proposition #2. A group of 13 subcontracting companies with similar background were selected to investigate the impact of six key preconditions to the outcomes of their *APP*/*OPM3* adoptions. Condition and outcome data sets were developed for *Truth Table* analysis. Collectively, the case studies and *QCA* analysis established a causal ground to support Proposition #2 "*Assuring positive contributions from key factors is a precondition for successful new practice adoption.*"

6.3. Proposition #3

A cross-sectional case study and the *QCA* research approach were also used to examine Proposition #3. A total of 23 sample Agile projects were selected to investigate the impact of six risk variables on project outcomes. Conditions (risk variables) and project outcome data sets were developed for *Truth Table* analysis. The case studies and *QCA* analysis established sufficient case-based reasoning to support Proposition #3 "*Pragmatic management of key risk variables is prerequisite for successful applications of adopted practices in facility project execution.*"

6.4. Proposition #4 and #5

Mixed use of thematic (survey) and narrative (case study) data analysis methods were used to examine Proposition #4 and #5. Semantic differential, Likert rating, and other numerical scale were used in survey questions to gain respondent opinions on topics of government regulations, incentive programs, and corporate sustainability policies. Case studies provided supplementary demonstration and investigation on related topics. Drycleaner site cleanup, Brownfield Act, high-efficiency power generation, Chesapeake Bay ecosystem protection were discussed and analyzed to demonstrate the impact of government involvement on sustainability development. Jones Lang LaSalle, The May Company were used as examples to analyze and illustrate the key role that corporation policy play in converting government efforts into results. PNC Bank, Starbucks, and CBRE Europe were selected as example to discuss lacking audits and accountability on some grandiose goals that some organization published. Together, the survey results, quantitative and quantitative analyses, and case studies provided investigations from multiple angles and established a case-based reasoning to support Proposition #4 "*Government involvement is the backbone of achieving sustainability.*" And Proposition #5 "*Corporate sustainability policies and practices play critical roles in converting government efforts into results."*

6.5. Proposition #6

Besides survey and case studies, IPA analysis (interview) and Content analysis (special topic research) data analysis methods were also employed to examine Proposition #6. A total of six survey questions, three case studies, and 15 interviews were used to discuss current challenges encountered in facility sustainability practice and explore

potential solutions. LEED and BIM application were selected as primary examples to investigate successful public-private collaboration and the industry-wide barriers preventing BIM to achieve full capacity. Interviews with Chinese officials and executives and special topic research on BIM application in European countries suggested that government involvement was highly effective in advancing sustainable facility growth. Collectively, the survey results, case studies, interviews, and special research have established a support for Proposition #6 "*Collaboration among government, corporations, and industry associations is needed to overcome current challenges encountered in sustainable facility practices.*"

In the beginning, the research aimed to discuss technical and procedural issues in sustainable facility management. As the research developed, it become more evident that the roots of the challenges that encountered in facility sustainability practices were the government regulations, industry compositions, upstream and downstream market support, and workforce training. The technical and individual organizational issues were relatively less challenging in comparison to the deep-seated governmental and industrial issues.

7. Future Steps

Due to time and space limitations, there are elements left in this dissertation for future improvement. My hope is that other researchers interested in the topics discussed in the dissertation can contribute their insights and expertise in the future research.

7.1. Increase Research Sample Size

Two *Pre-Post* analyses were conducted to demonstrate the impact that adopting innovative practices has on corporate facility management. Personal experience, firsthand observation, and 14 years of cost records and audited financial statements were used, respectively, in each case to analyze and support the proposition. Adding more case studies with similar research objectives would enlarge the sample size and significantly strengthen the argument.

This dissertation employed qualitative comparison methods in examining propositions related to innovative practice adaption. Qualitative analysis is an effective research method, but it is also criticized for lacking statistic rigor. The practicality of qualitative analysis makes it a fitting method for this dissertation that aims to study current challenges and develop any potential solutions using qualitative case histories.

7.2. Use Computer-Aided QCA Analysis

QCA is usually employed for analyzing an intermediate number of cases between 10 and 50. Two cross-sectional case studies used 13 sample subcontractors and 23 sample Agile projects respectively for *QCA* analyses. Due to both a manageable sample size and relatively simple coding processes, software applications were not used in this research.

Future research on larger sample sizes might use as *QCA* software such Tosmana™ or fs/QCA™ to improve research efficiency and outcome quality.

7.3. Interview Follow-ups and Research Update

Interviews conducted with Chinese government officials and industry veterans were resourceful and helped to gain an in-depth understanding of the government's direct involvement in sustainability development in China. The interviews provided detailed timetables of mandatory BIM applications in the cities of Xiamen, Wuhan, and Shenzhen. In the ensuing years, following up with these municipal government implementations and updating the dissertation research would offer significant data to this dissertation research.

7.4. Individual Dissertation Research on Each Sustainability Proposition

Each of the three propositions related to sustainability management is a worthy topic and merits a separate in-depth research in the future. The survey of this dissertation was designed in the early stage without clear aims. Only 12 out of the 15 were used in the final research. With the experience gained in this research, I would conduct future research on each of the propositions requires a survey with specific design aligning with research topic, a larger case study sample size, and a more structure analysis approach.

I wished for more time to expand the research, deepen the discussions, and better present the arguments, and hope this dissertation research may provoke the interests of other researchers to join forces to continue the academic research work, enhance the knowledge body of facility management, and explore pragmatic solutions for industry practices.

Appendix A - The May Company Corporate Facility Portfolio 2005

Lord & Taylor's Stores

	Store Name	City, State	1,000 sf	Year Built/Acquired
	NJ			
1	Quakerbridge Mall	Lawrenceville, NJ	136	1976
2	Ridgewood Fashion Center	Paramus, NJ	156	1957
3	Rockaway Town Squares Mall	Rockaway, NJ	131	1980
4	Westfield Mall	Westfield, NJ	142	1963
5	Willow brook Mall	Wayne, NJ	121	1997
6	Woodbridge Center	Woodbridge, NJ	123	1996
7	Bridgewater Commons	Bridgewater, NJ	140	1988
8	Freehold Raceway Mall	Freehold, NJ	122	1990
9	Garden State Plaza	Paramus, NJ	130	1996
10	Livingston Mall	Livingston, NJ	131	1972
11	Monmouth Mall	Eatontown, NJ	125	1975
12	Mooretown Mall	Mooretown, NJ	121	2000
	NY			
13	New York 5th Ave	NYC, NY	611	1914
14	Bayshore Shopping Mall	Bayshore, NY	120	1990
15	Carousel Mall	Syracuse, NY	101	1994
16	Eastview Mall	Victor, NY	90	1995
17	Garden City Shopping Mall	Garden City, NY	154	1956
18	Manhasset Mall	Manhasset, NY	125	1941
19	Palisades Center	West Nyack, NY	121	1993
20	Walden Galleria	Cheektowaga, NY	100	1991
21	Walt Whiteman Mall	Huntington Station, NY	120	1996
22	Westchester Plaza	Scarsdale, NY	169	1996
23	Crossgates Mall	Albany, NY	102	1994
	PA			
24	Bala Cynwyd	Bala Cynwyd, PA	121	1955
25	Center City Mall	Philadelphia, PA	354	1997
26	King of Prussia	King of Prussia, PA	119	1995
27	Pittsburgh Downtown Center	Pittsburgh, PA	146	2000
28	Harrisburg Place	Harrisburg, PA	113	1997
	VA			
29	Dulles Town Center	Loudon, VA	120	1996
30	Fair Oaks Mall	Fairfax, VA	127	1996
31	Landmark Mall	Alexandria, VA	122	2001
32	Tyson's Corner	McLean, VA	120	1980
	CT			
33	Danbury Fair Mall	Danbury, CT	79	1991
34	Stamford Center	Stamford, CT	155	1969
35	Westfield Shopping Center	Trumbull, CT	114	1984
36	Westfarms Mall	Farmington, CT	117	1983
37	Buckland Mall	Manchester, CT	106	1984
38	Lynnhaven	Virginia Beach, VA	102	1989

39	Meriden Center	Meriden, CT	92	1990
	DE			
40	Christiana Mall	Newark, DE	129	1997
	DC			
41	Metro Center	Washington DC	146	1959
42	Chevy Chase	Washington, DC	131	2004
	IL			
43	Northbrook Court	Northbrook, IL	124	1976
44	Oakbrook Center Mall	Oakbrook, IL	102	1973
45	Old Orchard Shopping Center	Skokie, IL	115	1976
46	Water Tower Place	Chicago, IL	141	1975
47	Woodfield Mall	Chicago, IL	124	1985
	MD			
48	Annapolis Mall	Annapolis, MD	110	1996
49	Columbia Mall	Columbia, MD	120	1995
50	Lakeforest Shopping Center	Gaithersburg, MD	123	1995
51	White Flint	Kensington, MD	116	1977
52	White Marsh Mall	White Marsh, MD	120	1998
53	Towson Mall	Towson, MD	118	1995
54	Montgomery Mall	Rockville, MD	112	1993
	MA			
55	Prudential Center	Boston, MA	125	1968
56	Burlington Mall	Burlington, MA	120	1978
57	Natick Mall	Natick, MA	115	1984
58	Holy Yoke Place	Holy Yoke, MA	111	1983
59	North Attleboro Mall	Attleboro, MA	120	1990
60	Northshore Mall	Peabody, MA	114	1993
61	Southshore Mall	Briantree, MA	114	1979
	MI			
62	Fairlane Town Center	Dearborn, MI	122	1978
63	Lakeside Mall	Sterling Heights, MI	122	1978
64	Twelve Oaks Mall	Novi, MI	122	1978
	MO			
65	Galleria	St. Louis, MO	115	1991
66	West County Center	Des Peres, MO	120	2001
	CO			
67	Cherry Creek Common	Denver, CO	121	1997
68	Park Meadows	Littleton, CO	136	1999
69	Broomfield	Denver, CO	120	2000
	FL			
70	International Plaza Mall	Orlando, FL	140	2002
71	Aventura Mall	Miami, FL	127	1983
72	Boca Raton Shopping Center	Boca Raton, FL	116	1986
73	Fashion Mall	Plantation, FL	102	1989
74	Wellington Commons	Wellington, FL	139	2001
75	Tampa Mall	Tampa, FL	140	2001
	GA			
76	Mall of Georgia	Buford, GA	120	1999
77	North Point Mall	Alpharetta, GA	115	1993
78	Atlanta Center	Atlanta, GA	123	1969

	NC			
79	Crabtree Mall	Raleigh, NC	100	1995
	RI			
80	Providence Place	Providence, RI	119	2000
	TX			
81	Memorial City Mall	Houston, TX	141	2002
82	West Park Mall	Plano, TX	140	2001
83	Galleria Mall	Houston, TX	134	1974
84	North Park Mall	Dallas, TX	126	1974
85	Brookwillow Mall	Houston, TX	121	1996
	Others			
86	New Orleans	New Orleans, LA	116	1988
87	Louisville	Louisville, KY	120	1996
88	Polaris	Columbus, OH	140	2001
	Locations: 88	**Total Area:**	**11,505**	**sf**

Filene's Stores

	CT			
1	Stamford Town Center	Stamford, CT	173	1995
2	Buckland Hills Pavilion	Manchester, CT	186	1990
3	CT Post Mall	Milford, CT	150	1991
4	Danbury Backus Center	Danbury, CT	172	1996
5	Enfield Square	Enfield, CT	172	1971
6	Buckland Square	Meriden, CT	179	1971
7	Trumbull Shopping Park	Trumbull, CT	200	1978
8	Brass Mill Center	Waterbury, CT	165	1997
9	Crystal Mall	Waterford, CT	90	1984
10	Westfarms Mall	Farmington, CT	292	1974
	RI			
11	Providence Place	Providence, RI	204	1999
12	Warwick Mall	Warwick, PA	185	1970
	ME			
13	Stillwater Mall	Bangor, ME	145	2000
14	Maine Mall	Portland, ME	151	1998
	MA			
15	Southbridge Mall	Auburn, MA	202	1995
16	Belmont Place	Belmont, MA	71	1970
17	Boston Common	Boston, MA	384	1997
18	Westgate Mall	Brockton, MA	156	1996
19	Burlington Mall	Burlington, MA	182	1968
20	Cambridge Galleria Mall	Cambridge, MA	126	1990
21	Chestnut Hill Mall	Newton, MA	186	1974
22	Eastfield Mall	Springfield, MA	121	1994
23	Hanover Center	Hanover, MA	123	1972
24	Ingleside Mall	Holyoke, MA	202	1995
25	Cape Cod Mall	Hyannis, MA	107	1970
26	Independence Mall	Kingston, MA	149	1989

27	Sears Town Mall	Leominster, MA	140	2002
28	Solomon Pond Mall	Marlborough, MA	186	1996
29	Dartmouth Mall	N. Dartmouth, MA	145	1995
30	Natick Mall	Natick, MA	210	1985
31	North Attleboro Center	North Attleboro, MA	185	1989
32	Berkshire Mall	Pittsfield, MA	111	1994
33	Square One Mall	Saugus, MA	179	1994
34	South Shore Plaza	Braintree, MA	277	1961
35	Stamford	Stamford, CT	179	1978
36	North Shore Plaza	Peabody, MA	200	1993
37	Galleria Mall	Taunton, MA	151	1992
	NH			
38	Mall of New Hampshire	Manchester, NH	165	1996
39	Pheasant Lane Mall	Nashua, NH	150	1993
40	Fox Run Mall	Newington, NH	60	1983
41	Rockingham Park Mall	Salem, NH	165	1991
	NY			
42	Crossgates Mall	Albany, NY	201	1994
43	Hudson Valley Mall	Kingston, NY	121	1995
44	Palisades Center	West Nyack, NY	202	1998
45	Poughkeepsie Galleria	Poughkeepsie, NY	165	1987
46	Rotterdam Square Mall	Schenectady, NY	120	1995
	VT			
47	Vermont Mall	Burlington, VT	152	1999
	Locations: 47	Total Area:	8,048	sf

Kaufmann's Stores

	OH			
1	Belden Village	Canton, OH	129	1971
2	Canton Center	Canton, OH	120	1968
3	Chapel Hill Mall	Akron, OH	165	1957
4	City Center	Columbus, OH	142	1989
5	Eastwood Mall	Niles, OH	158	1969
6	Great Lakes Mall	Mentor, OH	189	1964
7	Great Northern	Olmsted, OH	233	1965
8	Midway Mall	El Yria, OH	105	1990
9	Ohio Valley Mall	St. Clairsville, OH	103	1979
10	Parmatown Center	Parma, OH	250	1960
11	Polaris Fashion Center	Columbus, OH	200	2001
12	Randell Park	North Randall, OH	154	1976
13	Richland Mall	Mansfield, OH	132	1994
14	Richmond Mall	Richmond Heights OH	165	1998
15	Rolling Acres Mall	Akron, OH	104	1978
16	Sandusky Town Square	Sandusky, OH	147	1979
17	Southern Park	Youngstown, OH	186	1970
18	Steubenville Mall	Steubenville, OH	132	1974
19	Stow Kent Center	Stow, OH	83	1965

20	Strongsville Place	Strongsville, OH	180	1995
21	Summit Mall	Akron, OH	194	1965
22	Tuttle Crossings	Dublin, OH	165	2001
23	University Square	University Heights, OH	165	2002
	NY			
24	Oakdale Mall	Johnson City, NY	139	2000
25	Boulevard Mall	Amherst, NY	220	1993
26	Carousel Center	Syracuse, NY	191	1990
27	Clay Shopping Plaza	Clay, NY	88	1989
28	Eastern Hill Center	Williamsville, NY	127	1971
29	Eastview Mall	Victor, NY	175	1971
30	Elmira Mill	Horseheads, NY	119	1995
31	Greece Ridge Mall	Rochester, NY	164	1995
32	Irondequoit Mall	Rochester, NY	125	1990
33	Market Place	Rochester, NY	150	1982
34	McKinley Square	Blasdell, NY	118	1989
35	Shopping Mall	Dewitt, NY	122	1993
36	Sugar Town Square Mall	New Hartford, NY	161	1995
37	Walden Galleria	Cheektowaga, NY	190	1988
38	Crystal Run Mall	Middletown, NY	180	1992
39	Williamsport Mall	Muncy, PA	120	1995
	PA			
40	Altoona Mall	Altoona, PA	149	1995
41	Mill Creek Mall	Erie, PA	161	1976
42	Nittany Mall	State College, PA	95	1999
43	Scranton Center	Scranton, PA	141	1995
44	Shenango Plaza	Hermitage, PA	106	1976
45	Waterfront Place	Homestead, PA	120	1987
46	Wyoming Valley Mall	Wilkes-Barre, PA	147	1995
47	Williamsport Lycoming Mall	Pennsdale, PA	171	1995
48	Ross Park Mall	Pittsburgh, PA	229	1986
49	South Hills Village	Pittsburgh, PA	173	1987
50	Pitts Downtown	Pittsburgh, PA	755	1946
51	Monroeville Mall	Monroeville, PA	204	1987
52	Greensburg Common	Greensburg, PA	192	1976
53	Washington Crown Center	Washington, PA	140	1999
54	Century III Center	West Miffin, PA	191	1979
55	Robinson Town Center	Pittsburgh, PA	198	1996
	WV			
56	Charleston Mall	Charleston, WV	146	1983
	Locations: 56	Total Area:	9,162	sf

Robinson's-May Stores

	AZ			
1	Arrowhead Towne Center	Glendale, AZ	200	1993
2	Chandler Mall	Chandler, AZ	200	2001
3	El Con Shopping Center	Tucson, AZ	263	1969

4	Fiesta Mall	Mesa, AZ	159	1979
5	Metro Center	Phoenix, AZ	105	1973
6	Paradise Valley Mall	Phoenix, AZ	157	1990
7	Scottsdale Shopping Center	Scottsdale, AZ	283	1961
8	Superstition Springs Mall	Mesa, AZ	154	1994
9	Tucson Palace	Tucson, AZ	140	1991
	CA			
10	Bakersfield Mall	Bakersfield, CA	130	1998
11	Baldwin Hills	Los Angeles, CA	219	1947
12	Beverly Hills Shopping Center	Beverly Hills, CA	240	1952
13	Bonita Mall	National City, CA	196	1991
14	Brea Mall	Brea, CA	195	1977
15	Carlsbad Shopping Mall	Carlsbad, CA	150	1999
16	Los Cerritos Mall	Cerritos, CA	153	1971
17	Citicorp Mall	Los Angeles, CA	139	1986
18	Del Amo Shopping Center	Torrance, CA	180	1991
19	Downey Shopping Plaza	Downey, CA	183	1990
20	Eagle Rock Shopping Mall	Los Angeles, CA	150	1973
21	El Cajon Center	El Cajon, CA	119	1972
22	El Centro Mall	El Centro, CA	152	1994
23	Escondido Mall	Escondido, CA	228	1996
24	Fashion Valley Square	San Diego, CA	219	1969
25	Fox Hills Mall	Culver City, CA	150	1975
26	Glendale Shopping Mall	Glendale, CA	179	1993
27	Inland Center	San Bernardino, CA	150	1998
28	Irvine Spectrum Mall	Irvine, CA	140	2004
29	Lakewood Mall	Lakewood, CA	299	1952
30	Laurel Plaza	North Hollywood, CA	225	1955
31	Mission Valley Mall	San Diego, CA	269	1961
32	Mission Viejo Mall	Mission Viejo, CA	224	1979
33	Montclair Plaza	Montclair, CA	169	1998
34	Montebello Town Center	Montebello, CA	141	1996
35	Town Gate Mall	Moreno Valley, CA	160	1992
36	Fashion Island	Newport, CA	224	1967
37	Northridge Mall	Northridge, CA	142	1995
38	Pacific View Mall	Ventura, CA	175	1999
39	Palm Desert Town Center	Palm Desert, CA	236	1982
40	Puente Hill Shopping Center	City of Industry, CA	153	1974
41	Rancho Cucamonga Mall	Rancho Cucamonga, CA	150	1996
42	Riverside Tyler Mall	Riverside, CA	150	1972
43	Santa Anna Mall	Santa Anna, CA	259	1991
44	Santa Anita Fashion Park	Santa Anita, CA	182	1976
45	Santa Clarita Shopping Center	Santa Clarita, CA	145	1992
46	Santa Maria Town Center	Santa Maria, CA	130	1990
47	Santa Monica Place	Santa Monica, CA	137	1991
48	South Bay Shopping Mall	Redondo, CA	200	1959
49	South Coast Plaza	Costa Mesa, CA	239	1966
50	Winchester Mall	Temecula, CA	183	1999
51	Westminster Mall	Westminster, CA	202	1974
52	Thousand Oaks Mall	Thousand Oaks, CA	245	1978

53	Topanga Mall	Canoga Park, CA	231	1994
54	University Town Center	San Diego, CA	147	1978
55	West Covina Plaza	West Covina, CA	150	1993
56	Santabarbara Mall	Santa Barbara, CA	149	1967
57	West Los Angeles Mall	Los Angeles, CA	223	1985
	NV			
58	Fashion Show Plaza	Las Vegas, NV	180	1991
59	Sunset Galleria	Henderson, NV	180	1996
	Locations: 59	Total Area:	10,832	sf

Meier and Frank Stores

	OR			
1	Clackamas Mall	Portland, OR	189	1990
2	Downtown Portland	Portland, OR	478	1966
3	Valley River Center	Eugene, OR	163	1969
4	Lloyd Center	Portland, OR	250	1966
5	Rogue Valley Mall	Medford, OR	107	1996
6	Salem Shopping Center	Salem, OR	196	1986
7	Tanasbourne Mall	Hillsboro, OR	154	1985
8	Washington Square	Portland, OR	261	1973
	UT			
9	Cottonwood Mall	Salt Lake City, UT	230	2000
10	Salt Lake Downtown	Salt Lake City, UT	226	2000
11	Fashion Place	Murray, UT	126	2000
12	Layton Hills	Layton, UT	162	2000
13	Riverdale Park	Riverdale, UT	140	2004
14	South Towne	Sandy, UT	203	2000
15	University Mall	Orem, UT	207	2000
16	Valley Fair	West Valley City, UT	99	2000
	WA			
17	Vancouver Mall	Vancouver, WA	120	1977
	Locations: 17	Total Area:	3,311	sf

Hecht's and Strawbridge's Stores

	DC			
1	Metro Center	Washington, DC	272	1985
	DE			
2	Christiana Mall	Newark, DE	214	1993
3	Concord Center	Wilmington, DE	206	1996
4	Dover Mall	Dover, DE	140	1997

	MD			
5	Annapolis Mall	Annapolis, MD	199	1970
6	Harford Center	Bel Air, MD	141	1991
7	Bowie Town Center	Bowie, MD	140	1991
8	Center at Salisbury	Salisbury, MD	139	1991
9	Chevy Chase Place	Chevy Chase, MD	219	1995
10	Columbia Mall	Columbia, MD	319	1975
11	Francis Scott Key Mall	Fredrick, MD	129	1993
12	The Valley Mall	Hagerstown, MD	129	1999
13	Lakeforest Mall	Gaithersburg, MD	170	1987
14	Laurel Center	Laurel, MD	113	1991
15	Marley Station Mall	Glen Burnie, MD	139	1991
16	Marlow Heights Mall	Marlow Heights, MD	199	1990
17	Montgomery Mall	Bethesda, MD	267	1968
18	Owings Mills Town Center	Owings Mills, MD	195	1996
19	Prince George Shopping Center	Hyattsville, MD	183	1988
20	Security Square Mall	Baltimore, MD	154	1979
21	St. Charles Town Center	Waldorf, MD	141	1987
22	Towson Town Center	Towson, MD	204	1982
23	Wheaton Plaza	Wheaton, MD	179	1987
24	White Marsh Shopping Center	Baltimore, MD	165	1991
	VA			
25	Ballston Common	Arlington, VA	150	1959
26	Chesapeake Shopping Center	Chesapeake, VA	95	1999
27	Chesterfield Town Center	Richmond, VA	142	1990
28	South Park Mall	Colonial Heights, VA	101	1989
29	Dulles Town Center	Dulles, VA	191	1998
30	Fair Oak Mall	Fairfax, VA	239	1990
31	Fredericksburg Mall	Fredericksburg, VA	140	1993
32	Greenbriar Mall	Chesapeake, VA	143	1990
33	Coliseum Mall	Hampton, VA	183	1977
34	Landmark Shopping Mall	Alexandria, VA	198	1995
35	River Ridge Mall	Lynchburg, VA	130	1975
36	Lynnhaven Mall	Virginia Beach, VA	200	1998
37	Manassas Mall	Manassas, VA	138	1996
38	Military Circle Mall	Norfolk, VA	151	1975
39	Patrick Henry Center	Newport News, VA	140	1998
40	Regency Square	Richmond, VA	248	1990
41	Valley View Shopping Center	Roanoke, VA	149	1995
42	Short Pump Shopping Center	Richmond, VA	150	2004
43	Tyson's Corner	McLean, VA	237	1969
44	Virginia Commons	Glen Allen, VA	110	1993
	PA			
45	Capital City Mall	Camp Hill, PA	120	1995
46	Exton Square	Exton, PA	198	1994
47	Harrisburg East Mall	Harrisburg, PA	189	1995
48	King of Prussia Plaza	King of Prussia, PA	215	1995
49	Lehigh Valley Mall	Lehigh Valley, PA	175	1996
50	Montgomery Mall	North Wales, PA	184	1995
51	Neshaminy Mall	Bensalem, PA	240	1996

52	Roosevelt Mall	Philadelphia, PA	189	1995
53	Oxford Valley Center	Langhorne, PA	179	1995
54	Market East Downtown	Philadelphia, PA	621	1996
55	Springfield Mall	Springfield, PA	196	1996
56	Plymouth Meeting Mall	Plymouth Meeting, PA	215	1996
57	Willow Grove Center	Willow Grove, PA	235	1995
58	York Shopping Center	York, PA	120	1995
	NJ			
59	Burlington Mall	Burlington, NJ	109	1996
60	Cheery Hill Town Center	Cheery Hill, NJ	258	1986
61	Deptford Place	Deptford, NJ	173	1995
62	Echelon Shopping Mall	Vorhees, NJ	246	1995
63	Moorestown Town Center	Moorestown, NJ	200	1996
	NC			
64	Carolina Place	Pineville, NC	150	1993
65	Cary Towne	Cary, NC	165	1991
66	South Park Shopping Mall	Charlotte, NC	143	1998
67	Crabtree Center	Raleigh, NC	175	1995
68	Cross Creek Mall	Fayetteville, NC	123	1975
69	Friendly Center	Greensboro, NC	146	1959
70	Hanes	Winston-Salem, NC	154	1990
71	Triangle Town Center	Raleigh, NC	180	2002
72	Northgate Mall	Durham, NC	152	1994
73	Mall at Southpoint	Durham, NC	180	2001
74	Mayfair Town Center	Wilmington, NC	150	2004
75	Wendover Place	Greensboro, NC	140	2004
	TN			
76	Bellevue Center	Nashville, TN	175	2001
77	Cool Springs Galleria	Franklin, TN	271	2001
78	Green Hills Mall	Nashville, TN	146	2001
79	Hickory Hollow Mall	Antioch, TN	179	2001
80	Rivergate Mall	Goodlettsville, TN	200	2001
	Locations: 80	Total Area:	14,482	sf

Foley's Stores

	CO			
1	Aurora Mall	Aurora, CO	179	1975
2	Boulder Shopping Center	Boulder, CO	150	1983
3	Broomfield Mall	Broomfield, CO	190	2000
4	Cherry Hill Creek	Denver, CO	200	1990
5	Citadel Town Center	Colorado Springs, CO	173	1994
6	Chapel Square	Colorado Springs, CO	177	1998
7	Fort Collins Shopping Mall	Fort Collins, CO	129	1974
8	Park Meadows Center	Park Meadows, CO	211	1997
9	South Glenn Mall	Littleton, CO	190	1974
10	Southwest Plaza	Littleton, CO	145	1992
11	Westminster Mall	Westminster, CO	151	1996

	LA			
12	Acadiana Mall	Lafayette, LA	195	2001
13	Cortana Place	Baton Rouge, LA	209	2001
14	Lake Charles Mall	Lake Charles, LA	198	2003
15	Mall of Louisiana	Baton Rouge, LA	209	2001
	NM			
16	Coronado Mall	Albuquerque, NM	154	1976
17	Cottonwood Mall	Albuquerque, NM	168	1996
	OK			
18	Crossroads Mall	Oklahoma City, OK	151	1996
19	Penn Square	Oklahoma City, OK	160	1998
20	Promenade Place	Tulsa, OK	179	1996
21	Quail Springs Mall	Oklahoma City, OK	145	1986
22	Woodland Hills Mall	Tulsa, OK	190	1982
	TX			
23	College Station Shopping Center	College Station, TX	102	1984
24	Almeda Mall	Houston, TX	296	1996
25	Barton Creek Mall	Austin, TX	226	1982
26	Baybrook Mall	Friendswood, TX	168	2001
27	Beaumont Shopping Center	Beaumont, TX	170	2002
28	Cielo Vista Mall	El Paso, TX	180	2002
29	Collin Creek Mall	Plano, TX	196	1990
30	Corpus Christi Shopping Mall	Corpus Christi, TX	199	1997
31	Deerbrook Mall	Humble, TX	200	1994
32	Denton Town Center	Denton, TX	185	2002
33	Stonebriar Center	Frisco, TX	201	2000
34	Greenpoint Mall	Houston, TX	308	1976
35	Highland Mall	Austin, TX	227	1979
36	Houston Galleria	Houston, TX	210	2004
37	Houston Downtown	Houston, TX	392	1947
38	Hulen Mall	Fort Worth, TX	220	1977
39	Hurst Shopping Center	Hurst, TX	240	2001
40	Ingram Park	San Antonio, TX	176	1983
41	Irving Mall	Irving, TX	185	1990
42	Laredo Center	Laredo, TX	145	1996
43	Lewisville Shopping Mall	Lewisville, TX	180	1991
44	McLean Shopping Center	McLean, TX	229	1997
45	Memorial City Mall	Houston, TX	299	2001
46	North Star Mall	San Antonio, TX	256	1991
47	North Park Center	Dallas, TX	254	2000
48	Northwest Mall	Houston, TX	292	1987
49	Northwest Austin	Cedar Park, TX	180	1995
50	The Parks	Arlington, TX	200	1990
51	Pasadena Shopping Mall	Pasadena, TX	216	1962
52	Redbird Mall	Dallas, TX	147	1975
53	Ridgemar Shopping Center	Ft. Worth, TX	167	1998
54	River Center Mall	San Antonio, TX	95	1989
55	Rolling Oaks Mall	San Antonio, TX	150	1992
56	San Jacinto Mall	Baytown, TX	159	2001
57	Sharpstown Center	Houston, TX	357	1961

58	South Park Center	San Antonio, TX	120	2000
59	Sugarland Town Center	Sugarland, TX	202	1996
60	Sunland Park Mall	El Paso, TX	175	2002
61	Temple Shopping Center	Temple, TX	110	1995
62	Texas City Mall	Texas City, TX	155	2003
63	Town East Mall	Mesquite, TX	196	1972
64	Tyler Shopping Center	Tyler, TX	97	1991
65	Valley View Town Center	Dallas, TX	300	1973
66	West Oaks Mall	Houston, TX	245	1982
67	The Shops at Willow Bend	Plano, TX	203	1984
68	Willowbrook Mall	Houston, TX	245	1991
69	Woodlands Mall	The Woodlands, TX	201	1994
	Locations: 69	Total Area:	13,509	sf

Famous Barr Stores

	IL			
1	Alton Square	Alton, IL	168	1978
2	Carbondale Mall	Carbondale, IL	106	1991
3	Eastland Mall	Bloomington, IL	124	1993
4	Champaign Town Center	Champaign, IL	151	1999
5	Peoria Town Center	Peoria, IL	165	1995
6	Belleville St. Clair Square	Fairview Heights, IL	152	2000
7	White Oaks Mall	Springfield, IL	162	1977
	IN			
8	Bloomington Shopping Center	Bloomington, IN	95	1982
9	Castleton Square	Indianapolis, IN	207	1990
10	Evansville Town Center	Evansville, IN	180	1996
11	Glenbrook Mall	Fort Wayne, IN	240	1996
12	Glendale Place	Indianapolis, IN	233	1958
13	Greenwood Mall	Greenwood, IN	162	1995
14	Honey Creek Square	Terre Haute, IN	175	1998
15	Lafayette Town Center	Lafayette, IN	140	1994
16	Lafayette Square	Indianapolis, IN	154	1974
17	Merrillville Plaza	Merrillville, IN	165	1978
18	Muncie Towne Village	Muncie, IN	120	1996
19	University Park	Mishawaka, IN	153	1979
20	Washington Square	Indianapolis, IN	147	1974
	KS			
21	Leawood Mall	Leawood, KS	179	1998
22	Metcalf South Center	Overland, KS	289	1998
23	Oak Park Mall	Overland, KS	183	2002
24	Prairie Village	Prairie Village, KS	180	1998
25	West Ridge Mall	Topeka, KS	183	1998
	KY			
26	Bowling Green Shopping Center	Bowling Green, KY	120	1999
27	Towne Square	Owensboro, KY	130	1998
	MO			

28	Battlefield Mall	Springfield, MO	134	1982
29	Cape Girardeau Shopping Center	Cape Girardeau, MO	107	1991
30	Chesterfield Mall	Chesterfield, MO	240	1995
31	Columbia Shopping Mall	Fairview Heights, MO	247	1973
32	Crestwood Plaza	Crestwood, MO	196	1989
33	Downtown Plaza	St. Louis, MO	462	1924
34	Independence Shopping Center	Independence, MO	183	1998
35	Jamestown Mall	Florissant, MO	196	1994
36	NorthPark Mall	Joplin, MO	140	1987
37	Metro North Mall	Kansas City, MO	244	1997
38	Mid-River Mall	St. Peters, MO	198	1991
39	Northwest Plaza	St. Ann, MO	236	1996
40	Galleria	St. Louis, MO	265	1991
41	South County Center	St. Louis, MO	208	1963
42	West County Center	St. Louis, MO	266	2001
	IA			
43	Des Moines Mall	Des Moines, IA	165	2000
44	Omaha Shopping Center	Omaha, IA	175	1998
	Locations: 44	Total Area:	8,125	sf

Distribution Centers

1	Foley's	Houston, TX
2	Famous-Barr	St. Louis, MO
3	Meier Frank	Fleming, OR
4	Foleys	Aurora, CO
5	Hetch's and Strawbridge's	Joppa, MD
6	Kaufmanns	Clear Lakes, OH
7	Robinson's-May	City of Industry, CA
8	Robinson's-May	Goodyear, AZ
9	Marshall Fields'	Pulaski, IL
10	Lord Taylor	Wilkes Barre, PA
11	Hetch's and Strawbridge's	Washington, DC
12	Filene's	Manchester, CT
13	David Bridals	Bristol, PA

Credit and Teleservice Centers

1	Credit Center	Lorain, OH
2	Credit Data Center	Chesterfield, MO
3	Credit Center	Scottdale, AZ

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