# Agile Project Management for Data Centers

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## Abstract

Data center is ultimately IT complex ecosystems, and the complex systems can quickly become unmanageable subject to time, cost, and quality or performance called Iron Triangle. The traditional project management (TPM) is based on a predictable, fixed, relatively simple, and certain model but project change is natural phenomenon. It is dissociated from change in the IT environment and business needs of project life cycle (PLC). Scrum is the leading agile development methodology, used wildly with adaptive change requirements and complex systems by managing and breaking project into several stages and involving constant collaboration with stakeholders and continuous improvement and iteration all every stages. The Scrum methodology proposes the way of transforming of project team to tackle the complex and dynamic projects by bringing the agile project management (APM) approach beyond the project management body of knowledge (PMBOK) to the real world of data center project management (DCPM).

**Keywords-data center;** agile project management; project life cycle

## I. INTRODUCTION

Traditional lifecycle development methodologies of data center project grew out of a need to control ever-larger development projects, and the difficulties of estimating and managing these efforts to reliably deliver results. These methodologies drew heavily on the principles from engineering such as integrated build construction and data center project management, normally called engineering procurement construction (EPC) project. As a result, they stressed predictability on master plan before it is built, and linear development cycles – requirements led to analysis which led to design which in turn led to development. Along with predictability, they inherited a deterministic, reductionist approach that relied on work breakdown structure (WBS), and was predicated on stability – stable requirements, analysis and stable design [2]. This rigidity was also marked by a tendency towards slavish process compliance as a means of project control.

Data center project (DCP) is complex, unique, and ambiguous. Since, stakeholders are continuously available and engaged, therefore, requirements are not clearly defined and project scope is always changing. These changes have led to an increased interest in agile development methodologies with their promise of rapid delivery and flexibility while maintaining quality. Researcher believe that the slow adoption of agile methodolo-

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gies stems mainly from this misalignment between the data center fundamental of traditional project management (TPM) and those of the new agile development methodologies. This paper proposes a new management framework of agile approach for data center project management (DCPM). This new framework has applied an integral part of complex adaptive systems (CAS) inspired framework for agile approach. Agile project management (APM) reduces complexity of data center by breaking down the many months long cycle of building requirements for the whole data center project, building the conceptual design to detail design and then proving concept testing to bidding contractors before project construction.

## II. BACKGROUD

### *A. Data Center Project*

Data centers are highly complex things, and complex things can quickly become unmanageable [3]. Modular design allows you to create highly complex systems from smaller, more manageable building blocks. These smaller units are more easily defined and can be more easily replicated. They can also be defined by even smaller units, and you can take this to whatever level of granularity necessary to manage the design process. Tier IV fault tolerance system is much more than just engineering the most technically correct or best system [4][5]. However, customers may want is not the best system, they really need is the most practical system that is focused on and addresses our particular basics. Therefore, data center Tier classification was designed to optimize business needs, as presented in Figure 1.

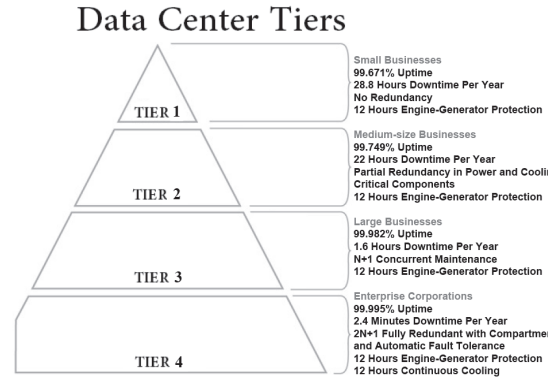


Figure 1. Data center Tier classification.

Project management is the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements [1]. Project management is a solution of process transform requirements to design and design through construction. Project management is accomplished through the appropriate application and integration of 5 process groups: Initiation; Planning; Executing; Monitoring and Controlling; and Closing. Typical project management is consisted of process transformation as follows:

1. Identifying requirements from stakeholders
2. Addressing the various needs, concerns, and expectations of the stakeholders in planning and executing the project
3. Setting up, maintaining, and carrying out communications among stakeholders that are active, effective, and collaborative in nature
4. Managing stakeholders towards meeting project requirements and creating project deliverables
5. Balancing the competing project constraints, which include, but are not limited to: scope, quality, schedule, budget, regulations, standards, resources, and risks.

Data center facility infrastructure has performed as the foundation of information technology that facility infrastructure has been evolutional throughout the last several years and transformational after the beginning of the 21st century. The data center life cycle is around 10-15 years but project life cycle (PLC) of data center is around 36-48 months of traditional project management (TPM) [10], as demonstrated in Figure 2. The TPM of PLC of data center can calculate from Equation number (1).

Project life cycle (PLC) $= t_1 + t_2 + t_3 + t_4$ (1)

methodology helps incorporating all changes required by clients during initiating and planning processes in building effective relationships with clients by engaging with them on change requirements as regular basis [19]. However, within 5 years technology will be changed, thus most data center design is flexible and easily upgradable. Therefore, it is critical to a successful long-term design. Strategic planning of data center is not an attempt to eliminate risk or to forecast what the data center will look like in fifteen years, it is taking action to understand what risks to take and what

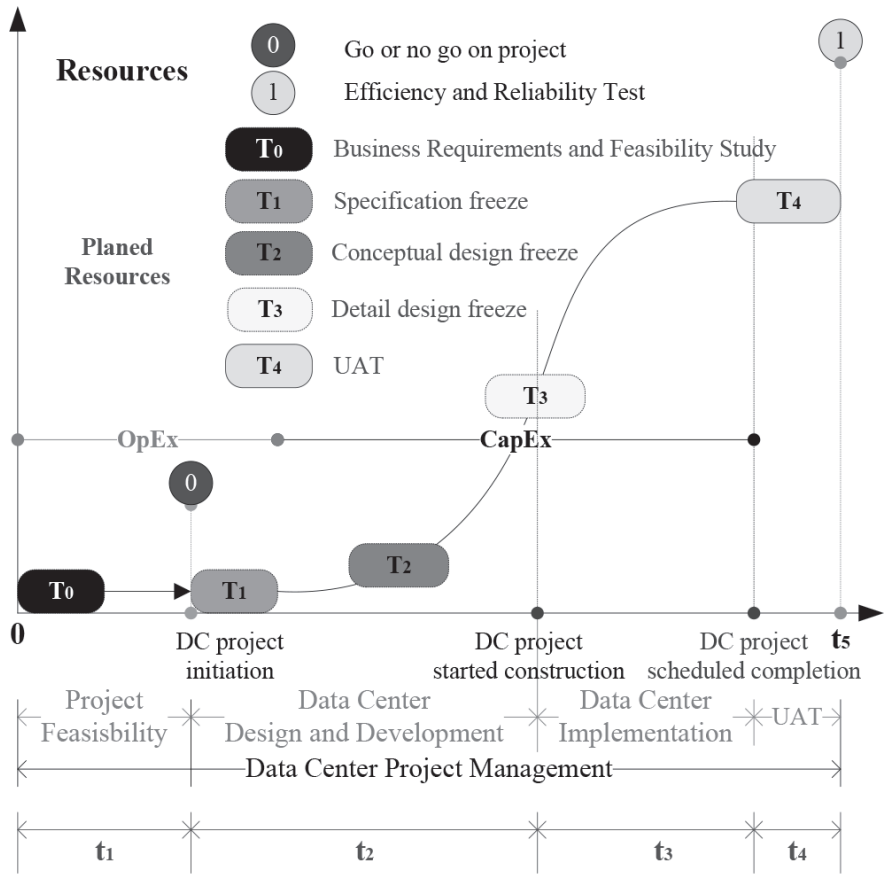


Figure 2. Traditional data center project management.

From Figure 2, during period of $T_0$ to $T_1$ or project feasibility ($t_1$) is the most important of DCP initiation and planning, therefore adopting agile paths will align with the business. Partial flexibility concept is advantage the design cost-effective. Tier classification design decision has as impact

on the investment. Designing a cost effective data center is greatly dependent on the mission critical applications of the enterprise. Data center design and build can be classified into 2 concepts, design for scalability or modular design. For this reason, DCPM requires different strategic approach and steps to transform called chronological transformation [13]. It is differed from enterprise to enterprise. Without proper DCPM, a design and build project can experience delays, increased costs and frustrated team members. Regardless of project size, activities need to be structured and standardized so everyone is on the same page and the project outcome is predictable. Strong project management makes sure nothing slips through the cracks or any effort is duplicated. When building or upgrading a data center's physical infrastructure, project management provides the foundation for a successful result. Its purpose is to structure the project into phases, coordinate the work of the entire team and monitor progress. A typical team might consist of the end users, consultants, hardware and software providers, general contractor and more.

*B. Project Management Body of Knowledge (PMBOK)*

Each project forms a unique data center and operation. The outcome of the data center project (DCP) may be substantial or insubstantial. While repetitive characteristics may be portrayed in some DCP deliverables and activities, this repetition does not change the fundamental, unique functions of the DCP design. DCPM is the application of knowledge, experiences, skills, tools, and techniques to project activities to meet the project requirements and constraints. DCPM is accomplished through the appropriate application and integration of SBS, which are categorized into five process stages. This generic life cycle structure is often referred to when communicating with predecessor management stage or other stakeholder with the details of the project. These five stage groups in IEEE 1490 or PMBOK, as presented in Figure 3 and Figure 4 are:

1. Initiating or Starting
2. Planning
3. Executing
4. Monitoring and Controlling, and
5. Closing

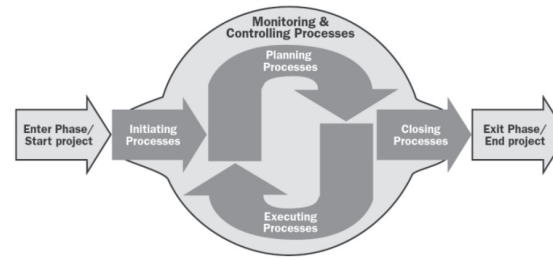


Figure 3. Project management process groups.

DCPs vary in size, investment, and complexity. Managing a DCP normally consists of:

1. Identifying business and user requirements
2. Concentrating the various needs, concerns, constraints, regulations, and expectations of stakeholders in planning and executing the DCP
3. Setting up, operating monitoring and controlling, maintaining, and carrying out communications among stakeholders that are active, efficient, effective, collaborative, and integrative in nature
4. Managing stakeholders towards meeting DCP requirements and creating project deliverables
5. Balancing the competing DCP constraints, which comprise;
    - Scope or term of references (TOR)
    - Quality or Tier classification
    - Schedule

- Budget
- Materials and resources
- Risks

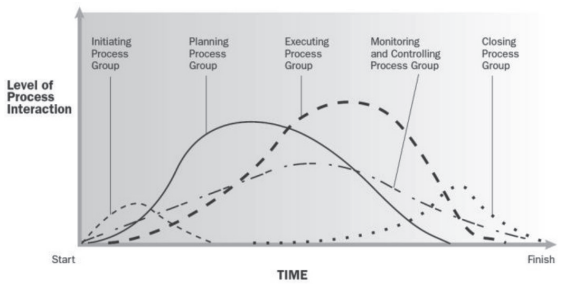


Figure 4. Process groups interact in a project phase.

The specific DCP attributes and situations may influence the constraints on which the DCPM team needs to concern. These factors are derived from requirements and constraints to detail design if it has any requirement's changed during project construction there is difficult to change detail's design because PMBOK is sequence process or phase process. Therefore iteration process needs to be applied to handle rigid and complex processes.

*C. Agile Methodology*

Agile development is an iterative and incremental method for managing the design and builds activities for engineering, information technology, and new product or service development project [15]. It requires individual requirements from the stakeholders, such as consultants, contractors, suppliers, and customers input to work in a highly integrated approach, in small stage, to complete small portions of the deliverables in each delivery cycle (iteration), and where possible deploying deliverables to live (increment) to achieve value and real feedback, whilst iterative methods evolve the entire set of deliverables over time, completing them near the end of the project.

Agile methodology such as Scrum strives to reduce time and cost of change throughout the data center development process. Scrum is a management framework for incremental project development deploying cross-functional, self-organizing teams [18]. For instance, Scrum uses rapid iterative planning and development cycles in order to force trade-offs and deliver the highest feature as early as possible. The advantage of this is the flexibility of being able to react quickly to changes in requirements and the priorities of the business. Moreover, the constant, systematic testing that is part of Scrum ensures high quality via early defect detection, requirement adjustment, and resolution.

## III. RESEARCH METHODOLOGY

The traditional project management (TPM) is based on a predictable, fixed, relatively simple, and certain model. It is dissociated from change in the environment or in business needs; once data center has created the project plan, it sets out the objectives for the project, and the project manager must execute the plan using a management as planned. After the project is launched, progress and performance are assessed against the plan, and changes to the plan should be atypical, if possible, avoided. This paper was observed and investigated on two major drivers of data center project management (DCPM):

1. The triple constraint (time, budget, and performance goals or business requirements called iron triangle)
2. One size fits all (all projects are not the same)

This paper was deployed qualitative analysis and project survey methodologies to explore and reveal problems during DCPM.

*A. Qualitative Analysis*

Qualitative analysis is a creative process, depending o the insights and conceptual capabilities of the analyst. This research paper relies on triangulation analysis which consists of combinations of interview, observation or fieldwork survey, and document analysis. This qualitative analysis uses multiple methods in which different types of data provide cross-data validity checks. The framework of paper is applied 4 kinds of triangulation contribute to verification and validation of qualitative analysis [17], as shown in Figure 5:

1. Checking out the consistency of findings generated by different data collection methods (methods triangulation)
2. Examining the consistency of different data source within the same methods (triangulation of sources)
3. Using multiple analysts to review findings (analyst triangulation)
4. Using multiple perspectives of theories to interpret the data (theory/perspective triangulation)

State Enterprise, and Government). Problems and issues identified in the exploratory pilot case study point to important variables for future investigation such as space occupancy, project investment, project time to implement, Tier classification and data center site condition, as shown in Table I. The multiple case studies, on the other hand, had the objective of explaining as far as possible, the relationships between key variables studied. The dependent variable in the multiple case studies was consultant engagement project success and the independent variables of interest were those factors identified from the pilot case study and the literature reviews, which are posited to have a major influence on the level of engagement project success to stakeholder experiences.

TABLE I. DC PROJECT CASE STUDIES

| Project Cases | Project Status | Sqm. | Project Inv. (USDSM). | Project Time (Yrs.) | Tier Classification | DC Site Condition |
|---|---|---|---|---|---|---|
| DC#1 | UAT | 5,000 | 57.14* | 4.0 | 3 | Stand-alone |
| DC#2 | On Operations | 1,500 | 19.43 | 4.5 | 3 | Tenant |
| DC#3 | Details Design | 1,200 | 15.72 | 1.0 | 3 | Tenant |

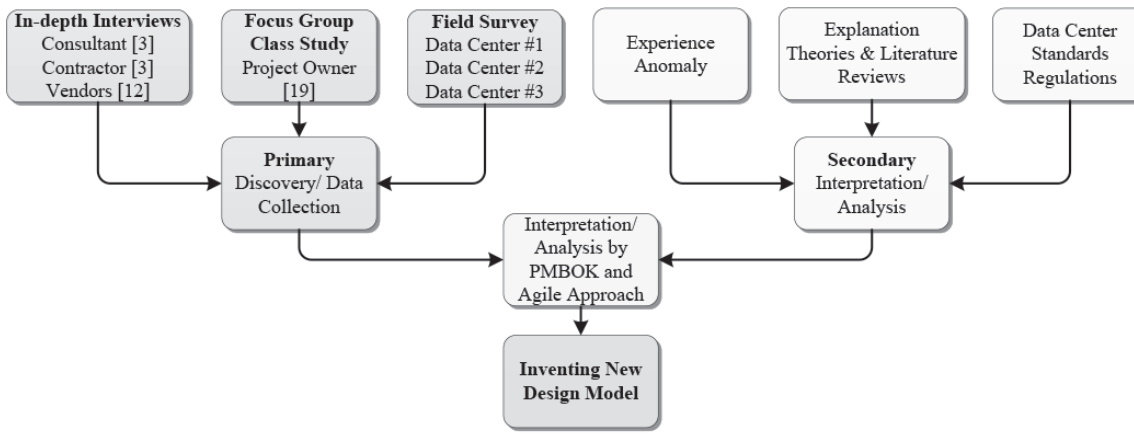


Figure 5. Data collection and analysis process.

*B. Data Center Projects Case Studies*

The data center case studies include 3 projects from different organizations (Private,

## IV. SCRUM METHODOLOGY FOR DCPM

Scrum methodology is iterative approach that trades the traditional project management (TPM) of chronological development for the ability

to develop a subsystem of high value attribute first, incorporating response faster. The Scrum framework can be classified as follows:

1. A data center project owner creates a prioritized wish list called a project backlog (system of systems).
2. During sprint planning, the team pulls a small chunk from the top of that wish list (systems), a sprint backlog, and decides how to implement those pieces.
3. The team has a certain amount of time — a sprint (usually four weeks) — to complete its work, but it meets each day to assess its progress (daily Scrum).
4. Along the way, the Scrum master keeps the team focused on its goal.
5. At the end of the sprint, the work should be potentially system milestone: ready to step up to other system/stages, put on a store shelf, or show the progress of data center project to stakeholders.
6. The sprint ends with sprint validity, verify, retrospective, and update information to PMI.

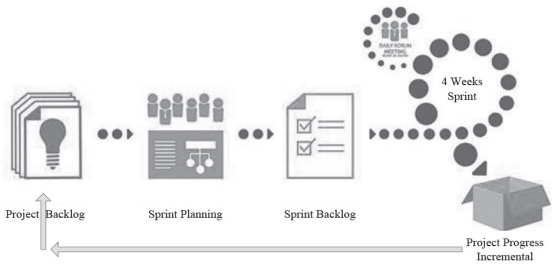


Figure 6. Scrum iterative development [18].

As the next sprint begins, the data center project team chooses another chunk of the system backlog and begins working again, as present in Figure 6.

*A. Define Requirements and Design Cycles*

How well team can define data center requirements upfront. The project team can reduce these uncertainties by obtaining data from business requirements, project constraints, and regulations, by testing the data center prototype on real customers or reference sites. The DCP may often need several iterations by applying agile project management (APM) of this process until final requirements can be frozen [16], as illustrated in Figure 7.

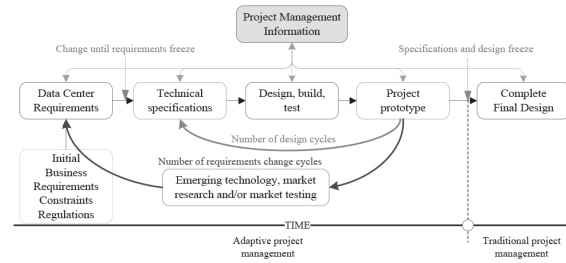


Figure 7. APM approach to reflect the residual uncertainties.

The initial technological uncertainty determines how well project team can define the system's technical specifications and system design. This process can reduce system uncertainty by conducting several design, build, and test design. All update information will send to project management information (PMI) (online and real time repository) subject to specifications and modify design after each cycle until the final design if frozen. The number of system design cycle and time to design freeze increases with the level of system complexity and technological uncertainty [14]. This dual iterative process, which is depicted in Figure 8, continues for both uncertainties until and final decision about the data center design is made.

*B. Reflect from Data Center Projects Survey*

Many organizations focused on improving data center operations but not their projects.

Data center is a tendency to focus on a formalized project management approach structured around a project management methodology that contains rigid policies and procedures as to how project work must take place, as shown in Figure 8.

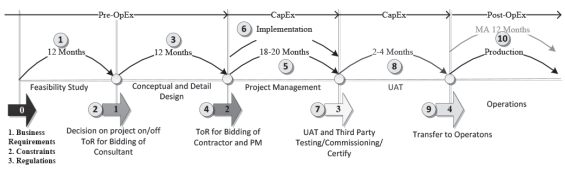


Figure 8. Traditional project management.

Deviations from the project plan were disheartened because there was an inherent fear at the execution or implementation stages that there might be a loss of control without formalized processes. The fact findings from 3 DCPs survey shown the feasibility of 3 DCPs took around 12 months to make decision to go project. DCP is also time-phased efforts. The sequence activities processes take all the activities, processes, and orders them by precedence. All of DCPs took another 12 months for conceptual and details design before opening for bidding process to quantify a contractor.

While agile project management practices may ultimately replace TPM practices, there is the phobia that implementation failure may occur. They are several forms of APM such as Scrum which are designed to alleviate some of the constraints and critical factors with TPM, as seen in Table II. However, for any organization, it may be difficult to go directly to APM without first having some advises or experience forms of TPM in place.

*C. Reflect from Focus Group*

An in-depth analysis of how agile approach effect data center project management, the research was conducted a class with 19 data center key performances (CIO, COO, CEO, IT directors, project managers, and data center decision makers). The study framework was given and ideas and concepts of data center project theories such as; TPM [10, 11], PMBOK [12], IEEE 1490 [9]; data center best practices, TIA-942 [5], Uptime [4], BICSI-002 [3]; 3 cases studies as shown in Table I; and international standards of data center design such as IEEE 493 [8], ASHRAE [6], and ASHRAE TC 9.9 [7]. A research class was classified into 5 groups for discussion and redesign on agile approach for DCPM by applying of those theories, best practices, and international standards as a guideline.

TABLE II. FACTOR COMPARISON OF TPM VERSUS APM

| Factor | Traditional Project Management | Agile Project Management |
|---|---|---|
| Structure focus | Tools and processes | People |
| Completion focus | Paper work and contractual documentation | Results and deliverables |
| Leadership style | Authoritarian | Participative |
| Amount of documentation | Extremely heavy | Minimal |
| Trust | Mistrust may prevail | Trust |
| Customer interfacing | Negotiation | Collaboration |
| Customer feedback | Minimal, perhaps only at project termination | Throughout the project |
| Project direction | Follow the plan exactly | Respond to changes |
| Project solution | Follow the contractual requirements exactly | Constantly evolving solution |
| Delivery | Offer a late delivery | Shorter delivery time |
| Unused features | Too much gold-plating | Minimal |
| Number of features | Too many | What the client needs |
| Acceptance | Offer a high rejection of deliverables | Minimal number of rejected deliverables |
| Beat practices and lessons learned | Discovered from successes | Discovered from successes and failures |

The objectives of this assignment were how to go for next step of DCPM by applying agile methodologies as given a guideline in Table II. The results from assignment came up with the new framework of agile project management (APM) for data center, as presented in Figure 9.

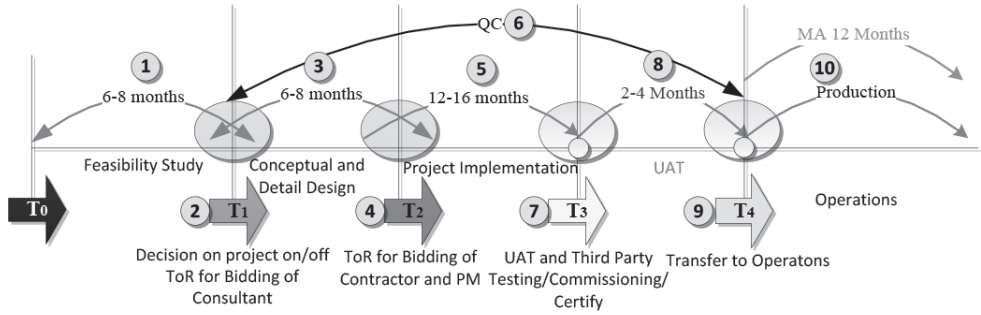


Figure 9. Agile project management.

The best time PLC of APM is 6+6+12+2 = 26 months, refer to as Equation number (1).

The worst time PLC of APM is 8+8+16+4 = 36 months, refer to as Equation number (1).

According to Table I, the case studies that average project life cycle (PLC) of data centers are 48 months. How to confirm 36 months are the right PLC time of DCP. Where is 12 months or a year gone from DCP? These 2 questions are the results of research questions. The losses 12 months from PLC of APM were derived from the inherent characteristics approach of APM as follows:

1. Iterative process in which constant communication between the customers (business requirements) and the project team: By every 30 days or a month all design and problems are discussions during project team meeting. DCP is based on past projects recorded from consultant and contractor firms during open bid for design and consultant process. This information was recorded and retrieved for analysis and synthesis over and over throughout APM process by project management information (PMI) as demonstrated in Figure 8 and 10. This approach was reflected the residual uncertainties of business requirements to formative prototype as validated and verified processes.

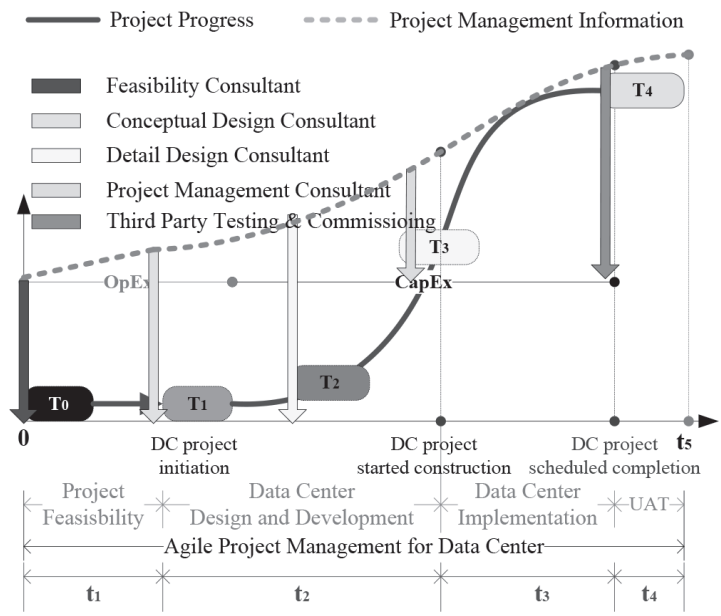


Figure 10. Agile project management and project management information.

2. Operates in a more fluid and adaptive to change environment: The complex adaptive systems (CAS) are unique attribute of agile approach. The CAS emphasizes the incremental delivery of working project or prototype for customer evaluation and optimization. Agile approach assumes that changes, improvements, and additional elements will be incorporated throughout the project development life cycle and that change is an opportunity to improve the project and make it more fit for requirements, rather than a traditional project management of the process.
3. Stakeholder's collaborative effort focused on the project vision and the end results: Agile project team must transform from management to leadership, from monitoring compliance to enabling self-direction and from acting as a foreman to becoming a facilitator to creativity and innovation.

*D. Iron Triangle Trap*

Most goal-oriented project managers look only at the time, cost, and quality or performance parameters [1]. If an out-of-tolerance condition exists, then additional analysis is required to identify the cause of the problems. Consideration only at time, cost, and quality or performance might identify immediate contributions to profits, but will not identify whether the project itself was managed correctly. Data center best practices [16] are those actions or activities undertaken by the company or individuals that lead to a sustained competitive advantage in DCPM. However, from evaluation matrix, Table III, presents APM can save 8-12 months during project feasibility and data center design and development phases, as shown in Figure 10, but APM need more resource than TPM around 35 percent. The quality of the TMP and APM is not clearly present on this research.

TABLE III. RESULT COMPARISON OF TPM VERSUS APM

| | Phase Applying | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Comparative Study | Initating | | Planning | | Executing | Monitoring and Controlling | Closing | |
| PMBOK | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Agile Approach | ✓ | ✓ | ✓ | ✓ | None | None | ✓ | ✓ |
| Comparative Study | PMBOK | Agile | PMBOK | Agile | | | PMBOK | Agile |
| Number of Cycle | 1-2 times | 1 per week | 1-2 | 1 per month | | | TOR | 1 per week |
| Time reduce | 12 months | 6-8 months | 12 months | 6-8 months | | | N/A | N/A |
| Percent of resouce | 100 | 120 | 100 | 150 | | | N/A | N/A |

Poor communication is the reason most DCP fail, since communication is a component of a project management at every stage, and one project manager understand the objectives of the DCP, the expected results, time, and budget restrictions, they need to clearly communicate that information to everyone involved and often as sprint planning doing in Scrum framework.

Next generation data centers should be integrated APM with PMBOK as a project plan-based to reduce project time 6 months during initiating project and 6 months during planning project. From this research case studies, it revealed that applied APM throughout DCP can be reduced project time almost a year, as shown in Table III. Moreover, it means DCP can be starting operations 8-12 months faster. It means time value of money during 12 months will generate revenues and it helps and reduces ROI period of DCP.

## V. CONCLUSION

The agile strategic approach combines all the elements of project development such as requirements, constraints, regulations as a project input before analysis, design, development, and testing, in brief, regular iterations, while traditional project management methods assume that the entire set of project requirements and activities can be forecast at the beginning of the project and can be control and monitoring throughout the project life cycle (PLC). Agile project management (APM) is a strategic

methodology framework coinciding with the agile approach in data center project management (DCPM) which is designed to alleviate some of the constraints and weak points within the traditional project management. The research case studies have been proved subject to reduce time to project completion or project life cycle (PLC), faster return on investment (ROI), and improve quality of team project management.

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