Managing Iterations in the Modular Real Estate Development Process

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Abstract: Real estate development (RED) is a dynamic business with long-duration projects involving multiple parties with both common and sometimes conflicting goals. With large capital budgets in RED projects, time management is a primary factor determining success or failure. In recent years, Modular Construction Methods (MCM) have been successfully used to accelerate the construction of both residential and commercial RED projects. However, MCM requires higher levels of involvement from many parties earlier in the design and engineering stages of the RED process. This paper explores the interdependent relationships among the tasks involved in MCM RED projects. Using Design Structure Matrix (DSM) analysis, we have identified the planned and unplanned iterations in the development process which reflect rework of tasks that inherently require it and feedback loops that occur because of unanticipated problems. In our application of DSM to a typical large residential RED project, we have created both a normative process model and an improved one employing solutions to avoid the unplanned iterations in the original process which would result in costly setbacks. In doing so, we have identified best practices from MCM processes that can help enhance traditional RED processes.

Keywords: Real estate development, construction projects, design iteration, project acceleration, design structure matrix

1 Introduction

Prior research has applied DSM to projects in the real estate and construction industry (Austin et al. 2000; Weskett et al. 2010) and has demonstrated the utility of this approach to the planning of large projects. Bulloch and Sullivan used DSM to explain the cross-functional nature of iterations involved in commercial real estate development (RED) projects (Bulloch and Sullivan 2010). They extended Grasskamp’s four-quadrant spiral model (Geltner et al. 2007) to include a fifth business function, project management, recognizing the critical coordination role the real estate developer plays in the process. They presented a DSM showing the individual tasks of a conventional RED project by phase and denoted the different functions involved in planned iterations within each phase. Figure 1 illustrates the typical phases of both a conventional RED project and of one using Modular Construction Methods (MCM) which we will explore in this paper. The figure also displays the five-function spiral model of RED which represents the primary functions involved in the planned iterations of each project phase.

As with many types of projects, a critical performance metric for RED is development duration. Given the large amount of capital funds involved in real estate projects, time management is of paramount importance to achieve target investment returns and to avoid costly setbacks. We chose to study MCM given the intense focus on time in such projects.
Modular construction methods represent a relatively new way to build real assets and provide key advantages to developers – savings in both time and manufacturing based labor, two of the biggest cost drivers involved in construction. MCM accomplishes its efficiency primarily in three ways: 1) production of modular building sections using factory-based manufacturing processes, 2) performing site preparation (grading, foundations, utilities, etc.) in parallel with the fabrication of the modules, and 3) rapidly completing on-site installation of the factory-built modules.

Reducing the duration of the development process shortens the period when the invested capital is not directly producing revenues and return for investors.

![Functional Spiral Diagram]

Figure 1. Phased development processes for conventional and modular construction real estate projects, wherein the functional spiral represents planned iterations in each phase

We were granted access to a multi-family residential RED project under development in Massachusetts, USA. Our field research involved interviews and site visits with all the key stakeholders of the project. Due to the extraordinary coordination between the parties involved we were able to fully capture the relationships and coordination between the developer, investor, architect, manufacturer, and general contractor. Upon completion of the interviews we mapped the tasks, identified the functional phase(s) each task fell into and in some cases added new phases to the process.

2 DSM Modeling

In this research, we have applied the DSM method to analyze a typical MCM RED project. Our focus is on understanding the iterations that drive development process timing and uncertainty. The DSM provides a method to map out the process including both planned and unplanned iterations. We then specifically focused on the unplanned iterations in order to address the timing impact of such process failures.

We utilized a task-based DSM model to represent the activities and related information flows comprising a project (Eppinger and Browning 2012). We associated each task with one of the five functions: market, design, political, financial, and project management.
Figure 2 shows the normative development process, in seven sequential phases comprising 85 activities. The phases are titled as follows: 1) Idea Inception, 2) Feasibility, 3) Preconstruction, 4a) Factory, 4b) Site Preparation & Module Set, 5) Site Work & Complete Construction Work, 6) Stabilization, and 7) Asset Management and/or Sale.

The planned iterations inside the phases are found in the DSM in the boxed areas on the diagonal and are labelled numerically, 1 to 7. Unplanned iterations across the phases are shown in the shaded regions above the diagonal and are labelled alphabetically, A to F. The color coding of the shaded task names represents the five functions shown in the spiral graphic at the top left corner.
3 Planned Iterations

Below we describe the set of planned iterations within each phase of the process.

**Phase 1. Idea Inception**

This is a stage in which little capital is spent, but extensive iterations occur that involve evaluating land opportunities, understanding the organization’s strategy for pursuing the opportunity, deciding on the rough timeline, and the feasibility of MCM.

**Phase 2. Feasibility**

This stage involves understanding the local zoning regulations and identifying the various players that will be involved to make the process smooth and efficient. Drawings, construction estimates, contractor involvement and an additional financial feasibility study all need to be completed during this stage.
Phase 3. Preconstruction

Real cost estimates, public participation, financing decisions, timelines, and construction documentation are finalized during this phase. This requires extensive iterations due to the various information flows provided by the many parties involved. This stage is critical to achieving the returns projected and realizing the potential of the project.

Phases 4 and 5. Construction

The construction phases include 4a) Factory, 4b) Site Preparation & Module Set, and 5) Site Work & Complete Construction Work. By fast tracking and having the site work completed while the building is being assembled in the factory, months can be shaved off the conventional construction period. Many unforeseen issues can arise during these phases, so the planned feedback loops are critical to ensure success.

Phase 6. Stabilization

This stage deals with all the final items: leasing all available spaces, collecting rents, and property management. The lack of planned iterations is due to the previous completion of the site work and major construction.

Phase 7. Asset Management

This stage involves taking a closer look at the long-term plan. Evaluating the capital markets, arranging long-term financing, and selling the property are all part of this stage. Refinancing the project’s permanent loan provides information for the firm’s organizational strategy. Iterations occur until a final deal has been reached.

4 Unplanned Iterations

Through the DSM analysis, we identified multiple instances where unplanned iterations could cause extensive delays and costly setbacks. Below we describe how the various unplanned iterations can be avoided through careful management of the process.
Part II: Project and process management

Figure 5. Unplanned iterations in (A) Design and (B) Project Definition

A. Determining Modularity through Design

The developer looks to avoid the setbacks related to determining whether the project can be modular. Having an architect and a modular manufacturer involved early in the process can help avoid costly redesigns and start construction earlier. Integration can be achieved most efficiently by assigning a lead person responsible for the project’s design.

B. Project Definition

Feedback to this stage includes estimating, approval, design, and schedule failure modes. Estimating errors can be avoided by having the contractor and manufacturer work with the developer and architect early in the process. The developer can also avoid approval setbacks by familiarizing the public and local jurisdiction with the project. For design and scheduling conflicts, a single point person should be appointed to manage the design definition between the feasibility and preconstruction stages. Adding tasks to evaluate the design strategy helps maintain the parallel nature between phases.

Figure 6. Unplanned iterations causing project delays in (C and F) Preconstruction, (D and E) MEP Integration and Construction Completion

C and F. Preconstruction Delays

The unplanned iterations here relate to the manufacturing and site work activities that in theory need to occur synchronously. During the preconstruction phase the set date (first day modules are set on site) should be determined. This allows the manufacturer and the general contractor to work backwards and determine the proper timelines for beginning site work and starting the manufacturing process. Financing delays can be avoided by utilizing existing relationships and getting the bank involved early in the process.
D and E. Integration and Construction Completion

The unplanned iterations here should be limited, given that there is a strong emphasis on mechanical, electrical, and plumbing integration work being performed satisfactorily during the planned iterations between the factory and the site work. However, project delays could still occur between construction completion and the stabilization stage. Project leasing can be delayed if the building’s tenant improvement requirements and updated market conditions have not been met.

5 Schedule Risk Estimation

In terms of addressing the risk inherent in the MCM RED process, we attempted to quantify the effect that the unplanned iterations would have on the overall return and time frame for the project. We estimated the average delay period and probability of occurrence for these unplanned iterations based on the developer’s experience. We used the following formulas for determining the overall expected impact.

\[
\text{expected rework delay} = \text{likelihood of rework} \times \text{average rework duration}
\]

\[
\text{expected rework cost} = \text{likelihood of rework} \times \text{average rework cost}
\]

For example, we found through interviews that at the Feasibility phase, unplanned iterations would have an average rework time of 63 days, at an approximate total cost of $100,000 and a probability of 30%. We were therefore able to compute an expected impact of 19 days and $30,000 for that stage of the project. Using this approach for each of the unplanned iterations, we estimated the expected impact to this project of $284,000 and 187 days. This emphasizes the importance of managing each unplanned iteration very carefully, as discussed in the section above.

6 Conclusion

By visually representing the process of MCM RED with DSM we were able to document the planned and unplanned iterations. We identified how to solve the unplanned iterations, and in doing so to avoid costly setbacks. We also believe that the improved planning methods shown here for execution of real estate projects using MCM can be applied to conventional (site-built) development.

Our application of the DSM applied to RED has demonstrated a dynamic way to map out the complex relationships between parties that are integral in making a development work. Potential applications of other types of DSM to the real estate industry may also be insightful. For example: Product architecture DSM may reveal critical interfaces across sub-systems in large construction projects. Organization architecture DSM could show hierarchical and lateral relationships and the interactions thereof. Finally, multi-domain DSM models may help with the integration of the various parties and help understand the true nature of the parallel work among them.
References


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