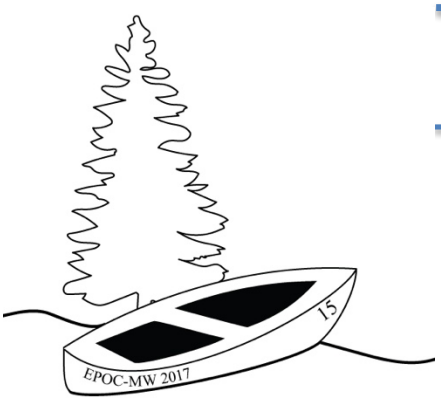

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Conceptualizing IPD Governance as a Common-Pool Resource Scenario

Daniel Hall, Stanford University, USA

Proceedings Editors
Ashwin Mahalingam, IIT Madras, Tripp Shealy, Virginia Tech, and Nuno Gil, University of Manchester

CONCEPTUALIZING IPD GOVERNANCE AS A COMMON-POOL RESOURCE SCENARIO

Daniel M. Hall[1]

ABSTRACT

The governance of Integrated Project Delivery (IPD) is often described using the language of 'risk pools' or 'common-pools,' yet very little work has been done to link IPD governance with economic, institutional and organizational theories of Common-Pool Resource (CPR) governance. This paper acts as a starting point to connect the two bodies of literature. First, the paper reviews the relevant literature from CPR scenario literature and recent project organization scholarship on pluralistic settings, finding several indicators that IPD scholarship would benefit from such a theoretical connection. The paper proceeds by formulating early propositions about the connections between the two using Elinor Ostrom's eight design principles for long-enduring governance structures of CPR scenarios. The paper concludes with a brief discussion of future research directions for scholars who attempt to conceptualize IPD governance as a CPR scenario.

KEYWORDS

Common-Pool Resources, Integrated Project Delivery, Collective Action, Institutions

INTRODUCTION

Integrated Project Delivery (IPD) is an emerging model for the delivery of North American construction projects. IPD uses a multi-party contract where multiple, independent design and construction firms collectively share financial risk and reward among themselves and with the project sponsor (Fischer et al. 2017; Thomsen et al. 2009). The project resources – namely the project budget and the project schedule - are available for use by all signatory parties. In this way, IPD project resources do not closely resemble the standard models of a market or a hierarchy (Ostrom 2010). This paper suggests that the characteristics of IPD resources might instead align with the prevailing definition of common pool resources (CPRs). In fact, early constructors and researchers of the IPD model consistently describe project resources using the language of "pools," whether it is common pool (Thomsen et al. 2009), contingency pool (Darrington and Lichtig 2010), profit pool (Cheng et al. 2012), incentive pool (Kent and Becerik-Gerber 2010) and/or at-risk pool (Ashcraft 2011; Ballard et al. 2015; Cohen 2010). Yet despite the potential synergy between IPD resources and CPR, very little scholarship has been done to theorize the governance of IPD resources using extant literature from common pool resource governance.

[1] Doctoral Candidate, Global Projects Center, Department of Civil and Environmental Engineering - Sustainable Design & Construction, Stanford University, USA, dhall12@stanford.edu.

Examples of common-pool resource systems include natural resources - such as lakes, groundwater basins, or forests - and manmade constructs – such as parking lots, digital wiki libraries, and pluralistic organizational governance structures. These resource systems are large enough that limiting potential beneficiaries from their use is difficult (but not necessarily impossible) (Gardner et al. 1990; Ostrom 2015). The resources are also fully subtractable, which means the logging of one tree or the parking of a car in one lot space means that specific resource unit is not available to any potential beneficiary (Gardner et al. 1990). The 'tragedy of the commons' occurs when users of a common pool resource 'overgraze' or 'overfish' by appropriating resources at a higher than optimal rate, resulting in a downward spiral of resource availability. Many economists and game-theorists paint a pessimistic outlook for CPR scenarios. For decades, the prevailing view of economists and game theorists assumed that actors would unable or unwilling to locally organize for the long-term provision of commons. Policy prescriptions overwhelmingly argued for centralized, outside intervention, often from the government, as the 'only' way to govern and avoid the 'tragedy of the commons' (Ostrom 2015).

However, seminal research by economist Elinor Ostrom (Ostrom 2010, 2015; Ostrom et al. 1994) and others (Gardner et al. 1990) has rejected the notion of centralized organization as the 'only' way to govern the commons. Ostrom's work – drawing from hundreds of case studies of common groundwater basins, forests, lakes and more - found local actors in pluralistic settings were quite successful at crafting long-enduring governance structures. One culmination of this line of scholarship is the development of a set of design principles shared by successful governance structures of CPR scenarios. These principles – not to be confused with specific rules or prescriptions - provide guidelines to best limit the use of natural resources so as to ensure their long-term economic viability.

Common pool resource scenarios are often applied to natural resources (Ostrom 2010), but they can also be applied to man-made resources. A recent line of engineering project organization scholarship, headed by Nuno Gil and Jeffrey Pinto (2016a), has examined the governance of construction megaprojects through a lens of pluralism. Gil and Pinto draw extensively on the work of Ostrom. Their application of CPR governance to the socio-technical arrangement of the construction project shows great potential to unravel the governance challenges found on megaprojects.

While this recent work explores the application of CPR design principles to complex projects (Gil and Baldwin 2013), there is much work to be done in this area. One such opportunity not yet undertaken is an exploration of IPD governance through the theoretical lens of CPR scenarios. In general, IPD research has done little to explore how the use of shared project resources might change prevailing theories of project management or project governance. Practitioners have issued calls for a 'new kind of IPD manager' (Seed 2014) but there remains the need to develop an underlying theory for what exactly this new type of manager should be managing. It is likely that the use of common pool governance literature from economic, organizational, and institutional theorists could be a great asset to IPD researchers and practitioners, but this has not yet been realized.

The purpose of this paper is to act as a theoretical starting place to link together Ostrom's work on CPR governance (drawing from the recent theorizations of Gil and Pinto) with the diverse and growing body of literature that focuses on IPD. The paper

proceeds with the following structure. First, the paper presents a review of Ostrom's CPR governance and its potential application to IPD projects. Second, the paper evaluates the fit existing rules-in-use from IPD theory and practice to each of Ostrom's design principles for the governance of long-enduring CPR scenarios. This section concludes with a summary of the principles that are and that are not currently well-aligned in theory and in practice. Third, the paper concludes with a discussion of future IPD research that can be undertaken using CPR governance as an underlying framework, including potential theoretical and practical governance implications for IPD.

COMMON POOL RESOURCE SCENARIOS

Common-pool resources (CPRs) are here defined as sufficiently large natural or manmade resources that are costly (but not impossible) to exclude potential beneficiaries from obtaining benefits from their use (Gardner et al. 1990). A common-pool resource scenario exists when a resource is subtractable – meaning that the resource unit withdrawn by one party is not fully available to another party – and has multiple appropriators – meaning more than one party is withdrawing resources units from the resource (Gardner et al. 1990). The term 'appropriator' refers to anyone who withdraws resource units from some type of resource system (Ostrom 2015). Examples of appropriators from natural resource systems include herders, fishers, and irrigators. Appropriators either consume the resource units they withdraw (e.g. fishers that harvest primarily for consumption) or use them as resource units for production processes (e.g. irrigators that apply water to fields) (Ostrom 2015).

In CPR scenarios, it is important to distinguish between the resource system and the flow of resource units produced by the system. Resource systems are defined as 'the stock variables that are capable, under favorable conditions, of producing a maximum quantity of a flow variable without harming the stock or the resource system itself' (Ostrom 2015). Examples of resource systems include fishing grounds, groundwater basins, bridges, and parking garages. Resource units are defined as 'what individuals appropriate or use from resource systems' (Ostrom 2015). Examples of resource units include the tons of fish caught, the cubic meters of water withdrawn from a basin, the number of bridge crossings used per year by a bridge, or the parking spaces filled (Ostrom 2015).

THE TRAGEDY OF THE COMMONS

The expression 'the tragedy of the commons' was first introduced by Garret Hardin (1968, 2009) to describe the expected degradation of the environment where many individuals withdraw CPRs. The tragedy is best explained using the example of a pasture 'open to all' that several herders might use to raise cattle. Because 'each herder receives a direct benefit from his own animals' and 'suffers delayed costs from the deterioration of the commons' due to his or others' cattle overgrazing, rational-acting herders are incentivized to continuously add more animals (Ostrom 2015). In doing so, they receive the full direct benefit of their own animals while only paying a share of the costs that result from overgrazing.

The tragedy emerges for two reasons. As described, CPR units are fully subtractable. While multiple appropriators can simultaneously or sequentially undertake the actual process of withdrawing resource units from the resource system,

the 'actual resource units are not subject to joint use or appropriation' (Ostrom 2015). In other words, the pasture grazed by one herder's cattle cannot be grazed by another's cattle. The resource system is subject to joint use, but the resource unit is not. The overuse or 'crowding effect' of the resource leads to the possibility of approaching the limit of the number of resource units available in a CPR (Ostrom 2015).

Further, appropriators face the temptation to avoid contributing to long-term maintenance of the resource system. This is known as the problem of free-riding, because:

> *"Once multiple appropriators rely on a given resource system, improvements to the system are simultaneously available to all appropriators. It is costly (and in some cases infeasible) to exclude one appropriator of a resource system from improvements made to the resource system itself. All appropriators benefit from maintenance performed on an irrigation canal, a bridge, or a computer system whether they contribute or not"* (Ostrom 2015).

Thus, the rational pursuit of the herder's own best interests results in the overuse and subsequent ruin of the common pastures. As Hardin eloquently summarizes, 'therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit - in a world that is limited' (Hardin 1968 p. 1244).

Tragedy scholars such as Hardin were quite pessimistic about the ability of individual rational actors to organize effective governance frameworks to manage the commons. Analysis by modern resource economics, including non-cooperative game theory, concludes that 'where a number of users have access to a common-pool resource, the total of resource units withdrawn from the resource will be greater than the optimal economic level of withdrawal' (Ostrom 2015). This pessimism is reflected in policy scholarship, with numerous recommendations that the *only* effective solution to the 'tragedy of the commons' is to use centralized state intervention to organize CPR scenarios.

GOVERNING THE COMMONS

The economist Elinor Ostrom challenged the fatalism of commons scholars with her seminal work *Governing the Commons: The Evolution of Institutions for Collective Action* (2015). Using extensive case study research from fisheries, forests, groundwater basins, pastures and other settings, Ostrom finds numerous and systematic failures of CPR scenarios when central government implemented one-size-fits-all policy with little local knowledge of the resource at hand. Furthermore, despite tragedy warnings to the contrary, field research continually finds common pool resources can be successfully governed by local actors.

Over the past three decades, Ostrom's work has evolved to understand the successful governance of CPR scenarios. Rejecting arguments for simple CPR models and prescriptions to be applied uniformly by a centralized agent, Ostrom argues that there is no one-size-fits-all solution. Instead, the governance of CPR requires consideration of the:

- Biophysical conditions of the resource system

- Attributes of a community including the history of prior interactions, internal homogeneity or heterogeneity of key attributes, and the knowledge and social capital of those who may participate or be affected by others.
- Rules-in-use, which specify common understanding of those involved related to who must, must not, or may take which actions affecting others subject to sanctions (Crawford and Ostrom 1995).

A full description of the types of rules-in-use available to actors is presented in Table 1. These rules-in-use often evolve over time in CPR scenarios as actors interact with one another or self-consciously decide to work with one another to change the governance framework.

Table 1 - Types of rules-in-use (Crawford and Ostrom 1995)

Type of Rule-in-use	Purpose of Rule-in-use
Boundary rules	specify how actors are chosen to enter or leave positions;
Position rules	specify a set of positions and how many actors hold each one;
Choice rules	specify which actions are assigned to an actor in a position;
Information rules	specify channels of communication among actors and what information must, may, or must not be shared
Scope rules	specify the outcomes that could be affected;
Aggregation rules	specify how the decisions of actors at a node are to be mapped to intermediate or final outcomes (e.g. decision by majority, decision by unanimity)
Payoff rules	specify how benefits and costs are to be distributed to actors in positions

Using combinations of the rules-in-use presented above, local actors craft governance structures for CPR scenarios that attempt to solve a) the problem of over-use or over-crowding (caused by resource subtractability), and b) the free-rider problem of deficient long-term maintenance and planning (caused by the difficulty to exclude appropriators from improvements made to the resource system). Successful arrangements require the rules-in-use to link effectively with the structure of the resource system (the biophysical conditions) and the attributes of the community (Blomquist et al. 1994). From the case studies, Ostrom was able to determine sets of design principles that effectively accomplished this linkage. The result was the determination of eight design principles illustrated by long-enduring CPR institutions (Ostrom 2010, 2015) with some subsequent reformulation of the categories (Cox et al. 2010). The design principles are summarized in Table 2; a full description of each rule is presented later in the paper.

Table 2 – Design Principles for CPR scenarios

Design Principle (Ostrom 2015)	Subcategories (Cox et al. 2010)
1. Clearly defined boundaries	a. for the users b. for the resource
2. Congruence	a. with local conditions b. between appropriation & provision rules
3. Collective choice arrangements	
4. Monitoring	a. of users b. of the resource
5. Graduated sanctions	
6. Conflict-resolution mechanisms	
7. Minimal recognition of rights to organize	
8. Nested enterprises	(only when part of large, complex system)

These design principles are not prescriptions; successful CPR scenarios utilized many different types of rules-in-use. However, the larger point is that when participants crafted governance frameworks with rules-in-use that addressed each of these design principles, they were often more successful. Furthermore, the failure of CPR scenarios often noted an absence of one or more of the design principles; in other words, the tragedy of the commons occurred when participants failed to address some or many of the eight design principles above.

THE TRAGEDY OF THE PROJECT

> *"Everyone knows that the basic problem is overfishing; however, those concerned cannot agree how to solve the problem."*
>
> *Elinor Ostrom, Governing the Commons, 2015*

Much like the commons, the 'tragedy of the project' can occur within the governance of complex projects in the built environment. This can take the form of 'overcrowding' where multiple appropriators wish to use the same physical space, leading to schedule delays. It can take the form of 'overfishing' where appropriators claim more space in the budget than is optimal for the resource system. The project also faces the problem of 'free-riders' at the front-end of projects when slack resources and budget contingency must be used to appease multiple stakeholders (Gil and Pinto 2016b) and during the project when self-interested actors appropriate resource units from the project scope, schedule or budget without making contributions to the 'maintenance' (e.g. reliable information, improvement of

processes) of the project governance system. In summary, the resource units of the project are often appropriated in suboptimal ways, and the health of the resource system (e.g. the quality of the project governance) is sparsely provided for or maintained. To rephrase the quote above in the context of complex projects, everyone knows the basic problem is going over budget and over schedule; however, those concerned cannot agree on how to solve the problem.

A recent line of scholarship, headed by Nuno Gil and Jeffrey Pinto (2016a), seeks to trace the poor performance of megaprojects 'to the pluralistic structure at the core of this complex form of organizing work.' Gil and Pinto (2016a) argue:

> *"It is the diffusion of power over strategic choice across multiple independent actors that makes it so hard to define upfront the design structure of the complex system, aka project scope, and to commensurately produce reliable cost and schedule forecasts."*

Understanding this pluralism, they argue, can reconcile scholarship that claims the frequent failure of megaprojects is due to strategic misrepresentation and capability problems (Flyvbjerg et al. 2003) with scholarship that argue failure is due to multiple institutional logics that create 'wicked problems' (Rittel and Webber 1973). Placing pluralism at the root of complex projects, Gil and Pinto advocate for the application of Ostrom's work on collective action and governance of CPR scenarios to the sociotechnical arrangements of megaprojects. Unravelling the pluralism at the core of projects could be key to understand how individuals and firms jointly using project resources might be able to achieve effective governance forms to manage their own projects (Ostrom 2015). Gil and Pinto highlight the need to study the 'design and management of collective action in megaproject organizations' in order to further understand the complexity of this management pluralism. (Gil and Pinto 2016a). A few recent studies attempt to unravel this idea of pluralism at the core of complex projects (Gil et al. 2017; Gil and Pinto 2016b). Yet despite the promise of this new line of thought, applications to the governance of construction project delivery is relatively sparse.

GOVERNING INTEGRATED PROJECT DELIVERY AS A CPR SCENARIO

Integrated Project Delivery (IPD), an emerging form of organization for the delivery of complex construction projects in North America, represents an unrealized opportunity to apply this line of scholarship. IPD uses a multi-party contract to unite a collaborative team of architecture, engineering and construction specialists from multiple firms. Formally IPD is defined as 'a project delivery method that integrates people, systems, business structures and practices into a process that collaboratively harnesses the talents and insights of all participants to reduce waste and optimize efficiency through all phases of design, fabrication and construction' (AIA 2014). In a sense, IPD creates a virtual project-based 'company' whose employees are retained by their respective firms but take on roles based on project needs rather than the nature of their employer (Thomsen et al. 2009). This 'company' is both a legal entity and a temporary project-based social organization.

In many ways, IPD represents an ideal opportunity to frame project governance as a CPR scenario. For most projects, pluralism and CPR scenarios are most prevalent during front end of the project during strategic planning and design. Table 3

demonstrates how CPR governance is present during the front-end shaping phase (Gil and Pinto 2016b) or during the design stage (Gil and Baldwin 2013).

Table 3 - Pluralistic and CPR Scenario Research

Setting	Study	Unit of Analysis	Stakeholders	Pluralistic / Common Pool Setting	Primary Resource at stake
Shaping Phase	Gil and Pinto (2016a)	Front End of Mega-Projects	• Promoters (e.g. nested levels of national and city government); • Interest groups and associations; • Designers and builders; General public	Promoter yet to enter into formal agreements; cannot use authority hierarchies and contracts to govern.	Slack Resources
Design Phase	Gil and Baldwin (2013)	Design Stage for Multiple New School Buildings	Meta-Organization composed: • School faculties; • City council staff; • Private contractors (designers and builders)	Polycentric decision makers for design of multiple projects use shared governance structure and granted high local autonomy	User Design Preferences

Once front end strategic decision making is completed, parties often enter into dyadic contracts and an organizational hierarchy is formed among the project firms. The pluralistic dynamics of the project might not completely fade away, but the contractual hierarchy rules-in-use enforce the distribution of project resources. However, IPD projects explicitly create a 'common pool' of project resources, most notably the profit pool, to which the multi-party signatory firms are privy during the construction phase. In fact, early constructors and researchers of the IPD system consistently describe project resources using the language of "pools." IPD scholarship uses various language to describe the resources, including: common pool (Thomsen et al. 2009); contingency pool (Darrington and Lichtig 2010); profit pool (Cheng et al. 2012); incentive pool (Kent and Becerik-Gerber 2010); and at-risk pool (Ashcraft 2011; Ballard et al. 2015; Cohen 2010). While prior work on CPR scenarios are particularly relevant to the design and shaping phases of all projects, CPR governance can also be applied during the construction stage for IPD projects (see Table 4).

Table 4 – Potential Setting for IPD as CPR scenario research

Setting	Study	Unit of Analysis	Stakeholders	Pluralistic / Common Pool Setting	Primary Resource at stake
Constr-uction Phase	none	The IPD Project	• Promoter (e.g. owner) • Prime Contractor • Architect • Engineers and designers • Trade Contractors	3 or more signatory firms enter into agreement to share risk and reward for profit pool	Stakeholder Profit

Despite this language of pools, little work to date applies elements of Ostrom's CPR governance to IPD governance. This is likely a missed opportunity; There remains a need to understand IPD governance as a new form of institutional arrangement (Hall and Scott 2016) and its implications for project management in the construction industry. Therefore, the use of CPR governance might be useful in weaving together multiple diverse categories of IPD scholarship. This includes current scholarship for comparative case studies of IPD projects (Cheng et al. 2012; University of Minnesota et al. 2016), detailed comprehensive strategies for achieving success on IPD projects (Fischer et al. 2017), investigations of the impact of IPD on desirable project characteristics such as trust, innovation, and supply chain collaboration (Hall et al. 2014; Lavikka et al. 2015; Pishdad-Bozorgi and Beliveau 2016a), quantifications of IPD project outcomes compared to other types of project delivery methods (El Asmar et al. 2013, 2016; Franz et al. 2016), and theorizations of ideal IPD profit pool distributions using cooperative game theory (Jung et al. 2012; Teng et al. 2017). As a starting place to link the two bodies of literature, this paper proceeds by matching existing rules-in-use from IPD theory and practice to each of Ostrom's design principles for the governance of long-enduring CPR scenarios.

THE ALIGNMENT OF IPD GOVERNANCE STRUCTURES TO THE DESIGN PRINCIPLES OF COMMON POOL RESOURCES

In theory, successful IPD governance principles might align with the design principles of CPRs. There is one important distinction to make. Ostrom's design principles are developed for renewable resources that can be sustained over an indefinite period of time. By nature, the construction project is a finite endeavor. Although the length of many IPD projects – design and construction often takes from four to ten years - can be considered long-enduring, resources of cost and schedule are continuously being depleted. This is an important point that future studies should seek to understand.

This section of the paper provides an exploration of how the rules-in-use of IPD governance in practice might align with the design principles of successful CPR governance structures. For each of the potentially aligned design principles, an example of a rule-in-use is provided from IPD governance frameworks (Ashcraft 2011; Thomsen et al. 2009) or IPD case studies (Linnik et al. 2013; University of Minnesota et al. 2016).

KEY TERMS

Before beginning, it is appropriate to explain key terms used in CPR governance and describe their usage in the construction / IPD context. The IPD project is a complex sociotechnical system with multiple resources available for appropriation. For simplicity, we will assume that the overall project budget is the primary common pool resource system. The resource units then include cost claims to a portion of that budget. Other resource units that will be considered are the physical space taken by construction, and the temporal space occupied in a project schedule. There is certainly an interdependence between these three resource units – decisions about one type of unit might impact the others - but for now let us consider schedule and space as subsets of the overall cost. Other resource units (e.g. quality, safety, energy usage) could potentially be considered but that exercise lies beyond the scope of this paper. Appropriators on IPD projects have two options to appropriate resource units. They have the opportunity to consume the resource units (use the cost or schedule themselves) or to sell the resource units (subcontract the work using a dyadic contract with parties outside the shared risk/ reward pool). Table 5 explains in greater detail other definitions used in this exercise.

Table 5 – Defining CPR scenario terms in context of IPD

Term	CPR scenario definition	CPR example	IPD example
Resource System	Stock Variables	lake, forest, pasture	Overall Project Budget
Resource Unit	Item that is appropriated	tons of fish; acreage of forest, tons of fodder	Claim on Budget; Physical Space taken by construction; temporal space occupied in schedule
Appropriator	One who withdraws resource units from a resource system	fisher, herder	Trade partner (e.g. Mechanical contractor); Design partner (e.g. Structural Engineer)
Provider	to those who arrange for the provision of a CPR	central authority; local group that arranges for collective action	Leaders / Principles of Signatory Firms
Producer	one who actually constructs, repairs, or takes actions that ensure the long-term sustenance of the resource system itself	farmer who repairs a fence around the common	IPD Project Managers; team facilitators and coaches

1A. USER BOUNDARIES (ALIGNED)

CPR Design Principle: Clear and locally understood boundaries between legitimate users and nonusers are present.

Alignment with IPD governance: Multi-Party Contract negotiated to determine who is a 'partner' and who is not.

Boundary rules act as a mechanism to ensure that appropriators a) interact with others nearby and b) have a long-term interest in sustaining the productivity of the resource. (Ostrom 2015). When a resource system is overused, appropriators might change the composition of the group that uses the CPR; this is typically done by increasing the proportion of participants:

- Who have a long-term interest in the resource
- Who are more likely to use reciprocity, and
- Who can be trusted (Ostrom 2015).

The creation of IPD boundary rules for users have done precisely this. Governance rules of the traditional construction project tend to 'open up a resource [or resources] to strangers without a long-term commitment to the resource, create too large a geographic domain, generate conflict among users, and lead to an unwillingness to abide by any rules (Ostrom 2015).' Meanwhile, IPD resource governance emphasizes the inclusion of firms that are aligned for the long-term governance of the project (Henisz et al. 2012) and are more likely to use trust and reciprocity (Pishdad-Bozorgi and Beliveau 2016a; b; Townes et al. 2015).

IPD accomplishes this through a multi-party contract with a shared risk and reward structure. As few as three and as many as fifteen parties can be signatories to the contract, while other firms might have joining agreements that allow them to also participate in the resource pool (University of Minnesota et al. 2016). In extreme cases, early IPD contracts even included language requiring project teams to engage in trust and mutual reciprocity (University of Minnesota et al. 2016). In doing so, IPD projects have a clear boundary around 'inside groups' responsible to act as 'producers' - actors who actually construct, repair, or take actions to ensure the long-term sustenance of the resource system itself (Ostrom 2015). These insiders appropriate the resources for themselves (by laying claim to budget or schedule resources) or sell stake in the resources (by subcontracting resource claims to other actors outside of the user boundary).

1B. RESOURCE BOUNDARIES

CPR Design Principle: Clear boundaries that separate a specific common-pool resource from a larger social-ecological system are present.

Alignment with IPD governance: Validation Study

In addition to the user boundaries that determine who can appropriate resources, IPD projects often use a period of validation to determine the resource boundaries. In CPR scenarios, it is difficult to estimate the 'impact to expected benefits and costs given the difficulty of making precise measures of many of these variables and weighing them on a cumulative scale' (Ostrom 2015). Likewise for IPD projects, the scope of

the complex project is unique and therefore 'cannot be tightly defined at project execution' (Ashcraft 2011). The period of the validation study is the time to ensure expectations about scope, cost, and schedule are aligned and agreed upon between all appropriators. The end result of this validation period is a go/no go decision about moving the project forward (Ashcraft 2011).

2A. Congruence with Local Conditions

CPR Design Principle: Appropriation and provision rules are congruent with local social and environmental conditions.

Alignment with IPD governance: Early Involvement of Key Stakeholders

Long-lasting IPD governance frameworks try to design for congruence with local conditions by bringing in key stakeholders with the best knowledge about the local conditions of the project (Thomsen et al. 2009; University of Minnesota et al. 2016). In this way, appropriation rules that emphasize the time, place, technology, and/or quantity of resource units come into congruence with the local conditions and with provision rules regarding the local availability of labor, material, and/or other resources required by the project. This also allows for clear resource boundaries (design rule 1B) to be set around the project budget and schedule. However, in practice and in literature, there is little understanding

3. Collective Choice Arrangements

CPR Design Principle: Most individuals affected by a resource regime are authorized to participate in making and modifying its rules.

Alignment with IPD governance: Joint Decision Making

For the commons, 'proponents of centralized control want an external government agency to decide the specific herding strategy that the central authority considers best for the situation: The central authority will decide who can use the meadow, when they can use it, and how many animals can be grazed' (Ostrom 2015). Likewise, proponents of the traditional command-and-control project management advocate for the general contractor to centralize all decision making. For example, the general contractor would be responsible for deciding the specific scheduling strategy that the central project authorities consider the best for the situation. The general contractor will decide who can use the floor, when they can use it, and how many crew members they will need. By contrast, IPD governance allows the majority of the individuals affected by the operational rules to participate in crafting and modifying any rules-in-use. In fact, complex decision-making structures have been proposed to enforce joint decision making while avoiding deadlock in decisions. Figure 1 illustrates the flowchart for one such example.

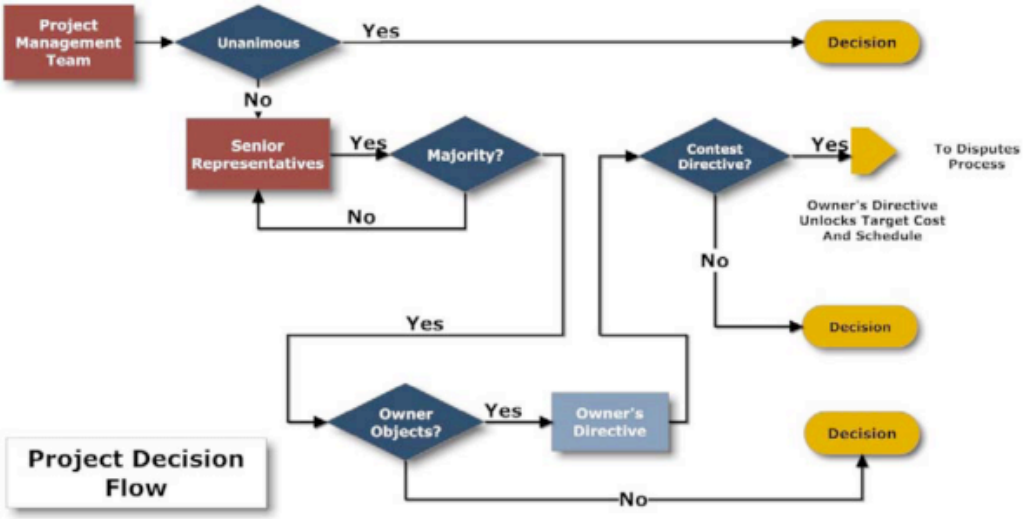

Figure 1 - Decision Making Flowchart Example (Ashcraft 2011)

4A. Monitoring Users

CPR Design Principle: Individuals who are accountable to or are the users monitor the appropriation and provision levels of the users.

Alignment with IPD governance: Planned Percent Complete (PPC) and Production Tracking

CPR scenarios often use position rules to appoint an external 'guard' responsible for monitoring the users and monitoring the resource. In smaller CPR scenarios, this might be undertaken collectively by the individual appropriators. One example of monitoring users often used on IPD projects is a metric known as Planned Percent Complete (University of Minnesota et al. 2016). The PPC statistic reflects the percentage of tasks that an individual actually completes compared to the number of tasks they promised to complete at the start of the week. PPC scores are often aggregated by inter-organizational cluster sub teams (see design rule 8). The scores act as a monitor to see which users are acting in a trusting and reliable manner. Low PPC scores can be used as a proxy; a low score means an actor or sub team is not acting reliably or is overrunning promised tasks, which might require withdrawal of more resource units than would be optimal for the resource system. In some cases, the PPC score acts as a metric used for early forms of social sanctioning (see design rule 5) in weekly meetings.

4B. Monitoring the Resource

CPR Design Principle: Individuals who are accountable to or are the users monitor the condition of the resource

Alignment with IPD governance: Target Value Design Risk and Opportunity Log (budget), Takt Time Planning (schedule), BIM laser scanning for correct as-built conditions (physical space)

Appropriators and guards must actively monitor the resource pool. On the budget side, IPD projects in practice keep a 'risk and opportunity log.' Ideas to provide for the resource system (e.g. innovations, better processes, etc.) are noted as opportunities, while potential dangers to the health of the resource system (e.g. cost escalations, undefined scope, schedule delays) are noted and monitored as risks (Denerolle 2013). Other examples of resource monitoring include the use of Takt Time planning to designate which scheduling spaces are available to certain appropriators at certain times (Frandson and Tommelein 2015; Linnik et al. 2013) or the use of BIM laser scanning to check if materials have been installed in the location as promised – this monitors the resource unit of physical space by ensuring that incorrect placement of materials does not impede the work of others.

5. GRADUATED SANCTIONS

CPR Design Principle: Sanctions for rule violations start very low but become stronger if a user repeatedly violates a rule.

Alignment with IPD governance: unclear

When appropriators violate the rules-in-use or do not conform with the norms set by the appropriators, CPR governance uses graduated sanctions that depend on the seriousness and context of the offense. These sanctions might be social or financial. They are assessed by other appropriators, by officials accountable to these appropriators, or by both (Ostrom 2015). The concept of graduated sanctions in IPD deserves future attention, but some case studies document instances of the removal of individuals or firms that are not performing or do not fit the team culture (see Sunnyvale case, University of Minnesota et al. 2016).

6. CONFLICT RESOLUTION MECHANISMS

CPR Design Principle: Rapid, low cost, local arenas exist for resolving conflicts among users or with officials.

Alignment with IPD governance: Liability Waivers, Dispute Resolution Strategies

Appropriators and their firms need rapid access to low-cost local arenas to resolve conflicts with one another. Although 'some IPD agreements prefer to follow traditional risk management approaches, with each party fully responsible for its own failings' (Ashcraft 2011), other projects work to craft risk management frameworks that include waivers of liability for project errors coupled with clear dispute resolution strategies to avoid costly litigation proceedings.

7. MINIMAL RECOGNITION OF RIGHTS:

CPR Design Principle: The rights of local users to make their own rules are recognized by the government.

Alignment with IPD governance: Owner empowerment of team rules-in-use

The rights of appropriators to devise their own rules-in-use, including the technologies, tools and processes for the project, are not challenged by the project sponsor. One example from a recent case study (University of Minnesota et al. 2016) demonstrates this. Team members applauded an owner's project manager who

showed flexibility and recognized a certain tool was 'meeting resistance from the team.' In this case, the project manager acquiesced and let the team create their own rules. In this case the owner's project manager empowered the rules made by the team, even saying 'it was working—I just don't agree with the way they were doing it' (University of Minnesota et al. 2016).

8. NESTED ENTERPRISES

CPR Design Principle: When a common-pool resource is closely connected to a larger social-ecological system, governance activities are organized in multiple nested layers.

Alignment with IPD governance: Inter-organizational clusters

Because the IPD project is a complex socio-technical system, it requires that governance activities are organized in multiple layers. In practice, IPD teams are organized into multi-firm subgroups termed 'inter-organizational clusters' (De Melo et al. 2013; Nicolini et al. 2001). Cluster teams are composed of designers, engineers, contractors, trade-partners and/or suppliers from many different firms. These clusters perform 'design and construct' mini-projects within the larger framework of the project (Nicolini et al. 2001). Examples of cluster teams include preconstruction, interiors, structural, envelope, mechanical/electrical/plumbing/fire protection (a.k.a. systems), site/civil, and furnishings teams (Denerolle 2013). These nested clusters engage in intensive collaboration to optimize value, reduce costs, reduce schedule, and minimize waste. Clusters operate as "semi-independent parts of the project under the overall coordination of the contractor or project manager, replicating the logic of one-point responsibility down the supply chain" (Nicolini et al. 2001).

DISCUSSION: CHARTING A FUTURE RESEARCH COURSE FOR THE STUDY OF IPD GOVERNANCE AS A CPR SCENARIO

Applying a CPR governance framework to IPD management opens up numerous theoretical and practical scholarship opportunities. Here this paper touches on three areas that can be researched to further explore the convergence of the two bodies of literature.

USING CASE LITERATURE, SYNTHESIZE THE DESIGN PRINCIPLES OF IPD GOVERNANCE USING CPR THEORY.

In the case of Ostrom's work:

> *"extraordinarily rich case-study literature already existed, written by field researchers who had invested years of effort in obtaining detailed information about the strategies adopted by the appropriators of CPRs and the rules they used."*

However,

> *"that literature had been written by authors in diverse fields and frequently had appeared in obscure publications. Almost no*

> *syntheses of the findings from that literature had been undertaken"* (Ostrom 2015).

This is a similar case for IPD literature. There are numerous in-depth field reports from IPD work (Cheng et al. 2012, 2015; Cohen 2010; e.g. University of Minnesota et al. 2016), but to date very little synthesis has taken place. CPR governance can be an overarching frame to tie together diverse streams of literature. From this synthesis, researchers can then identify common types of rules-in-use that IPD projects use for successful governance. In doing this, researchers can begin formulating an underlying theory about what type of governance IPD is. This provides the opportunity to study failed or less successful IPD projects (e.g. Ballard et al. 2015) to see if those projects failed to provide specific rules to meet certain design principles. It also provides opportunity for new theories to emerge about how improvements that can be made to IPD governance. Ostrom (2015) explains 'Given the importance of understanding how institutions help users cope with CPR problems, and given the existence of a rich theoretical literature concerning these problems, it seemed to me that it was important to use these case studies as an empirical basis for learning more about the effects of institutions on behaviors and outcomes in diverse field settings.'

USE THIS NEW THEORY OF THE IPD PROJECT TO UNDERPIN FUTURE RESEARCH OF THE NEW PROJECT MANAGER

A new theoretical understanding of the IPD project that can then underpin ongoing calls from scholars and practitioners for a new kind of project manager. This call has been explicit from practitioners claiming 'IPD requires a new Project Manager' (Seed 2014) and academics arguing that 'the underlying theory of Project Management is obsolete' (Koskela and Howell 2002) and calling the industry to move 'towards Project Management 2.0' (Levitt 2011). Understanding this new project manager is one the Engineering Project Organization Societies Grand Challenges (Taylor et al. 2014). Part of the puzzle of creating a new theory of the project manager is the need for a new theory of project management. As Ostrom (2015) writes 'Theories affect the way that a problem is framed, not simply the particular assumptions used in an explanation. The way a problem is framed affects which questions are asked and what one looks for in conducting empirical inquiries.' Using CPR as the underlying theory of IPD governance and project management can move the conversation forward about what the new kind of project manager should look like.

CONTRIBUTE TO THE ONGOING RESEARCH OF COLLECTIVE ACTION IN PLURALISTIC SETTINGS

The IPD project offers a unique context to further contribute to an understanding of strategic decision making in pluralistic settings. Future IPD field work can add to this ongoing work by Gil and Pinto (2016a) situated in the context of megaprojects and other complex projects. As Ostrom (2015) describes, 'all organizational arrangements are subject to stress, weakness, and failure. Without an adequate theory of self-organized collective action, one cannot predict or explain when individuals will be unable to solve a common problem through self-organization alone, nor can one begin to ascertain which of many intervention strategies might be effective in helping

to solve particular problems.' IPD offers a uniquely pluralistic setting that may be of interest to economic, organizational and institutional scholars of collective action.

CONCLUSION

This paper acts as the starting point to connect Ostrom's work(Ostrom 2010, 2015; Ostrom and Crawford 2005) on CPR governance with the diverse set of IPD literature. The paper reviews Ostrom's theories of CPR governance and recent scholarship on pluralistic structures in complex projects (Gil and Baldwin 2013; Gil and Pinto 2016a; b). It proceeds by highlighting the fit of IPD governance with a CPR governance structure, while noting that little work has been done to connect the two. The paper then proceeds with a preliminary discussion of how IPD governance rules-in-use align with Ostrom's design principles for CPR governance. The paper concludes with three potential areas of future research to continue this work: a) Synthesizing case study literature to understand the current design principles of IPD Governance, b) Use CPR governance to underpin research calls on the subject of the 'New Kind of Project Manager' and c) contribute to the ongoing work of collective action in pluralistic, project-based organizations.

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REFERENCES

Ashcraft, H. W. J. (2011). "Negotiating an Integrated Project Delivery Agreement." *The Construction Lawyer*, 31(3), 17-34-50.

El Asmar, M., Hanna, A. S., and Loh, W.-Y. (2013). "Quantifying performance for the integrated project delivery system as compared to established delivery systems." *Journal of Construction Engineering and Management*, School of Sustainable Engineering and the Built Environment, Arizona State Univ., P.O. Box 870204, Tempe, AZ 85287-0204, United States, 139(11).

El Asmar, M., Hanna, A. S., and Loh, W.-Y. W. (2016). "Evaluating Integrated Project Delivery Using the Project Quarterback Rating." *Journal of Construction Engineering*, School of Sustainable Engineering and the Built Environment, Arizona State Univ., P.O. Box 870204, Tempe, AZ, United States, 142(1), 1–13.

Ballard, G., Dilsworth, B., Do, D., Low, W., Mobley, J., Phillips, P., Reed, D., Sargent, Z., Tillmann, P., and Wood, N. (2015). "How To Make Shared Risk and Reward Sustainable." *Proc. 23rd Ann. Conf. of the Int'l. Group for Lean Construction*, Perth, Australia, 257–266.

Blomquist, W., Schlager, E., Tang, S. Y., and Ostrom, E. (1994). "Regularities from the field and possible explanations." *Rules, games, and common-pool resources*, Ann Arbor: The University of Michigan Press, 301–318.

Cheng, R., Allison, M., Dossick, C. S., and Monson, C. (2015). *IPD : Performance, Expectations, and Future Use*.

Cheng, R., Dale, K., Aspenson, A., and Salmela, K. (2012). *IPD Case Studies*. *American Institute of Architects*.
Cohen, J. (2010). "Integrated Project Delivery: Case Studies." *AIA National, AIA California Council, AGC California, McGraw Hill Construction*.
Cox, M., Arnold, G., and Villamayor, S. (2010). "A Review of Design Principles for Community-based Natural Resource Management." *Ecology and Society*, 15(4), 38.
Crawford, S. E. S., and Ostrom, E. (1995). "A Grammar of Institutions." *American Political Science Review*, Cambridge University Press, New York, USA, 89(3), 582–600.
Darrington, J., and Lichtig, W. (2010). "Rethinking the G in GMP: Why Estimated Maximum Price Contracts Make Sense on Collaborative Projects." *Constr. Law.*
Denerolle, S. (2013). "Technical Report: The Application of Target Value Design to the Design Phase of 3 Hospital Projects." University of California Berkeley.
Fischer, M., Khanzode, A., Reed, D., and Ashcraft, H. W. (2017). *Integrating Project Delivery*. John Wiley & Sons.
Flyvbjerg, B., Bruzelius, N., and Rothengatter, W. (2003). *Megaprojects and risk: An anatomy of ambition*. Cambridge University Press.
Frandson, A. G., and Tommelein, I. D. (2015). "COMPARISON BETWEEN LOCATION BASED MANAGEMENT AND TAKT TIME PLANNING." 3–12.
Franz, B., Leicht, R., Molenaar, K., and Messner, J. (2016). "Impact of Team Integration and Group Cohesion on Project Delivery Performance." *Journal of Construction Engineering and Management*, American Society of Civil Engineers, 4016088.
Gardner, R., Ostrom, E., Walker, J. M., and Wilson, D. B. (1990). "The nature of common-pool resource problems." *Rationality and Society*, Sage Publications, 2(3), 335–358.
Gil, N. A., and Baldwin, C. Y. (2013). *Creating a Design Commons: Lessons from Teachers' Participation in the Design of New Schools*. *Working Paper*.
Gil, N. A., Msulwa, R., and Pinto, J. K. (2017). *Integrating without Authority : The " Wicked " Division of Labour between Mandated Coordination and Politicized Cooperation Integrating without*.
Gil, N., and Pinto, J. (2016a). "THE COMPLEXITY OF PLURALISM : Designing collective action in megaproject organizations." (April), 1–28.
Gil, N., and Pinto, J. K. (2016b). "Pluralism at the Front-end of Complex Systems Projects: Governance and Performance Implications." (February), 45.
Hall, D., Algiers, A., Lehtinen, T., Levitt, R. E., Li, C., and Padachuri, P. (2014). "The Role of Integrated Project Delivery Elements in Adoption of Integral Innovations." *Engineering Project Organization Conference 2014 Proceedings*, P. Chan and R. Leicht, eds., Engineering Project Organization Society, Devil's Thumb Ranch, Colorado, 1–20.
Hall, D., and Scott, W. R. (2016). "Early Stages in the Institutionalization of Integrated Project Delivery." *Engineering Project Organization Conference 2016 Proceedings*, Cle Elum, Washington, USA, 1–19.
Hardin, G. (1968). "The tragedy of the commons." *science*, Washington^ eDC, 162(3859), 1243–1248.

Hardin, G. (2009). “The Tragedy of the Commons.” *Journal of Natural Resources Policy Research*, Routledge, 1(3), 243–253.
Henisz, W. J., Levitt, R. E., and Scott, W. R. (2012). “Toward a unified theory of project governance: economic, sociological and psychological supports for relational contracting.” *Engineering Project Organization Journal*, 2(January 2015), 37–55.
Jung, W., Ballard, G., Kim, Y.-W., and Han, S. H. (2012). “Understanding of Target Value Design for Integrated Project Delivery with the Context of Game Theory.” *Construction Research Congress 2012*, 556–563.
Kent, D. C., and Becerik-Gerber, B. (2010). “Understanding Construction Industry Experience and Attitudes toward Integrated Project Delivery.” *Journal of Construction Engineering and Management*.
Koskela, L., and Howell, G. (2002). “The Underlying Theory of Project Management Is Obsolete.” *Project Management Institute Reseearch Conference*, Seatle 2002, 293–301.
Lavikka, R. H., Smeds, R., and Jaatinen, M. (2015). “Coordinating collaboration in contractually different complex construction projects.” *Supply Chain Management: an International Journal*, 20(2), 205–217.
Levitt, R. E. (2011). “Towards project management 2.0.” *Engineering Project Organization Journal*, 1(3), 197–210.
Linnik, M., Berghede, K., and Ballard, G. (2013). “AN EXPERIMENT IN TAKT TIME PLANNING APPLIED TO NON-REPETITIVE WORK.” 609–618.
De Melo, R. S. S., Granja, A. D., and Ballard, G. (2013). “Collaboration to extend target costing to non-multi-party contracted projects: Evidence from literature.” *21st Annual Conference of the International Group for Lean Construction 2013, IGLC 2013*, Construction Management Research Laboratory (LAGERCON), School of Civil Engineering, Architecture and Urban Design, University of Campinas, 951 Albert Einstein Ave., Campinas, SP 13083-852, Brazil, 21–30.
Nicolini, D., Holti, R., and Smalley, M. (2001). “Integrating project activities: the theory and practice of managing the supply chain through clusters.” *Construction Management and Economics*, 19, 37–47.
Ostrom, E. (2010). “Beyond Markets and States: Polycentric Governance of Complex Economic Systems.” *American Economic Review*, 100(3), 641–672.
Ostrom, E. (2015). *Governing the Commons: The Evolution of Institutions for Collective Action*. *Canto Classics*, Cambridge University Press, Cambridge.
Ostrom, E., and Crawford, S. E. S. (2005). “Classifying rules.” Princeton University Press.
Ostrom, E., Gardner, R., and Walker, J. (1994). *Rules, games, and common-pool resources*. University of Michigan Press.
Pishdad-Bozorgi, P., and Beliveau, Y. J. (2016a). “Symbiotic Relationships between Integrated Project Delivery (IPD) and Trust.” *International Journal of Construction Education and Research*, Georgia Institute of Technology, Atlanta, GA, United States, 12(3), 179–192.
Pishdad-Bozorgi, P., and Beliveau, Y. J. (2016b). “A Schema of Trust Building Attributes and Their Corresponding Integrated Project Delivery Traits.” *International Journal of Construction Education and Research*, Georgia Institute of Technology, Atlanta, GA, United States, 12(2), 142–160.

Rittel, H. W. J., and Webber, M. M. (1973). “Dilemmas in a general theory of planning.” *Policy sciences*, Springer, 4(2), 155–169.
Seed, W. R. (2014). “Integrated project delivery requires a new project manager.” *22nd Annual Conference of the International Group for Lean Construction: Understanding and Improving Project Based Production, IGLC 2014*, Project Integration Executive, Walt Disney Imagineering, United States, 1447–1459.
Taylor, J., Chinowsky, P., and Sakhrani, V. (2014). “Grand Challenges in Engineering Project Organization.”
Teng, Y., Li, X., Li, H., Li, S., Xu, B., and Wang, J. (2017). “Research on Profit Distribution of IPD Project’s Participants Based on Cooperative Game Theory.” *Proceedings of the 20th International Symposium on Advancement of Construction Management and Real Estate*, Springer, 1045–1056.
Thomsen, C., Darrington, J., Dunne, D., and Lichtig, W. (2009). “Managing Integrated Project Delivery.” 105.
Townes, A., Franz, B. W., and Leicht, R. M. (2015). “A Case Study of IPD Team Selection.”
University of Minnesota, University of Washington, University of British Columbia, and Scan Consulting. (2016). *MOTIVATION AND MEANS: How and Why IPD and Lean Lead to Success*.