An Assessment Framework for Discovering and Using Patterns in Virtual Project Management

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Abstract

Virtual project management in global organizations is both challenging and important. Being able to identify and apply best practices is an essential skill, as is an understanding of how to leverage the right technology for communication and information sharing. Based on a typology of virtual projects, and using the theoretical frame of patterns, we propose an integrative way of identifying and applying best practices for the management of virtual projects. We present an assessment approach that allows managers to determine the nature of their virtual projects and discover and apply patterns for managing them.

1. Introduction

Projects are inherently collaborative activities and the management of projects includes the design of appropriate collaboration processes. Virtual projects in particular are especially interesting and challenging from a collaboration perspective. Project managers, like people in general, are naturally inclined to carry their assumptions about traditional environments to virtual environments. Existing perspectives, current skills, and comfort levels with well-known tools can keep virtual project managers from adapting rapidly to the needs of new environments. The integration of technology with project management practices and tasks is essential, especially in virtual projects. We assert that the effective combination of perspective, skills, and technology can be done in a seamless way through a blueprint or pattern. We use the theoretical frame of patterns to propose that effective patterns of virtual projects can be identified and applied in order to enhance management in this new environment.

The purpose of this paper is two-fold: (1) to propose a pragmatic assessment framework for classifying virtual projects; and (2) to illustrate how virtual project managers can use this assessment framework to identify, describe, and use patterns for effective virtual project management. Section 2 provides the conceptual foundation for the framework, by defining the key concepts that form the foundation for developing a virtual project typology and pattern framework. Section 3 develops the assessment instruments to be used for measuring the aspects of virtual projects that identify where they fall in the typology, as well as measures to inventory collaboration technology. Section 4 shows how virtual project managers can identify, describe and utilize patterns of effective management of virtual projects. Section 5 concludes with a discussion of key challenges and issues for research and practice.

2. Conceptual Framework

The assessment framework is based on a set of concepts that comprise the detailed characteristics of virtual projects, virtuality, and technology. Each of these is defined in turn, to provide a clear foundation for assessment. These detailed definitions and the typology itself were developed in an in-depth study of virtual projects using pattern theory [14]. We do not repeat all the detail here, because our focus in this paper is on the framework, or method, by which patterns can be identified. However, the definitions are an important foundation for the pattern framework and therefore are provided here in sufficient detail to establish the foundation for the assessment framework that is the focus of the current paper. Readers are referred to [14] for more in-depth justification of the development of each of the concepts.

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Figure 1 summarizes the concepts and provides a preview of the different elements of the framework.

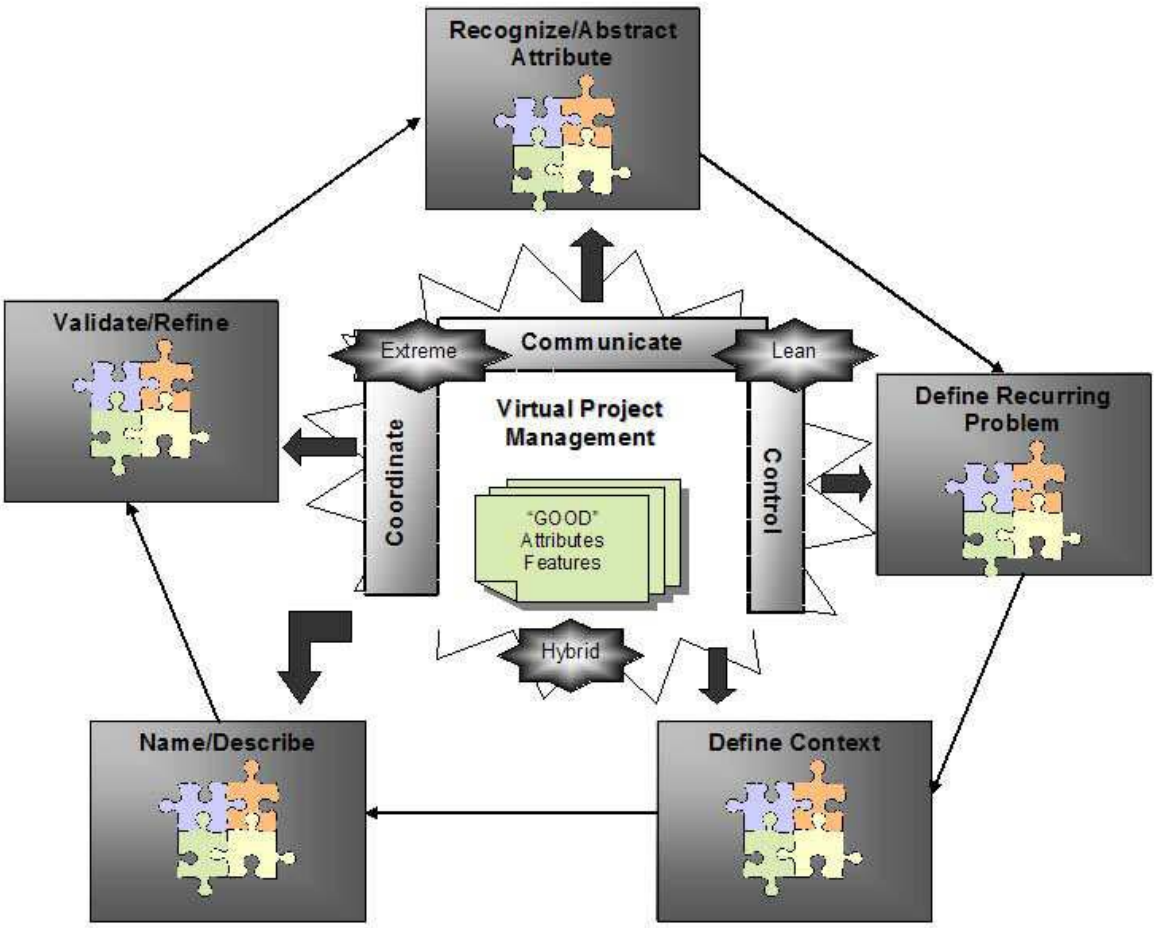

Figure 1: Assessment Framework for Virtual Project Management

2.1 Key Concepts

A *virtual project* can be defined as an alliance of dispersed people who are working together to accomplish a specific task or opportunity under time and resource constraints [19, 23, 27]. We describe virtual projects in terms of three key elements – virtuality, technology, and project characteristics [14]. Virtuality is the extent to which project members are dispersed on one or more dimensions and rely on information and communication technologies for carrying out project goals. Dispersion includes but is not limited to geography, time, and organizational affiliation. Reliance on technologies is also recognized as a fundamental component of virtuality. This definition is consistent with recent reviews of virtual teams and the virtuality concept [7, 20, 21].

Based on extant literature [e.g., 4, 8, 11, 21, 23] and project management standards from professional associations, we have identified three fundamental descriptive dimensions of projects: (1) complexity, (2) scope, and (3) risk. Project complexity reflects project characteristics that have to be managed for successful completion of a project, i.e., team size, culture, language, gender composition, personal characteristics, resources, innovation, and knowledge. Project scope means the boundaries of a project, namely project duration, final product scope, and project multiplicity [22]. Project risk encompasses threats or opportunities that may adversely or positively affect successful completion of a project.

Technology for virtual projects is defined as consisting of an integrated and flexible set of tools for structuring process, supporting task analysis and

performance, and communicating among project members. This definition incorporates our belief that in the context of virtual projects, process structure, task support, and communication support are three critical dimensions of technology [18, 26].

In addition to identifying the nature of projects and the technology that supports them, we also need to define the elements of management of virtual projects. We identify the following three elements: (1) coordination, (2) communication, and (3) control. We argue that these elements need particular attention in virtual projects because of the reliance on technology, which defines the environment through which coordination, communication, and control occur [14].

Communication can be defined as the process by which people convey meaning to one another via some medium through which they exchange messages and information in order to carry out project activities [14]. *Coordination* is defined as the mechanisms through which people and technological resources are combined to carry out specified activities in order to accomplish stated goals [5, 12]. *Control* is defined as the process of monitoring and measuring project activities so as to anticipate and manage variances from project plans and organizational goals [13, 15, 22].

2.2 Typology for Virtual Projects

A typology is a theory-building exercise [6] that should focus on the essential characteristics of a phenomenon that make a difference. We use each of the three dimensions of project characteristics plus the virtuality dimension to propose a parsimonious typology of virtual projects. Three projects types are defined: Lean, Extreme, and Hybrid [14].

2.1.1 Lean projects. Lean projects have low complexity, narrow scope, and relatively low risk. They tend to be easily subdivided into manageable parts because they have relatively clear and tangible requirements or outcomes. An example of a lean project is an in-house software development project that has multiple segments, is located within one organization though across multiple locations, has clarity of goals and resource allocation, and includes relatively established teams.

Lean projects typically have experienced and relatively small teams with established rapport and homogeneous characteristics among members. Lean projects address relatively structured problems and are initiated using well-established processes and repeatable practices.

2.1.2 Extreme projects. Extreme projects have high complexity, broad scope, and high risk. Extreme projects are generally mission critical and highly visible. They require intense activity and participation by a number of teams and stakeholders. An example of an extreme project is the implementation of a global supply chain application by a multinational company. Such a project entails multiple internal and external units, varied cultural orientations, conflicting goals and personalities, and a high degree of heterogeneity and dispersion in all aspects of the project.

2.1.3 Hybrid projects. Hybrid projects have varying levels of the three dimensions of complexity, scope, and risk. An example of a hybrid project is the significant enhancement of a customer relationship management application that will be used by internal employees and call center partners. Such a project would be characterized by a systematic approach to development, side-by-side with the global heterogeneity of outside partnerships.

2.3 Applying Pattern Theory

To this point, we have provided definitions of virtual projects, the technology that supports them, and the key elements that make up the project typology, which is the foundation for management of virtual projects. Now, we show how pattern theory can be used to bring these ideas together for identifying and using best practices. Patterns are an intuitive way to understand the complexity of the world around us. Alexander first developed the concept of patterns in architecture as a way to define repeatable solutions for achieving quality [1, 2, 3]. The pattern concept has subsequently been applied in many areas, including object-oriented design [10], groupware design [17], and the design of facilitation techniques in groups [16].

Alexander defines a *pattern* as a three-part rule that expresses a relationship among a specific context, a problem, and a solution. The problem is a set of forces that occurs repeatedly in that context. The solution is a certain “spatial configuration” that allows the forces to resolve themselves. The pattern itself describes how the solution can be used whenever the problem occurs in that particular context. A collection of patterns represents a pattern language, defined as a system of patterns that combines to produce a variety of important outcomes [1, 2, 3].

We have found that patterns of virtual projects can be identified and effective patterns can be distinguished from ineffective ones [14]. We argue that a potential *design pattern for virtual project management* includes a description of processes, best practices, factors, tools and/or techniques that impinge upon coordination, communication, and control. Each such pattern is specific to the type of project (lean, hybrid, extreme) and is described in terms of: (1) the pattern's *name*—a descriptive word or phrase that captures its essence; (2) the *context*—a description of the situation to which the pattern applies; (3) the *problem*—a question that captures the essence of the problem that the pattern addresses; (4) the *solution*—a prescription for dealing with the problem; and (5) an optional *discussion*—any additional information that might be useful in applying the pattern. The next section describes the specific measures to be used for identifying project characteristics, from which point patterns can then be identified.

3. Project Assessment

The concept of organizational assessment is well established in the literature of organization management. Van de Ven and Ferry's [24] well-known program of research included the development of a comprehensive set of assessment instruments for a broad set of organizational attributes. The assessment measures ranged across such factors as demographics, structure, nature of work, personnel composition, decision making, norms and standards, and performance outcomes. The programmatic approach allowed tracking of organizations over time, to determine what factors contribute to success in a comprehensive way.

Our project assessment framework has an analogous approach albeit on a far more modest scale. We have developed a set of assessment instruments that allow a project manager to identify the nature of a virtual project across the set of dimensions that were defined in Section 2: project complexity, project scope, project risk, and virtuality.

The results of the project assessment can be displayed as a dashboard that displays a set of indicators. Each dimension of the project has a setting on the dashboard and the indicators as a whole reflect the type of project, which in turn has implications for how the project should be managed. The next sections show the detailed items for measuring each dimension. Other typologies of project characteristics may suggest a slightly different arrangement of items, but given that there is no single, dominant view on how these concepts are defined, our intent is to present a workable set of measures that reflects prevailing views from the literature. The specific details of these measures were developed in [14], and the end result of that analysis is presented here in order to show how each dimension would be measured.

3.1 Project characteristics

Based on the definitions provided in section 2.1, project characteristics are assessed on three dimensions: complexity, scope, and risk. Table 1 shows the specific items that are used to measure each of these dimensions. In each case, in addition to the specific measures, we include an "overall" measure for the concept, as a consistency check with the specific items.

Table 1: Measures for project characteristics

Characteristic	Measures
Project complexity	Size of project team Cultural diversity of team Language differences within team Proficiency with technology Historical knowledge of activities Resource availability at project sites Personality diversity of team Level of innovation Overall complexity of project
Project scope	Length of schedule Overall scope
Project risk	Programmatic risk of project Technical and engineering risk Quality risk Logistical risk Deployment risk Overall risk of project

3.2 Degree of Virtuality

Virtuality is assessed via four items, as shown in Table 2. The measure is kept deliberately simple to focus on the essential features of virtuality as defined earlier. Other differences, such as culture, are not virtuality-related but are a component of the overall complexity of the project.

Table 2: Measures for extent of virtuality

Characteristic	Measures
Virtuality	Time differences of members Geographical dispersion Number of organizations Reliance on information & communication technologies

3.3 Technology inventory

Technology for virtual teams and projects comes in many forms. Understanding technology capabilities and resources is essential for an organization to be able to conduct effective virtual projects. We present a classification of types of communication and information technologies that will allow an organization to inventory their technology capabilities.

Table 3 shows a classification of collaboration technologies in terms of how well they support communication, process structure, and information sharing. These three elements have been shown to be consistently important features of collaboration technologies [9, 26]. Communication represents any aspect of the technology that makes it possible for project members to communicate with one another, e.g., messaging. Process structure is support for the process by which groups interact, including the use of agendas, facilitation techniques, role assignment, or project phase definition and enforcement. The information feature is the capability to gather and evaluate information, for example, via categorization, rating, voting, analytical techniques such as multi-criteria decision making, or project.

Each technology was scored by the authors on the extent to which it supported the detailed definition of each of the elements of communication, process structure, and information. The scores range from a low of 1 to a high of 5. A score of 1 means that the specific technology has low or no support for that feature, a score of 3 indicates medium support, and a score of 5 indicates high support for that feature. For example, email remains one of the most widely-used collaboration technologies. It provides high support for communication because it allows people to send messages any time, in any form, for any purpose, to any location. Communication is the essence of the functionality of email. However, email has no support for process structure because there are no built-in methods for structuring the process. Information support is rated as medium because it is easy to gather and share information within email, for example, via exchanging attachments of reports or data, but there are no built-in mechanisms for evaluating that information.

A project manager can assess the team's capabilities for the three dimensions of communication, process structure, and information by inventorying the technology available and summing the scores on each dimension.

Table 3. Collaboration technology support

Technology	Extent of Support for:		
	Commu-nication	Process Structure	Infor-mation
Video conference	5	1	3
Phone conference	5	1	3
Fax	1	1	3
Email	5	1	3
Voice mail	5	1	3
Telephone	5	1	3
Intranet	3	3	5
Electronic meeting system	5	5	5
Instant messaging	5	1	3
Document editing	3	1	3
Shared whiteboard	3	1	3
Group calendaring	3	3	3
Distributed project management	3	5	5
Workflow	3	3	3

3.4 Classifying the project

Table 4 shows the measures for project type as well as project success. Project type is calculated based on the means of complexity, scope, and risk. We use a 5-point scale, ranging from a low of 1 to a high of 5. In general, projects whose overall mean is 4 or higher can be considered extreme projects, while those with an overall mean of less than 3 can be considered lean projects. Hybrid projects have a mean between 3 and 4 on the 5-point scale. Table 4 also shows measures for project success, to allow managers to relate success to project types and other measures within the framework. Success is measured on the same 5-point scale, thus allowing for the perception of degree of success, rather than a binary assessment.

Table 4. Measures for project success

Concept	Measures
Project type	Mean of complexity, scope, and risk.
Project success	Completed on schedule Completed within budget Met goals and specified requirements Perceived as successful overall

4. Identifying and Writing Patterns

Each of the measures described in the previous section provides a view of the virtual project and its characteristics. This section discusses a process for identifying patterns for effective management of projects, in light of the different types of projects identified by the measures just described, and using Alexander's approach and philosophy as described earlier [1, 3] .

4.1 Preconditions for identifying patterns

In order for project managers to be able to extract patterns for effective virtual project management and then communicate and continue to evolve them, they must have the following conditions in place:

- A common vocabulary and conceptual understanding of the guiding principles that govern the development of patterns.
- A simple, natural language interface that allows "master" and novice managers alike to contribute patterns without difficulty. Patterns should be easy to read and complete, since clarity comes not only from the language but also by focused abstraction of experiences. Clarity also makes patterns easier to share and communicate with others.
- A central repository of patterns to share knowledge and templates within the organization.
- A master/apprentice model very much like the editor and associate editor model in journals, where any virtual project team members can potentially identify and write a pattern but there is a validation process by a "master" manager who has more substantial experience in the field. People who have been successful at managing virtual projects have the expertise to mentor and teach novices in project management. According to Alexander, a person learns by helping someone who has mastery of the task.

The above items enumerate the bare minimum prerequisites that must be in place to accomplish the goal of developing a library of usable patterns. Once these conditions are in place, the manager can begin to extract and write patterns.

4.2 Method for extracting and writing patterns

Patterns reflect the essential meaning of actual experience that can be abstracted and applied in other contexts. Alexander suggests that if the *essential qualities* of what we do well can be captured, we can then apply them to do the same thing in other contexts and applications [3]. These "good qualities" can only be captured according to Alexander [3] by observation, experience, examples (both positive and negative ones) and at times by abstract argumentation [p. 255-259]. His notion is that in this way we can "… discover some property which is common to all the ones which feel good, and missing from all the ones which don't feel good" [p. 255]. This argument justifies starting with features of virtual projects, rather than starting with problem identification. Although problem identification is the typical first step in most problem-solving approaches, including classic systems development methods, the "Alexander approach" provides a distinctly different point of view.

Thus, in the spirit of Alexander's perspective, we recommend a five step approach to discovering, extracting, and writing patterns for virtual project management. Table 5 summarizes the steps, each of which is discussed in greater detail below.

Table 5. Steps for discovering patterns

Step	
1	Recognize and abstract an attribute/feature of virtual project management that affects communication, coordination, or control
2	Define the recurring problem that the feature solves
3	Define the context in which the feature is appropriate
4	Name and describe the pattern
5	Continue to validate and refine the pattern

The first step for discovering a pattern is to recognize and abstract an attribute or feature of virtual

project management that impinges on the effective coordination, communication, or control of the project. The feature might be a process, a best practice, a set of factors, tools and/or techniques, technologies, or some combination of these elements. Alexander and others refer to the notion of examining and visualizing an aspect that just feels right instinctively. For example, we have found that successful virtual teams are able to effectively manage virtuality and overcome distance barriers by eliminating them during activities that require intensive interaction and coordination. A classic example of such a strategy is temporarily collocating team members during project initiation [14].

The second step is to define the problem that this specific feature solves. In our example, the problem to be solved is not being able to handle time zone and geographic differences and effectively engage all team members in a virtual project.

The third step is to define the contexts in which this feature is appropriate. In our example, virtual teams have difficulty with time zone differences at both the national and global levels. This problem is exacerbated during crunch time or crisis situations when communication is not prompt, delaying the problem resolution process.

The fourth step is to name and describe the pattern, so it can be explained to, and shared with, others. Include evidence and other discussion as applicable in the description of the pattern. Table 6 shows a complete example of a pattern for "Manage Virtuality."

The fifth step is to continue to validate, refine, reevaluate, coalesce, abstract, and improve identified patterns as further intellectual analysis is brought to bear. Clearly, *prima facie* validation for a given pattern, particularly in terms of its soundness, plausibility, veridicality, and pragmatism, is achieved by the very fact that it is derived from what we know has worked with regard to control, communication and coordination in virtual project management. However, it is very reasonable to accept that the further validation of patterns such as "Manage Virtuality" is an ongoing process; as the pattern is applied in a new context, the abstracted description of the pattern will either reinforce its veridicality or result in revisions. Furthermore, identified patterns will necessarily be neither exhaustive nor in their final form.

It is important to note that a pattern is not a prescription, although a pattern could be used to create a prescription in a specific context. Patterns are generic and more akin to the idea of universal laws than to specific prescriptions. Consequently, all patterns will be related to other patterns and this web of relationships will need to be identified and documented as the patterns become solidified and stable. The greater this web of relationships with other patterns, the more likely the pattern will prove to be effective in terms of its representation of the features or practices or experiences imputed within its description.

Table 6: Example of a complete pattern for virtual project management; adapted from [14]

Manage Virtuality
Context The project team is having difficulty with time zone differences at both the national and global levels, especially during crisis situations when communication is not prompt and the problem resolution process is delayed.
Problem How do you overcome time zone and geographic differences and effectively engage all team members?
Solution Overcome distance barriers due to time zone and geography by eliminating them during activities requiring intensive interaction and coordination, such as project initiation, by temporarily collocating team members. Require periodic site visits and travel by team members to different sites. Designate team member liaisons as focal points of coordination. Have them spend some time in the home office location, to become acculturated and informed about technical issues. Liaisons can then transfer knowledge to local sites for day-to-day coordination. Assign team members in one geographic region (e.g., North and South America) to tasks requiring telephone or video-based interactions because they share time zones and thus can more easily schedule conferences.
Discussion Collocating team members for face-to-face interactions can also help them establish ground rules and common understanding that facilitate communication and coordination when team members return home. Collocation also allows team members to build a social network. It stimulates the development of team identity, cohesion, and commitment that can be potentially sustained once team members are again dispersed. Overcoming time zone differences is critical not just for global teams. Wherever there are multiple time zones, whether within the same country or different countries, virtuality must be explicitly managed.

4.3 Approach to identifying patterns

The most difficult aspect of the method illustrated in the previous section is the specific mechanism of

eliciting patterns within an organization (step 1). We recommend the use of a systematic internal assessment of practices via a variety of approaches, including focus groups, interviews, evaluation of documents, and questionnaires. Ultimately, the development of patterns is an organic activity that is driven by engaged employees and a culture that emphasizes such a free-form approach. The identification of patterns is specific to the organization and its culture, but there is no reason to believe that the identified patterns could not be generalizable to other organizations.

Our suggested method is a means to jump start the process of pattern identification within organizations. Initially, these techniques can be specifically used with "master" managers who have the expertise and experience that can inform the development of well known patterns within the organization. Table 7 provides examples of potential brainstorming questions that could be used to identify and examine attributes or facets of virtual projects that "feel like" potential patterns. The examples are from a virtual focus group that was conducted using collaboration technology [14].

Table 7. Extracting patterns via brainstorming

Brainstorming questions
What specific management and team member practices contributed to the effectiveness of your project? Think broadly to include individual behaviors, processes, technologies, and tools. For example, a team member practice might be to hold regular online meetings to monitor progress of the project.
What specific management and team member practices contributed to the ineffectiveness of your project? Think broadly to include individual behaviors, processes, technologies, and tools. For example, a team member practice that was ineffective might be to keep important information private rather than sharing with the group.

Brainstorming ideas from focus groups can be used to develop a set of patterns for each type of project identified using the typology assessment described earlier. The brainstorming responses can be coded for themes. The reason for starting pattern identification by project type is that this reduces the initial complexity of the process. Ultimately, it may be that a pattern applies to more than one type of project.

Table 8 shows one example of a coding scheme with specific examples from our research. The first column shows examples of complete ideas from brainstorming data. The second column shows the identified theme(s) of each idea. The third column shows any technologies that were mentioned, and the final column indicates whether the technology was perceived to have a positive (+) or a negative (-) effect on the project. This type of coding supports the identification of patterns via the brainstorming approach just described. Each brainstorming idea is identified as to its central theme, i.e., communication, coordination, or control. The ideas are then examined by theme and by technology, and clustered into potential patterns that address each of the themes.

Table 8. Coding scheme with examples

Text of Idea	Theme	Technology (if applicable)	+/-
Utilized the phone for discussion and error diagnosis and/or resolution	Communi-cation	Telephone	+
Good error logging capabilities of tools	Coordi-nation	Distributed PM tools	+
Daily checkpoint meetings amongst the developers and the architecture folks were crucial and added a lot value	Control		

4.4 Applying patterns

In order to apply the patterns that are developed by the steps recommended above, project managers can follow either a deductive or inductive process. A deductive approach would start with identifying the type of project (using the measures that were detailed in Section 3), then searching the patterns for that project type, and applying the prescribed solution for each relevant problem. An inductive approach would start with a search of the pattern library, looking for any patterns that apply. If the problems fall primarily into one project type, then the managers can reasonably infer that this is the type of project.

For example, a project manager may be in charge of a systems integration project in the banking sector that is being executed in three countries at the same time. Developers, systems integrators, and consultants may be working at multiple locations. Based on our project typology, this project would be classified as an extreme project. It is highly complex, large in scope,

has high risk, and is highly virtual. The project would need a variety of collaborative technologies for supporting tasks and communication. Having determined the project type, the manager could search the pattern library or repository to see which patterns would be relevant to this type of project. The manager could use those patterns to develop a project-specific implementation of the recommended practices. The example of the "Manage Virtuality" pattern that is provided in Table 6 would certainly be relevant to such a project.

We have just described a deductive approach in this hypothetical example. The inductive approach would be to explore the pattern library first, looking specifically at the context information for each pattern and seeking to match contexts in the patterns with the existing context of the situation. This inductive process would suggest the type of project, based on which patterns match the context the best. Note that an inductive approach can also be used as a training tool for project managers and members.

5. Implications and Conclusions

One contribution of this paper is to provide a conceptual foundation and structure for identifying patterns for the effective management of virtual project management. We have proposed a pragmatic assessment framework for classifying virtual projects and illustrated how virtual project managers can use this assessment framework to identify, describe, and use patterns for effective virtual project management. Pattern theory allows us to develop a higher-level understanding of what is effective and hopefully, what is not. Some authors have called the latter an anti-pattern, lessons learned, or pitfalls [25]. To paraphrase Alexander [1, 2, 3], patterns are descriptions of the *essential qualities* of things that we believe to be "good." These patterns can be used to build something completely different but which somehow embodies these qualities. Thus, patterns are sometimes profound and sometimes not so profound, sometimes at a high level of abstraction and sometimes at lower levels of abstraction.

We have taken the initial step of developing an approach for extracting patterns in the domain of virtual project management. The process and patterns identified may also be useful for traditional projects, but we leave that as an effort for future research. The validation step is also an important next step for research. A potential approach for validation would be to compare the pattern approach to other approaches, such as thinkLets in collaborative facilitation [16] or best practices. But at this point, we are not making a case for this approach being better than others. Instead we are showing how Alexander's pattern theory can actually be applied in this domain – as a useful method for enhancing virtual project management but not as a prescriptive set of steps.

Consistent with Alexander's ideas, patterns should help to create new processes and help organizations to continue to change and adapt. Patterns as a set represent an abstraction of something important – they provide a language for communication and action, and they embody a value set. We believe that it is these aspects of patterns that provide a higher level of understanding and the potential for organizational learning of practices that work and those that do not work.

Finally, despite all the challenges, we believe that pattern theory can be systematically applied to this domain and that effective patterns can be identified. Patterns can serve as a useful mechanism for communicating about effective virtual project management practices within and between organizations. The assessment framework presented in this paper is a first step toward using pattern theory in the actual practice of project management. The framework also provides fertile ground for future research in terms of validation and extension.

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