DISCONTINUITY IN ORGANIZATIONS: HOW ENVIRONMENTAL CHARACTERISTICS CONTRIBUTE TO THE PROJECT'S KNOWLEDGE LOSS PHENOMENON

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Abstract:

We conducted an ethnographic study of a large affordable housing organization to understand why knowledge loss (K-loss) continues recurring during facility development. We found four operational characteristics—multiple concurrent and sequential phases, discontinuous organizational memberships, task interdependencies, and knowledge form—which explain the environmental characteristics that contribute to the K-loss phenomenon. The finding suggests a study of organizational performance, which must include emerging dynamic knowledge flow theories with well established organization theories. Further application of this study will lead to the development of a knowledge management system that caters to dynamic or temporal teams within larger enterprises.

Key Words:

Organization Discontinuity, Discontinuous Membership, Knowledge Flows, Environmental Contingencies, Process Design, Organization Design

1. INTRODUCTION

The construction industry understands very well that incomplete knowledge transfer can cause unnecessary rework and delay (Paulson, 1976; Jin and Levitt, 1996). For instance, a facility developer agreed to preserve an oak grove at one corner of a property as one of the development approval terms with a city council. Several months down the facility development process, his building permit was rejected (hence, a six-month delay) because his mechanical engineer submitted a building plan that routed the water supply piping system through this oak grove. The

mechanical engineer, who was not aware of the preservation commitment, located the piping route in that corner because it was the location for all major water intake points to the site. In another instance, facility developers lost valuable operating revenues for 'forgetting' to deliver an agreed item. In this case, a funding program required a play structure in an affordable housing project. As the design progressed, the play structure became a flat playground area. A few years after the project completion, the funding agency fined the developer for not providing the play structure. It also requested the property developer to build a new play structure or return the fund to the agency. Why do these problems occur, even when the facility development organization has explicit information or maintains one project manager throughout the facility development life-cycle process? It negates Cohen's and Levinthal's (1990) absorptive capacity theory that an organization's knowledge is built upon its prior knowledge because somehow that knowledge is missing from the organization.

Knowledge loss (K-loss) matters when it impacts a project's schedule and cost. A grave consequence of incomplete knowledge transfer is the abandonment of a product development project when emerging information can turn it infeasible. Emerging information can complicate the process, extend the delivery schedule, or increase the cost so much that a product development project is no longer worth pursuing. We define knowledge as the "know how" that an individual or an enterprise possesses in selecting and applying information to complete a task. Information is the selective collection of data pertaining to a task that an individual or enterprise applies to complete the task, while data is a fact that an individual or enterprise can use to analyze or make a decision. Our research is motivated by the need to facilitate the transfer of tacit knowledge among members of a facility development team with discontinuous memberships. Discontinuous membership is an organizational operational situation where team

members can join and leave the organization to perform their specific roles while the workflow process continues. Tacit knowledge is the "knowing how," which is not explicitly documented in the organization (Polanyi, 1971; Nonaka, 1994).

Our main research goal is to develop a flexible knowledge management system that captures both tacit and explicit knowledge during a facility development life cycle process. The challenge was how to develop such a user-friendly knowledge management system that captures the inherent tacit knowledge of individuals or the enterprise. Since many facility developers complain about recurring K-loss despite their diligent measures, our study turned to the ethnographic method to understand the operating environment culture that surrounds the formal textbook process. We were encouraged when scholars such as Schreiber and Carley (2003) acknowledged that among barriers in knowledge transfer in an organization are: not knowing which members have the desired knowledge, not knowing whether they exist, and not knowing what knowledge they hold. They found that 53 percent of received answers by information seekers contained referral information using information technology. Their study identified two data types—task and referential—and determined how they are different. They described task data as a purely technical process whereby a member queries the database and obtains the results. On the other hand, referential data is a social process facilitated by technology. A fundamental study by Nonaka (1994) posits that many employees tend to seek knowledge from individual experts on a personal basis (i.e., socialization to transform tacit knowledge to explicit knowledge among individuals), but the organizations in Schreiber's and Carley's (2003) study use information technology to facilitate knowledge transfer. Neither studies integrates the transfer of individual or repository knowledge based on the work process in which the employees are

involved, but Schreiber and Carley (2003) did highlight the need to understand task complexities that an organization faces.

In order to provide a platform to capture tacit knowledge in a facility development process, we need to understand the environmental culture of the facility developer's organization. We conducted an ethnographic study within a case study research at an affordable housing development organization to find out whether or not there was something amiss from facility planning textbooks that could explain the recurring K-loss that facility owners and their consultants were experiencing. This study presents the results of the ethnographic study. We have utilized these findings to develop a computational model to study dynamic knowledge flows in a complex facility development life cycle process. Results of the computational model are reported in separate papers (Ibrahim and Nissen, 2004a and 2004b). In this paper, we first present the basic premises of our ethnographic study. Then, we explain how we determined the facility development and financing milestones, and how we developed the life cycle phases from the developer's perspective. Then, we present the analysis on how the four environmental themes we found (i.e., concurrent and sequential phases, task interdependencies, discontinuous membership, and knowledge forms) contribute towards the K-loss phenomenon. This section follows with explanation on how we use the case study approach to validate our findings. We conclude the paper with a discussion on how the findings will impact organization and knowledge flow theories, and recommend future studies.

2. POINT OF DEPARTURE

Unlike a case study (Yin, 2003) and grounded theory (Glaser & Strauss, 1999), an ethnography study does not require a theoretical point of departure. Instead, we refer to real estate development scholars to provide background information for our observations. Scholars such as Fulton (1999), Peiser and Schwanke (1992), Bookout et al (1990), Kone (1994), Schmitz et al (2000), etc. provide practical guides to land development processes and procedures for real estate development in the United States. However, Carrillo et al. (2004) found in a survey across major UK construction organizations that the lack of standard work processes is the main barrier to implementing a knowledge management strategy in the construction industry. The finding reflects an unsuccessful knowledge management strategy to fulfill the need to share tacit knowledge of key employees in these construction organizations. Their conclusion correlates with the real estate development scholars' recommendations that their guidelines are general and each facility development project needs to know the locality well before proceeding any further. Affordable housing development, finance adds complexity to the already ambiguous life cycle process. Other non-profit groups, such as Neighborhood Reinvestment Corporation (NRC, 1994) and California Redevelopment Association (CRA, 1998), and governmental agencies (such as the US Housing and Urban Development Department (HUD)) assist potential non-profit developers by providing guidelines on available financing programs.

At the ASCE 4th International Joint Symposium on Information Technology in Civil Engineering, participants discussed the need to understand the economic impacts of IT usage in civil engineering. Participants asked for IT tools that create better, more task-oriented views of complex project information that involves different interfaces for viewing data. The organizer (Garrett, Flood et al (2004)) concluded that there is still much challenging research to be done to

bring emerging, cost-effective information and communication technology to civil engineering practice. Our main research contributes in fulfilling this need.

3. ETHNOGRAPHY RESEARCH METHOD

Overview

The essential core of ethnography is the concern for the meaning of actions and events to the people we seek to understand (Spradley, 1980). We wanted to study the project managers involved in the facility development who would make constant use of these complex meaning systems to organize their behavior, to understand themselves and others, and to make sense out of the world in which they work. Spradley notes that these systems of meaning constitute their culture. The purpose of our ethnographic study is to know whether there is something unique going on in the facility development life cycle process that makes exception handling due to missing explicit information a common phenomenon. We would like to understand why this phenomenon is frequent in facility projects. We concentrated on determination of the workflow processes and the people responsible for these processes. The ethnographic study provides us insights into the cultural and operating environment of such an enterprise. Our ethnographic research question is, what is the operating environment of a facility development enterprise?

Data collection

We chose one of the major affordable housing developers in the San Francisco Bay Area as our unit of analysis. The affordable housing developer has completed 73 projects located in the Bay Area, and was managing about 5,000 units of affordable housing in year 2002. When the first author became a summer intern at its central office in 2002, there were seven project managers handling fourteen projects at various stages of the facility development life cycle. She was a participant-observer during the initial three months data collection period, and had continued access to the organization for the next two years as an observer. She reported to the chief operating officer, the gatekeeper, who gave her access to documents and human resources in the office. The major sources of data are archival documents of 73 projects, and interviews with selected executives and staff. All interviews were manually recorded and transcribed before the end of the day. The first author met weekly with the chief operating officer to present her analysis based on the interviews and document search of the previous week. It was during these meetings that the first author decided whether she needed to adjust or redirect the research schedule for the following weeks in view of emerging discoveries. The chief operating officer would accommodate the changes accordingly.

Analysis

The study selected thirteen cases in the facility developer's archive, which have almost complete information (see Table 1). There are eight family housing projects, two single residency occupation (SRO) projects, two senior housing projects, and one special needs project. The SRO projects provide small efficiency studio units primarily designed to accommodate the needs of one person. A special needs project is typically intended to provide apartments for

developmentally disabled adults who can be self-sufficient with a little help from social service providers. The size of the affordable housing projects ranges from 28 to 148 units. The developer completed them from 1992 to 2003. We chart the major milestone dates for these cases and identify the most constant events in terms of their sequencing and occurrences. A common iteration is charting the events, then reconfirming them with the responsible project manager or staff member who had participated in the project, and finally revising the chart. We compared the major event milestones among the cases. Upon affirmation of the major development milestones by the staff, we selected two cases—worst case versus best case—to study the organizational changes that occurred during the facility development life cycle until the first year of the facility's operation. We used SimVision®, an agent-based computational organization theory (COT) modeling tool (Jin & Levitt, 1994), to build a high-level facility development life cycle process which includes an organization responsible over each life cycle phase to emulate the operating environment, hence validating the ethnographic findings. Details of how we built and tested these models will be published separately (Ibrahim and Nissen, 2004a and 2004b).

[INSERT TABLE 1 HERE]

Table 1: List of affordable housing development cases

Limitation of study

We define facility development period as the duration from the time when a facility developer starts to seriously become interested in a property until the facility starts operating. This study concentrates on the pre-operation phases of a facility development. We chose affordable housing facilities because the process is richer in context, but more complex due to its financing requirements. We limited the scope of this study to (1) determining the milestones for a facility development life cycle, (2) understanding how the organization evolved during its life cycle, and (3) identifying the operational environment characteristics caused by the life cycle process.

Validation

We validate the ethnographic findings using Yin's (2003) case study validation approach. They are 1) establishing construct and internal validity, 2) establishing external validation, and 3) using a computational organization theory (COT) model. In establishing construct and internal validity (Yin, 2003), we obtained affirmation of results by key informants such as the project managers and the chief operating officer when they reviewed the draft of the findings. We compared the general findings with existing organization theories for external validation, specifically Burton's and Obel's (1998) *contingency theory*. The contingency theory describes the operating environment as high in uncertainty, high in complexity, and high in equivocality. The results are validated if they correspond positively.

4. DETERMINING AFFORDBALE HOUSING DEVELOPMENT MILESTONES

A facility development project starts when a developer becomes seriously interested in a property and ends when the facility starts its operation. The first step in our ethnographic study was determining the architectural-engineering-construction milestones during the facility development period. We explain why we chose these time and cost milestones below.

Architect's first sketch submission or architect's first fee proposal: These two items are the first formal indications that the developer began to seriously consider developing a property. The architect usually would sketch out the site plan to find out how many units were feasible so the project managers can conduct an initial feasibility analysis. Another alternative event is when the developer responded to a city's request for proposal (RFP). The developer usually pays the architects to prepare conceptual designs to complement its submission. Similarly acceptable was the architect's initial fee proposal that covered a conceptual design not meant for submission purposes. Purchase of property was not a good starting point because the closing month varied from project to project due to terms and conditions stipulated in the purchaser agreements. The developer's normal practice is to request the architects to submit the formal professional contract after it is comfortable with the property's feasibility analysis. The initial architect's professional fee contract proposal may or may not include consulting engineers' scope of work. In most cases, contracts for the architects came many months after they made their first sketches.

Application for development permit: This event marks a significant commitment by the developer to obtain a formal permission—an entitlement or a development permit—from the governing authority to develop an affordable housing project. We note that the development

application date is a little peculiar because authority submissions varied depending on their requirements. It depended on whether or not the developer had to submit for planned development approval. A developer submits for a planned development approval when it intends to construct a facility that is beyond the standard zoning regulation for that property. For example, a developer intends to build a five-unit housing block instead of the allowable four units. Until today, most cities and counties do not have standard '*entitlements*' processes, a common alternative name which real estate professionals use for this formal development approval process.

Receipt of the development permit: This date marked the developer's success in the entitlements process. It is the most consistent achievement of the entitlements process. Upon receipt of the development permit, major activities take place since the affordable housing projects had overcome any public opposition and could then move forward with financing arrangements and finalizing the closure of the property's purchase.

Receipt of the building permit or signing of building contract: At this point, all construction documents (i.e., plans and specifications) were completed and the general contractors were ready to start construction. The study did not choose the date for building permit submission because this date varies among the housing projects. Some housing projects received their building permits within a month of getting their development approval while some took more than twelve months. However, within a month of receiving the building permit, construction work would commence on site. We also noted that the site handing-over in the contracts normally occurred

several weeks after signing the building contracts. When the building contracts are missing from the files, there are occasional notices to the respective builders to commence work at site.

Receipt of certificate of occupancy: Prior to tenants move-in, all facilities on the properties must have their certificates of occupancy from the governing authorities. All permanent funding programs require proof of construction completion before disbursing their permanent loans. With a certificate of occupancy, projects were deemed complete from the perspective of design-construction staff. However, to project managers, the development processes completed only when they received the Internal Revenue Service's (IRS) Form 8609 for the partnership company. The application for this form required a copy of the certificate of occupancy, but due to its late delivery—usually within six to 12 months of tenants' move-in dates—this date was not a good choice. For 1992-1996 housing projects where no certificates of occupancy were available, the study found the certificate of occupancy dates on the properties' Form 8609 certificates. The Form 8609 is the acknowledgement from the State of California that the project will receive tax-credit exemptions for being an affordable housing property.

Figure 1 illustrates the sequence of major milestones during a facility development life cycle. The sequential events are: identifying a potential site, applying for a development permit, obtaining a development permit, starting construction, and completing construction. Figure 1 also charts when the project managers assume the completion of the standard American Institute of Architects (AIA) scope of architect's basic services (American Institute of Architects, 1997) with our ethnographic observations. There is no discrepancy in the *schematic design* and *construction* phases among the AEC and the Owner teams. However, there are overlapping

ambiguities between the times the developer submitted the development permit application until the start of a project's construction. The project managers viewed the *design development* at about sixty percent completion, and at the most at seventy percent completion, when the projects received their development permits. In addition, they only accepted the completion of the *construction documents* at the time of the building permit application after they had an independent construction estimator evaluate the project construction cost. The developer was not willing to risk applying for insufficient permanent financing (details in the following section) when *bidding or negotiation* may take too long for its financing application purposes. The study notes these vague *design development* and *construction documents* phases for possible explanation of the K-loss phenomenon later.

[INSERT FIGURE 1:

Figure 1: Financing and architectural-engineering-construction interdependencies during a facility development life cycle

5. DETERMINING AFFORDABLE HOUSING FINANCING MILESTONES

Financing requirements make an affordable housing facility development more complex than a similar for-profit's. Affordable housing finance requires a combination of equity partnership programs with multiple permanent soft and hard loans (see Table 2), most of which require time-consuming applications and approval processes by government agencies. The study found some cost estimates that reflected approximately the time frame of architectural-

engineering-construction events from documents that project managers produced for financing applications. The developer submitted these documents to obtain funding for the housing projects. Among the documents were:

[INSERT TABLE 2 HERE]

Figure 2: Examples of equity investment programs, permanent soft and hard loans for affordable housing development

Affordable Housing Program (AHP), Rental Housing Construction Program (RHCP), or Redevelopment Agency (RDA) Applications: Developers can submit AHP and RDA applications any time during the development process, provided they receive some confirmation from the governing city or county. From 1990 until 1995, RHCP was dominant. Cities or counties allocated and administered these funds. The developer would submit its applications at about the same time that it submitted the projects' entitlements applications. By this time, architects had already completed the schematic designs. The developer usually asked for increments whenever its development cost exceeded its earlier budget. Sometimes, it applied for additional funding more than once. Most cities and counties were flexible on this because they did not want the affordable housing projects to fail. Hence, there was no risk for the developer to apply before it received the development approvals. AHP, RHCP, and RDA funds generally subsidized the developer's early development costs such as land leases, consultant fees, legal fees, off-site infrastructure costs, etc.

California Low-Income Housing Tax-credit (LIHTC) Application: Unlike the AHP and RHCP applications, the LIHTC applications were more stringent. The points systems applied to rank competing projects depended on the readiness of developers to start construction after they received funding allocation. The LIHTC funding awards were one-time only awards. Therefore, the developer must obtain its best development estimate to finalize the tax-credit amount it was applying for. Hence, the developer tended to wait until it received the building approvals and completed negotiation of the building contracts based on final construction documents. However, if the project did not get the funds, developers had to wait for the next application round and delayed any construction on the site. LIHTC applications are bi-annual: March and July.

Final LIHTC Cost Report: At the end of the project, an appointed company auditor audited the project's total development costs and issued final cost certificates to the affordable housing developer. The final amounts recorded in these certificates were the basis to close tax-credit partnerships for the projects. Closing of these partnerships meant that full payment of the permanent funding for projects was available to pay off the respective projects' construction loans. In cases where the final cost certificates are not available, the study refers to the final cost reports prepared by project managers to LIHTC or AHP upon the completion of the projects.

6. FACILITY DEVELOPMENT PHASES

The ethnographic architectural-engineering-construction event milestones allowed the study to track development schedule changes through at least five sequential development phases and at least two concurrent phases (see Figure 2). The sequential phases are *feasibility*,

entitlements, *building permit*, *construction*, and *property management,* while the concurrent phases are *development financing* and *asset management*.

[INSERT FIGURE 2 HERE]

Figure 2: Multiple concurrent and sequential phases in a typical facility development life cycle with different organization in each phase

Sequential facility development phases

The facility development milestones allow us to divide the sequential life cycle process into four sequential phases. The milestones denote either the start or end of a phase.

Feasibility Phase: This phase is defined as the period during which the developer ascertains whether the housing project is profitable enough to justify the risks inherent in a facility development process (Ibrahim, 2001). Among the major components the developer considers in its due-diligence feasibility analysis are site selection, site analysis, title analysis, governmental requirements study, product design, market analysis, product cost estimation, and financial feasibility analysis. These lead to a decision on whether or not the developer wants to proceed. This phase starts when the developer first becomes interested in the property, and ends when the developer formally submits an application for the housing project's development permit. The

study observed the project managers and executives utilizing their well-established contacts in seeking potential sites and financing sources, and negotiating the entitlements process. These sources would inform the project managers of the availability of land or finance, and advise the developer about the best way to obtain the development permit. By the time the proposed housing development enters the planning application stage, most of the financing sources have given positive indications that the respective proposal has a good chance for implementation. Otherwise, the developer will abandon the proposal or wait until a better opportunity emerges.

Entitlements Phase: This phase is defined as a period during which the developer applies for the official permission to develop and construct the facility on a property within the governing jurisdiction. It starts when the developer formally submitted the development permit application and ends when it obtained the development permit. Obtaining the development permit allows the developer to build the project on that site according to the concept it was approved for, and it is no longer at risk of being opposed by parties beyond the control of the developer. Financing institutions will not consider any formal applications for a permanent or construction loan without this development permit. During the entitlement phase, the three major components are taking control of the land or property, obtaining the entitlements from the government authority, and securing financial commitments (Ibrahim, 2001). A financial commitment is a conditional approval from a permanent financing institution, which is subject to receipt of all required authority approvals prior to the finalization of any loan release.

The entitlements process varies from city to city. For the City of Palo Alto, among the major elements in obtaining its development permit are obtaining the Planning Commission approval, obtaining the Architectural Review Committee approval, and obtaining the City

Council approval. More time will be required if a housing project needs to undergo a Planned Urban Development (PUD) or Planned Development (PD) approval process when the developer intends to build outside the city's standard zoning regulations. Although this period seems more technical, the most challenging part is the exposure of the proposed housing project to the scrutiny of its neighbors, i.e., the public. The developer uses its best negotiation skills—maneuvering politically and publicly for social acceptance—in order to obtain the development permit. Opponents to the proposed housing project will use all the avenues available during the process to stop the project, while the developer arranges for public forums and bus tours to successful affordable housing projects to allay the public's fears of having such a project in their backyards.

Building Permit Phase: A developer needs a building permit before it can construct a facility on a property. The building permit phase is defined as a period during which architects and engineers collaborate on completing the proposed facility's design development and construction documents to obtain building permits from the governing authorities. This phase starts when the developer receives a project's development permits and continues until it receives the building permits from various building departments allowing the developer to build the facility. The major components during this phase are acquiring the site, obtaining the building permit, obtaining the construction financing, selecting the builder, preparing the construction documents, and product marketing (Ibrahim, 2001). The study notes that while the developer would bid and negotiate with builders, it concurrently worked hard to apply and negotiate for permanent financing to support the construction loan. During this period, the developer would allow the design team to collaborate in completing the design development documents and, eventually, the

construction documents. The developer will appoint new consultants as recommended by the existing design team should the team needs their expertise.

Construction Phase: This phase represents the building period from when builders start constructing physical work on site until the project receives its certification—*Certificate of Fitness*—from the authority that the facility is safe for occupation. From the developer's viewpoint, this period marks the culmination of all the hard work to put together the facility design with the complex finance schemes. This is the least eventful period to the developer's organization if the project manager did a good job in preparing the design and finance for the housing project. However, any exception occurring during this period is significant as it impacts schedule and cost the worst. In the developer's case, the construction phase for most of the housing project cases ranged from twelve to 24 months.

Property Management Phase: This phase begins when the housing development goes into operation. It starts when the developer receives the *Certificate of Fitness* (CF) from the governing authority that tenants can occupy the facility. The critical operating period starts after construction completion until the developer has complied with all the terms and conditions of the permanent soft and hard loans. The terms of these hard and soft loans varies from at least fifteen years to at most about sixty years. After this initial period, the developer has no more obligations to its creditors. In the case of for-profit developers, they can consider obtaining maximum revenue from their facility operations. However, in the case of affordable housing developers, many eventually initiate a refinancing scheme in order to refurbish the facility while ensuring itself of operating the facility for another long-term period.

The study notes that there is no clear demarcation when the entitlements phase actually started among the housing case studies, but there was a definitive ending with the issuance of development approval or permit. We note this ambiguity in Figure 1 when there are occasions when the developer becomes very sure of getting a proposed housing project development approval prior to any planning application submission. An instance is when the developer applies for a RDA fund to purchase the site. The developer obtains this fund from the city council, i.e., the final authority giving the development permit in the entitlements process. The same city council would not object to the development permit when the same proposed project formally would later apply for the planning approval several months into the process. We propose standardizing this dynamic period by combining both phases into the f*easibility-entitlements* phase. The chart in Figure 1 illustrates how we combined the two phases into one.

Concurrent facility development phases

Although the ethnographic study can distinguish among the sequential facility development life cycle phases, there are ambiguities in the developer's organizational structure which suggest different processes going on concurrently during the sequential facility development life cycle phases. They are the development finance and asset management processes. For overall congruency, the study names both processes as *phases*—d*evelopment finance* and *asset management phases*. In both phases, the organization maintains similar members throughout several sequential facility development phases (see Figure 2).

Development Finance Phase: This phase starts as soon as a project manager ascertains that the housing project has potential to proceed further upon the conclusion of the due-diligence

analysis. The project manager obtains the approval from the board of directors before committing further to pay the deposit to obtain site control and to hire the architect to prepare a conceptual proposal for the site. In the course of compiling available finance programs to support the proposed housing project, the project manager will come across favorable financing schemes. The project manager then designs a total finance package in lieu of the most favorable finance program. In our study, the developer has a well-established reputation with the *Low Income Housing Tax Credit* (LIHTC) program (refer to Table 2). Upon receipt of the development permit, the project manager will submit multiple applications for the various finance programs. The project manager will obtain all the permanent soft and hard loan commitments prior to closing the construction loan, which, in addition, requires a building permit and ownership of the site. The finance team is responsible for approving payments to the consultants and builder during the feasibility-entitlements phase until the end when the housing project has closed all of its permanent soft and hard loans. Then, the finance team will transfer the finance requirements to the asset management team for long-term operational sustainability.

Asset Management Phase: In a larger development organization, such as the developer in our study, an asset management team was created by staff from the property management team when the number of units in the housing portfolio grows, and many earlier projects have reached maturity with their long-term finance programs. Unlike property management, which oversees the operation of the portfolio, the asset management team acts as the owner representative throughout the development life cycle. Closing the land acquisition is its first task in a new housing development, while purchasing the limited partner equity share is first in older facility portfolios. A shareholder buy-out provides an opportunity to the developer either to run the

property as is, to rehabilitate the property, or to sell the property to a third party. The developer mainly decides to rehabilitate these properties by upgrading the facility to meet current tenants' needs. In doing so, the asset management team more often works closely with the design consultants and builder, and not the development project managers, to refinance the property from similar finance programs available. Sometimes, the role of the asset management staff is similar to the role of the project managers. They are initially involved in older properties that require large capital improvement programs before handing the projects to the development project managers. However, this rehabilitation fund is usually a small fraction compared to new development funding requirements. In addition, due to its role in overseeing capital improvement projects, the asset management staff does in some way oversee all major capital improvement projects by the property management's maintenance staff.

The study notes that the development finance and asset management tasks fall among optional additional services architects could provide to the owners for additional fees. The development organization we observed had its own team of permanent staff, besides it is very much involved in the operational aspects of most of its rental properties.

7. THE EVOLVING ORGANIZATION

Once we understood the sequential and concurrent phases of the facility development life cycle, we determined the organizational structure responsible for each phase. We obtained the project manager's input in charting the estimated full-time-equivalent (FTE) of each team member on a selected project. In the best case example, there are a total of six organizations over the facility life cycle. Referring to Table 3, the feasibility-entitlements phase has twelve

members, the building permit phase has ten members, the construction phase has twelve members, the property management phase has nine members, and the development finance has seven members, while the asset management has four members. The study finds the developer's organization depends on external consultants assisting its staff during the sequential feasibility-entitlements, building permit, and construction phases, while having full-time staff of its own during the property management phase. On the other hand, the concurrent phases—i.e., development finance and asset management—has about the same number of internal and external members. Among the reasons behind these organizational changes are the developer's staff is "not expert in technical matters," the developer "…. cannot afford to be liable for technical matters," it "…hire(s) as and when we need the expertise like preparing EIA report," and it "…cannot afford to pay the consultants on a retainer basis." In Table 3, a full-time-equivalent (FTE) value corresponds to an eight-hour day in a 5-day work week. The project manager for the best case study estimated the FTE contribution by each member of his development team based on his knowledge of how many projects he assumed each member would handle during each phase. For short-term consultants, such as the title company or the environmental engineer, their FTEs are 1.0 because the project manager assumed that their staff will concentrate on one project within a short period of time to complete a task. The project manager, for example, was handling three to four housing projects at various development phases throughout the best case's development life cycle.

[INSERT TABLE 3 HERE]

Table 3: Staff positions and their contributing full time equivalent (FTE) allocations for different facility development life cycle phase in an affordable housing case study

8. OPERATIONAL CONSTRUCTS

Based on the ethnographic study results, we developed four operating environment constructs for the facility development life cycle that could explain how knowledge flow impacts organizational performance. They are multiple concurrent and sequential phases, discontinuous membership, task interdependencies, and knowledge form. We describe the four constructs below.

Multiple concurrent and sequential phases: The facility development process is complex in general, but the affordable housing development process is more complex due to the financial and regulatory constraints that state and federal programs impose on their developments and operations (Ibrahim, 2001). Our ethnographic study finds the feasibility, entitlements, building permit, construction, and property management phases to occur in a sequential order, while it finds development finance and asset management to be concurrent with the sequential phases. The succeeding phase continues upon the completion of the milestones of the preceding phase, such as the feasibility phase ended with the submission of the planning application, while the

entitlements phase commences with the planning application submission. On the other hand, the study finds that the project managers have to commence development finance and asset management tasks separately upon the completion of a task in the sequential phases. For example, the developer needs to finalize the land acquisition, i.e., preparing legal and financial documents, while the architectural-engineering-construction team members prepare the schematic design documents.

Discontinuous membership: The second major construct represents a unique organizational character—a dynamic organizational structure that varies across different facility development life cycle phases. The study attributes the dynamicity of the evolving organization to the requirement for different skill sets which the development team needs in order to complete the tasks in a particular phase. It finds some team members contributing to multiple facility development life cycle phases, but the frequency and intensity of their participation vary across such phases (e.g., the architect is involved in three sequential phases that require design and construction tasks). Other team members served in only a single phase (e.g., the environmental engineer in the feasibility-entitlements phase). For instance, the feasibility-entitlements phase has a total of twelve members, but the building permit phase has a total of ten members. The organization changes when five original members leave, but it obtains three different new members. On the other hand, the development finance phase has a constant seven team members throughout. Please refer to Table 3 for discontinuous participation details for each member of the selected project.

Task interdependencies: The third major construct acknowledges that each phase has tasks that are interdependent with those in concurrent phases. Referring to Figure 1, the event milestones are the major convergent points for concurrent workflows during the facility development life cycle process. For instance, facility developers require building permits before starting construction, but they need to finalize the construction loan before handing the site to the general contractor to start construction. The tasks to obtain a building permit and handing over the site are sequential in the *building permit* phase (refer Figure 2). However, the task to finalize the construction loan is in another concurrent phase—i.e., the *development finance*.

Despite a risky outcome that a facility project may not see its implementation, the study found that the project managers were not so concerned about the uncertainties and complexity of the facility development life cycle process. Responses such as "….we will find other sources of finance," or "….we'll have the designers work on the construction documents, while we wait for the next (LIHTC) application round" are common. It reflects a readjustment of the critical path in the overall facility development process. Among the common causes for change in the critical path are: delay in getting the relevant approvals, failure to obtain the applied financing, rework due to additional requirements, etc. Despite the fact that all the project managers mentioned that there were no two similar projects they had handled, the ethnography study allows us to link the common workflow sequences on their selected projects. We chart a general summary of the task interdependencies for the selected best project in Figure 1.

Knowledge form: The final major construct identifies two forms of knowledge dominating during different facility development life cycle phases. Specifically, tacit knowledge dominates during the early feasibility and entitlements phase, while explicit knowledge is dominant during

the later building permit, construction, and property management phases. The study found that the developer project managers obtained tacit knowledge by socializing and internalizing the actions and sayings of the local elected officials and the public that supports them, while they ensured transfer of explicit knowledge among the team members during the design and financing application processes. It found these experienced project managers to be very comfortable in their social and political operating environment that enables them to maneuver socially, politically, and financially during the complex process to 'smooth' the sequence of the architectural-engineering-construction process. The study observed a number of remarks such as, "…I'll call so-and-so at the city hall to find out what's going on," or "….please arrange a lunch meeting with so-and-so so (that) I can clarify the details…." Explicit knowledge flows are represented by the sharing of documents each team member passes on to others to complete their tasks.

9. VALIDATION

We validated the ethnographic findings by using Yin's (2003) case study approach. First, we established construct and internal validity. Then, we established eternal validity followed by using a computational organization theory (COT) modeling for proof of concept (Thomsen, et al., 1999).

Constructs and Internal Validation: In establishing construct and internal validity (Yin 2003), key informants such as the project managers and the chief operating officer reviewed the draft of the findings. They affirmed the findings verbally. The chief operating officer found the weekly briefings enlightening as she gradually understood the functions and impacts of each life cycle

phase on an affordable housing project. The central office also arranged for a presentation to its central office staff during a monthly staff meeting in late summer. About fifty executives and staff attended the presentation. At the end of the presentation, many in the audience appreciated the interdependency finding that explains why some of the project managers seem "pushy" on many occasions. Despite the fact that most of the executives and staff the first author interviewed were very dedicated to their work and the developer's organization, they did not quite understand why they need to worry about other tasks outside of their own departments. The study observed the project managers taking the role of the main interdepartmental coordinators throughout the facility development process, such as calling for group meetings, carrying documents to and from the respective individuals, and initiating one-on-one meetings when necessary. The study concludes that the main reason is because they were unable to see the repercussions of their tasks on another task in a different workflow process that was handled by another department's staff.

Another construct validation came from the executive director who exclaimed, "That is exactly how my brain works to coordinate so many tasks!" where all the project managers agreed amidst the laughter of others. On that day, the project managers gained a new level of respect from their co-workers for their ability to coordinate multiple tasks. During several follow up visits after the presentation, the first author felt the central office working environment was becoming more pleasant due to better understanding of the team members' roles and responsibilities to one another. The developer provides a profound validation by accepting the interdependency finding and initiated their affordable housing development manual. The proposed manual takes into account the interdependency requirements and impacts from different department staff members, especially those critical decisions project managers will make during the feasibility-entitlements phase.

External Validation: We compare the general findings with existing organization and knowledge flow theories for external validation. Burton's and Obel's (1998) *contingency theory* describes the operating environment as high in complexity, high in uncertainty, and high in equivocality. It has high complexity because, despite having a functional organizational configuration, the facility development organization also reflects a strong matrix configuration. For example, it is common for a single project manager to handle several development projects concurrently. There are also many interdependencies between workflow processes in a development project. For instance, the facility development team needs to work with its finance and property management teams internally, while working with external design consultants and regulatory agencies to complete the development project. A facility development project has high uncertainty because, despite having a general sequential development activity schedule, each one is unique. Project managers cannot accurately predetermine which workflow path they need to concentrate on at any given time. For example, facility developers cannot be sure which program will fund a particular facility development project, and each funding program has different requirements and application procedures. The operating environment has high equivocality, because there exist multiple and conflicting interpretations, confusion, and lack of understanding among the stakeholders. These are apparent especially when dealing with regulatory agencies, city officials, and the public.

Nonaka's (1994) *SECI model*—socialization, externalization, combination, and internalization—describes the spiral process of knowledge life within a group interactions. The study finds different forms of knowledge dominating during different facility development life cycle phases. Specifically, tacit knowledge dominates during the early feasibility and entitlements phases, while explicit knowledge is dominant during the later building permit,

construction, and property management phases. Tacit knowledge (Nonaka, 1994) is rooted deeply in action, commitment, and involvement in a specific context. As such, it can be very difficult to articulate and share, as this study found that the project managers to be confident of "putting things" together. Explicit knowledge is transmittable in formal, systematic language. As such, it can be articulated and shared via plans, drawings, documents and databases. The study found that the developer's project managers obtained tacit knowledge by socializing and internalizing the actions and sayings of the local elected officials and the public that supports them, while they ensured transfer of explicit knowledge among the team members during the design and financing application processes.

Computational Organization Theory (COT) Model: We cross-validated our ethnographic findings by developing a simple model of the worst and best cases of our ethnographic study using an agent-based tool—SimVision®—to simulate the operating environment of a facility development life cycle. The models consist of high-level workflow processes for the different phases and illustrate the team members responsible for the tasks. We established the interdependency links between the various phases. The simulation results affirm the three of the four operating environment constructs: multiple concurrent and sequential phases, discontinuous participation, and task interdependencies. The knowledge form was not measurable using this COT tool. Please refer to Ibrahim and Nissen (2004a and 2004b), which describes how we developed the computational models.

With the constructs internally and externally validated using Yin's (2003) case study method, we can now further study how knowledge flows impact organizational performance during the facility development life cycle.

10. CONCLUSION AND FUTURE STUDIES

We conducted an ethnographic study of an affordable housing organization to understand why knowledge loss (K-loss) continues to recur during the facility development life cycle. The study found that project managers handled at least two concurrent phases (i.e. *development finance* and *asset management*) throughout the sequential facility development life cycle that were known to the architectural-engineering-construction team. The study renamed the sequential phases in the facility development life cycle to *feasibility*, e*ntitlements*, *building permit*, c*onstruction*, and *property management* based on the goals of the respective phases, which describe the overall workflow tasks completed by the team responsible for each phase.

When compared to the architect's standard basic services, the study found the most likely potential period for K-loss to occur was during the period when the developer submitted the development application until the builder started construction on the property. During the *design development* phase, the architect may recommend other professionals as necessary to complete the facility design, while the developer has to comply with various external requirements, namely public opinion, if it wants to see the housing project obtain the development permit. The new team members may not be aware of previously agreed decisions made by senior team members. This is especially so if a senior team member is no longer with the team. The situation is aggravated when goal of the design team differs from that of the developer.

Due to the professional fee constraints, most design team members aim to complete the design development and construction documentations as soon as possible. Unfortunately, the developer's need for design flexibility during the *entitlements* phas*e* does not augur well for the functional approach of the technical team members. Therefore, there is a high probability of inefficient knowledge transfer when not every member of the development team is aware of

changes that are happening in another concurrent phase. The phenomenon explains why the mechanical engineer missed the preservation of the oak grove when he designed the water supply routing. He came on board the development team during the *building permit* phase as recommended by the architect during the *design* development phase. We recommend further studies on this dichotomous situation where the flexible need of the developer clashes with the functional professional process. Moreover, we recommend further studies on how to converge the different goals in different facility development phases without compromising the quality and increasing the cost of the overall process. We also would like to suggest to the American Institute of Architects to evaluate whether there is need to review the contractual obligations to be more flexible while having the ability to financially sustain their design organizations.

The ethnographic study found a unique and dynamic organizational structure which changes throughout the sequential major phases, while maintaining the organizational structure in the concurrent phases throughout the facility development life cycle process. The need for different team memberships depends on the need of different skill sets to complete the tasks for the respective phases. There are many studies on organization as an entity that evolves (Bacharach et. al, 1996; Allmendinger and Hackman, 1996; Amburgey et. al, 1993), but there is no specific study of organization with discontinuous membership during an on-going work process. Using the discontinuous membership paradigm, we explained earlier how the mechanical engineer made an error in routing the water pipes through the oak grove. Using the multiple concurrent phases paradigm, our study could explain how the play structure ends up as a flat playground in another K-loss incident. It was simply that the design team was trying to minimize the construction cost by cutting down ‘non-essential’ items from the program requirements. Since the finance team thought that the play structure requirement had been

codified (i.e., in the finance program agreement), the developer was confident that it would be included. However, it is common practice not to issue a copy of the developer's financing agreement to non-finance team members, who in this case happened to be the architectural-engineering-construction team members.

These findings led us to posit that new members have difficulties 'knowing' when and how to retrieve available information regardless of whether the existing information is already documented in the developer's database system. The 'knowing' of when and how to use certain information is tacit knowledge to individuals, despite being explicit knowledge in the repository. It also involves 'who' should actually become aware of this information. This defeats the purpose of having a usable knowledge management system because the knowledge management systems will act as a repository entity only. We recommend further study into the impact of discontinuous memberships on knowledge flows. In addition, we recommend further study on how the disruptive knowledge flows would impact organizational performance in order for us to design a better organization for a facility development project. Any knowledge flows study should integrate how different knowledge forms would impact knowledge flows, especially tacit knowledge, and eventually how they would impact organizational performance.

The final major finding from the ethnographic study is the existence of task interdependencies between the work processes in different sequential and concurrent phases. Although the COT model could not measure knowledge flows, SimVision® allows us to view the dynamic change on the overall critical paths of the facility development life cycle spanning over multiple concurrent and sequential phases. The critical path changes correspond to various exceptions that the project managers highlighted. Among the exceptions are delays in getting an approval, failure to obtain financing, 'missed' information causing rework, etc. The

interdependencies cause the critical path to shift in multiple phases, but the overall work process does not change. Only members who are aware of the overall tasks, such as the project managers, can take mitigative actions to reduce the impacts in the relevant phase. Hence, the ethnographic study provides an answer as to why the project managers and many scholars (such as Carillo, et al. 2004) comment that "…no (facility) project is the same." We are recommending further research on the critical path change due to task interdependencies to facilitate knowledge transfer in a complex environment.

In conclusion, the ethnography results provide rich insights into the culture and operating environment of a facility development organization. The study found that the facility development life cycle has several consistent milestones—having a potential site, applying for development permit, obtaining development permit, starting construction, and completing construction. The four operational characteristics—multiple concurrent and sequential phases, discontinuous organizational memberships, task interdependencies, and knowledge form—can explain the K-loss phenomenon. We posit that the task interdependencies between multiple concurrent phases make the facility development process seems unstable due to changing critical paths when, in fact, the work process is stable within its own phasing. We also posit that discontinuous memberships promote inefficient knowledge transfer even when the organization is working on a single facility project. K-loss will tend to happen, and has the potential to worsen when knowledge transfer requires members to be aware of others in the organization. Our study suggests future study of organizational performance, which must include emerging dynamic knowledge flow theories with well established organization theories. Specifically, the study recommends further investigation into dynamic knowledge flow theories to understand how an organization can benefit from efficient knowledge transfers to improve organizational

performance. Further application of this study will lead to the development of a knowledge management system that caters to dynamic or temporal teams within larger enterprises.

11. ACKNOWLEDGEMENTS

The doctoral research of the first author is sponsored by the Ministry of Science, Technology, and Innovation of Malaysia in affiliation with Universiti Putra Malaysia. Additional support was provided by the UPS Foundation Endowment at Stanford University. We acknowledge the contributions of Professors Ray Levitt of Stanford University, Palo Alto, and Mark Nissen of Naval Postgraduate School, Monterey, California. We extend a special appreciation to Fran Wagstaff, Anna Kramer, Kevin Brown, and Susan Russell for their assistance throughout this study.

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13. ILLUSTRATIONSAND TABLES

Table 1: List of affordable housing development cases

Case No.	Year Completed	Number of Units	Housing Type
1	2001	43	Family
2	2001	148	Family
3	2001	74	Seniors
4	2000	70	Family
5	2001	80	Special Needs
6	2001	28	Family
7	2003	71	Family
8	2003	148	SRO
9	1994	121	SRO
10	1995	98	Family
11	1992	107	Seniors
12	1993	64	Family
13	1995	76	Family

Table 2: Examples of equity investment programs, permanent soft and hard loans for affordable housing development (CRA, 1998)

ACRONYM	FUNDING PROGRAM	PURPOSE
Equity Investment Program		
LIHTC	Low Income Housing Tax Credit	Allows investors in qualified low-income rental housing developments to receive a "tax credit" against their federal income tax liability for a period of 10 years. Equity investors usually become majority limited partners.
Permanent Soft Loans		
RDA	Redevelopment Agency Funds	Permanent soft loan provider. A public body created to designate redevelopment project areas, supervise and coordinate planning of a project area and implement the development program. In all but 14 communities in California, the agency is composed of the governing body of the community (city council or board of supervisors).
AHP	The Affordable Housing Program	Federal grant which provides subsidies to assist financial institutions in supporting the creation and preservation of housing for lower income families and individuals of its members affiliates. Subsidies are awarded to qualified projects submitted by members and selected through funding competitions held by each financial institution.
CDBG	Community Development Block Grant	Under Title I of the Housing and Community Development Act of 1974, communities of over 50,000 people are entitled to receive direct federal funding to encourage more broadly conceived community development projects and expand housing opportunities for low- and moderate-income persons.
Permanent Hard Loans		
CHFA	California Housing Finance Agency	A California state agency which provides below market interest rate financing for the development of affordable single-family (owner-occupied) and multifamily housing.

Table 3: Staff positions and their contributing full time equivalent (FTE) allocations for different facility development life cycle phases in the best case

ACTOR POSITIONS	Feasibility-Entitlements Phase	Building Permit Phase	Construction Phase	Property Management Phase	Development Finance	Asset Management
OWNER						
Executive Director	0.40	0.20	0.20	0.20	0.20	0.20
Project Manager	0.50	0.20	0.20	0.20	0.25	0.15
Services Director				0.10	0.10	
Accounting Department					0.50	
Chief Operating Officer				0.30		
Public Relations Executive				1.00		
Regional Manager				0.30		
Compliance Specialist				1.00		
Property Manager				0.30		
Site Manager				1.00		
A-E CONSULTANTS & BUILDER						
Title Company	1.00					
Env Engineer	1.00					
Surveyor	1.00		1.00			
Architect	1.00	4.00	0.50			
Civil Engineer	0.50	1.00	0.10			
Landscape Architect	0.50	1.00	0.10			
Geotech Engineer	1.00					
Financial Consultant	1.00				1.00	1.00
General Contractor	0.10	1.00	2.00			
Value Engineer	1.00	1.00				
Wood Structural Engineer		0.25	0.10			
Concrete Structural Engineer		0.25	0.10			
MEP Engineer		0.50	0.10			
3rd Party Inspector			0.10			
Geotech Inspector			0.10			
Legal Advisor					0.50	0.15
Auditor					1.00	

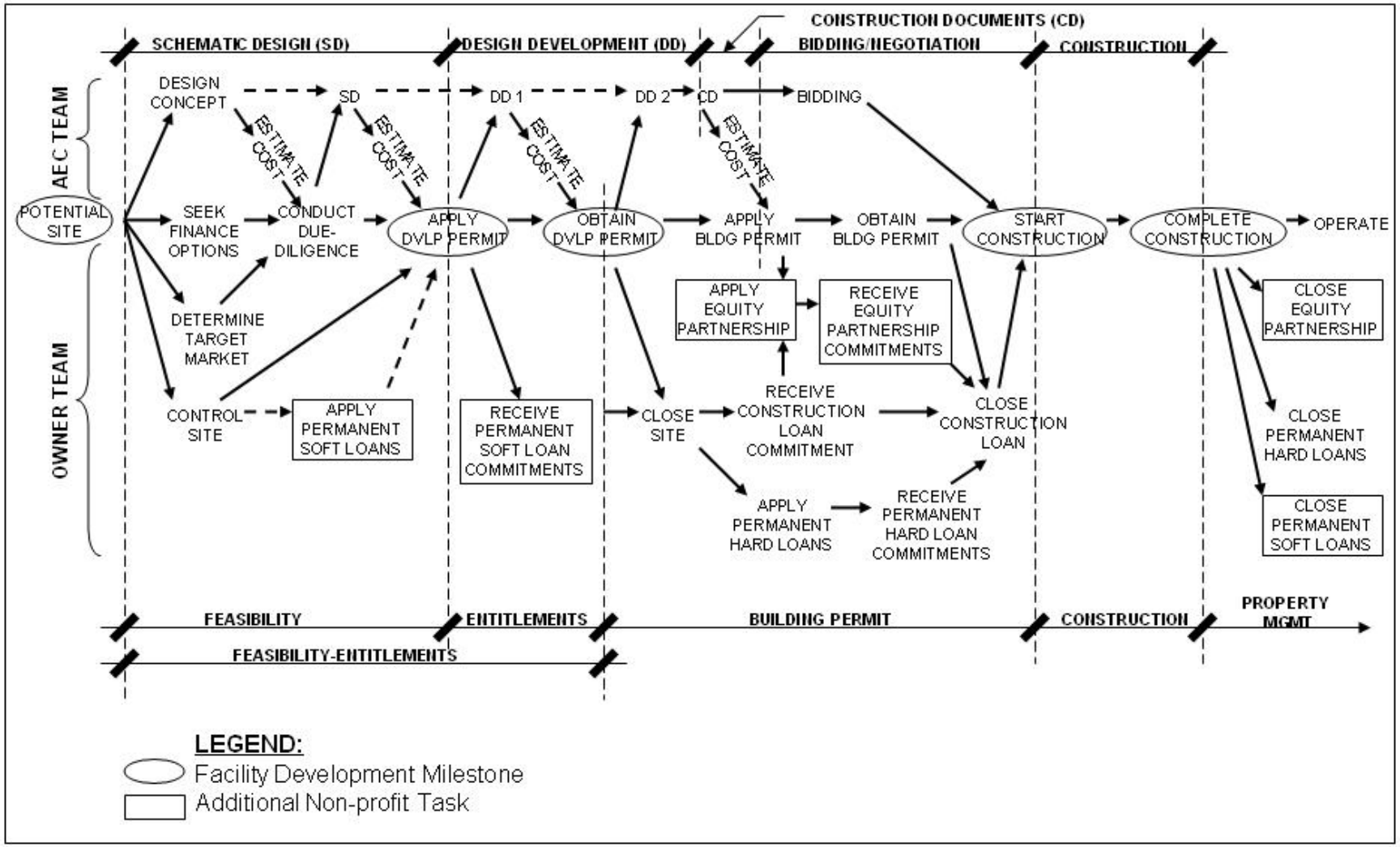

Figure 1: Financing and architectural-engineering-construction interdependencies during a facility development life cycle

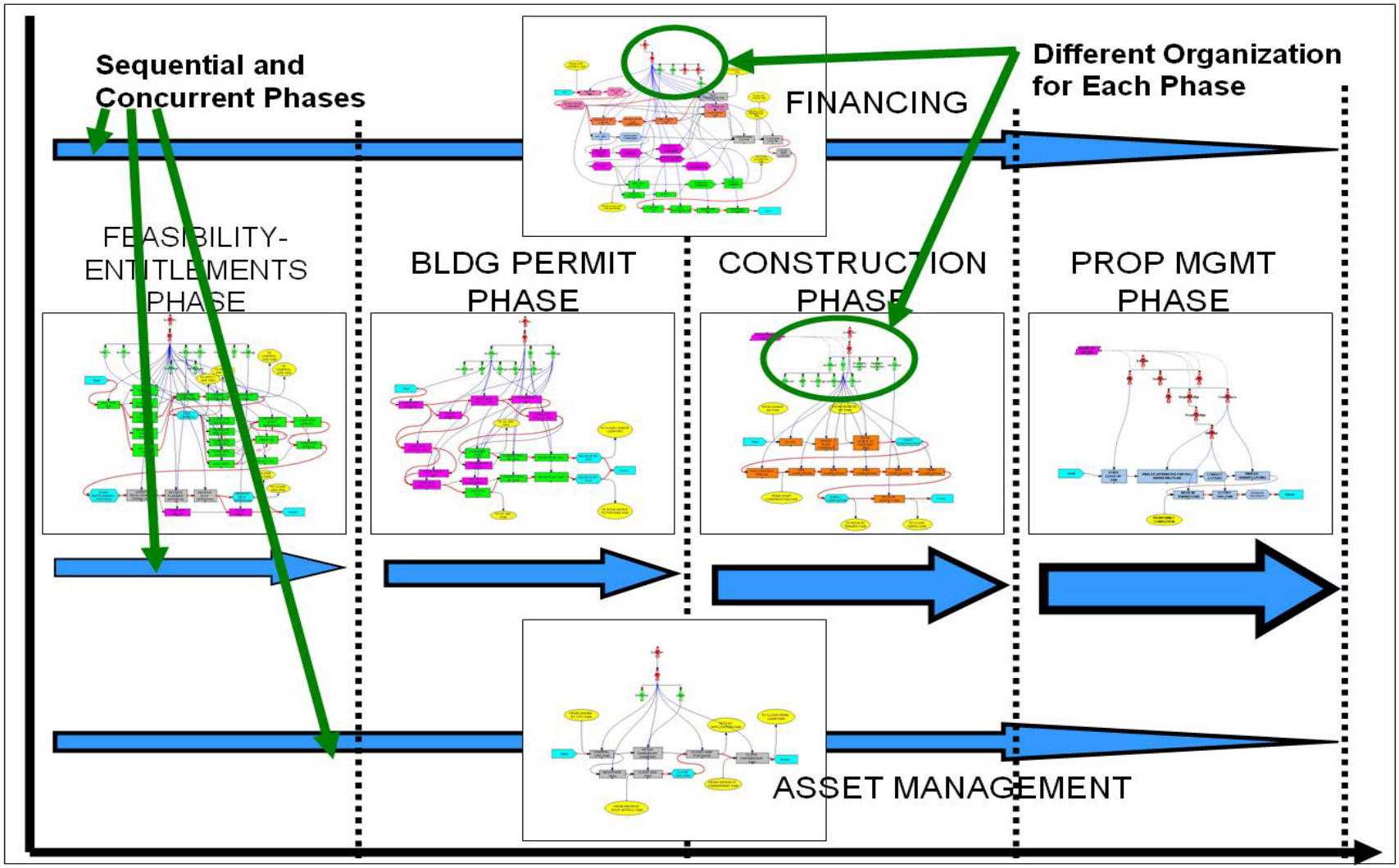

Figure 2: Multiple concurrent and sequential phases in a typical facility development life cycle
With a different organization in each phase