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Complex Systems and the Darnall-Preston Complexity Index

Complexity | Complex Systems

LEARNING OBJECTIVES

1. Describe the characteristics of complex systems.
2. Explain the benefits of using the Darnall-Preston Complexity Index.

COMPLEX SYSTEMS

When is a project complex? The complexity of a system is usually determined by the number of parts or activities, the degree of differentiation between the parts, and the structure of their connections. Heterogeneous and irregularly configured systems are complex, such as organisms, airplanes, and junkyards. Order is the opposite of complex. Ordered systems are homogenous and redundant, like an interstate toll booth or a production line in a factory. Complex systems have multiple interacting components whose collective behavior cannot be simply inferred from the behavior of the individual components.[1]

In addition to the number of parts, the degree of differentiation between parts and the number, type, and strength of relationships between parts also influences the degree of complexity. For example, the transistors in a computer have three connections to other parts of the computer, but each nerve cell in the human brain can be connected to thousands of other cells in the brain, which is why the human brain is more complex than a computer. Complexity is context dependent. A project is more or less complex in relation to the number of activities, the type and strength of relationships to other project activities, and the degree and type of relationships to the project environment.

Projects are complex ***adaptive systems***, which consist of a large number of parts or activities that interact with each other in numerous and various ways. A complex adaptive system is adaptive if the activities adjust or react to the events of the environment. Successful adaptive systems adjust in a way that facilitates or allows the system or project to achieve its purpose.

The dependence of the project on the activities, the interdependence of the activities, and the specialization of the activities underscore the relationship dependence of project activities. This ***relationship dependence*** is a key aspect of complex adaptive systems. The nature of complex adaptive systems can be probed by investigating the impact of change in one activity and the effect on other activities and the behavior of the whole. Activities must be studied and

understood as interrelated, connected parts of the whole. If you remove a computer chip from a computer and the computer powers down, do not assume the purpose of the chip was to provide power to the computer. If you remove or shorten a project kickoff activity, do not assume the project will finish earlier because of the dependence of later project activities on project kickoff activities. Any change to the kickoff activities will impact other activities and the project as a whole.

Common Core Curriculum

In 2009, the Council of Chief State and School Officers and the National Governors Association undertook the project of developing K-12 curricular standards that would be common across the adopting states. The project proved to have a level of complexity not traditionally seen in state curriculum development. The project catered to diverse stakeholders, including state legislatures, state departments of education, teachers, administrators, parents, colleges/universities, and businesses. The project included the creation of different committees who advised on steps in the process, requiring consensus across multiple states in different time zones with different educational values. The project complexity profile reflected the relationship dependence of project activities as well as the large number of interacting parts and stakeholders in the project.

Complex adaptive systems have three characteristics that are also reflected in complex projects.

Complex Adaptive Systems Tend to Self-Organize

Formal organizational charts indicate reporting relationships but are not very effective at displaying project relationships. Projects organize around the work, phases, or activities. The organization of the project reacts to the nature of the work at any given phase. During the start-up meeting of a large complex project, the project manager facilitated the development of the project organization chart that included all the major partners, client leaders and key team members. After the chart was complete, the project manager ripped the chart up in front of the entire project team to demonstrate his key message, which was that there are formal reporting relationships, but the real leadership and communication will change during the life of the project. In other words, the system will adapt to meet the needs of the project at each phase.

Informally, the project team reorganizes information flows and priorities to support the current work of the project and a good project manager facilitates this adaptive behavior of the project organization by minimizing the impact of formal authority and processes.

Complex Systems Adapt to Changing Environments

A ***deterministic system*** is a system that will produce the same results if you start with the same conditions. The outcome can be reliably predicted if you know the starting conditions. For example, if you fire a rifle several times at a target, the hits on the target will be closely grouped if all the initial conditions are almost identical. A ***nonlinear system***, or ***chaotic system***, can produce wildly different results even if the starting conditions are almost exactly the same. If today's weather pattern is almost exactly the same as it was on a previous date, the weather a week later could be entirely different. Projects are usually nonlinear systems. If we execute an identical complex project three different times, we would deliver three different outcomes. We start with the assumption that the project is deterministic and use scenarios and simulations to develop the most likely outcome, yet a small change such as the timing of someone's vacation or a small change in the delivery date of equipment can change the entire trajectory of a project.

Changing Environments

A design company was hired to create training for employees of the client's new enterprise. The company managers felt that the outcome would be fairly predictable and assigned the management of the project to one of their lead designers. Two weeks into the project start-up, the company president realized the project needed a manager with more expertise and assigned a new person to manage the project. Then the client informed the company that they had changed the location for their new offices from Seattle to Houston. Since they had initially wanted the training to have location-specific nuances, the project needed to be reworked. During the second month of the project, the client encountered a legal suit which necessitated that the project be placed on hold. This project environment was unstable and the project plan and organization adjusted and evolved to respond to each of these changes.

All projects experience some forms of environment shift during the life of the project. This is one of the reasons project managers develop an aggressive ***change management process***. The purpose of the change management process is not to stop change but to incorporate the change into the project planning and execution processes. Projects, like all other complex adaptive systems, must respond to the evolving environment to succeed. Plan as if the project is deterministic but be prepared for unpredictable changes.

Complex Systems Coevolve with Internal and External Changes

In addition to responding to changes in the project environment, the internal project organization and environment is in a constant state of change. New people become members of the team, people quit, retire, and get sick. The office roof starts leaking, headquarters rolls out a new computer program required for all workers, or the project's lead designer cannot get her immigration visa extended. These are real examples of events that occurred on one project, and the project team adjusted to each event. The adaptation to changes in the project's internal situation while also adapting to the external environment reflects the coevolving nature of a complex adaptive system. An increase in the number of events within the project and the project environment that are likely to change during the life of the project is reflected in an increase in the complexity of a project.

DARNALL-PRESTON COMPLEXITY INDEX

Projects are more likely to fail in the beginning, not in the end. This generalized statement reflects the importance of understanding the environment in which a project will be executed and the importance of developing an execution plan that can be successfully implemented within this environment. Profiling a project correctly requires a system that is relatively easy to use but that includes enough attributes to capture all the most important characteristics of a complex project. ***The Darnall-Preston Complexity Index (DPCI™)*** is one model for understanding and profiling projects (and will be explained further through the rest of this chapter). This index assesses the complexity level of key components of a project and produces a unique project profile. The profile indicates the project complexity level, which provides a benchmark for comparing projects and provides information about the characteristics of a project that can then be addressed in the project execution plan. It achieves this objective by grouping eleven attributes into four broad categories: internal, external, technological complexity, and environmental.

The DPCI provides project stakeholders with information about the project to define the experience, knowledge, skills, and abilities needed by the project manager. The DPCI also has implications for the composition, organization, and skills needed by the project leadership team. The DPCI provides information and a context for developing the project execution plan and for assessing the probability of success.

Recovery costs can be extremely high for projects where the environment is misread or the execution plan does not address critical issues of the project environment. In addition to cost overruns and delays in the project, execution plans

that are not aligned with the project environment can create barriers that make recovery difficult, and in some cases, the business purpose of the project cannot be met. The DPCI is a tool to assist project stakeholders in developing a comprehensive analysis of the project environment and a project execution plan more aligned with that environment, both of which increase the likelihood of project success.

The foundation of a sound project execution plan is an assessment of the project environment. This assessment provides the information on which the execution plan is built. In the absence of an accurate assessment of the project environment, the project leadership makes assumptions and develops the execution plan around those assumptions. The quantity and quality of those assumptions will significantly influence the effectiveness of the project execution plan. The amount of information available to the project manager will increase over time and assumptions will be replaced with better information and better estimates. As better tools are developed for evaluating the project environment, better information will become available to the project manager.

The project environment includes all the conditions that can influence the outcome or success of the project, such as the project size, technological complexity, cultural and language barriers, the political landscape, and resource constraints. Understanding these influences and developing a project profile creates a foundation for building an effective project execution plan.

KEY TAKEAWAYS

- Complex systems have many different parts that interact with each other in different and often unpredictable ways. They adapt to changes in their external and internal environments.
- The Darnall-Preston Complexity Index (DPCI) assesses project attributes, enabling better-informed decisions in creating the project profile.

[1] Stephen Jay Gould, Full House: The Spread of Excellence from Plato to Darwin (New York: Three Rivers Press, 1996).