

Meeting the Burden of Proof with Case-Study Research

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Abstract: The case-study research method is popular across various disciplines; however, critics of the method argue that results from this form of research are applicable only to the case studied and cannot be generalized further. In the field of construction engineering and management (CEM), the number of papers employing case-study research methods over the past decade has increased substantially. As the method proliferates, the question arises: are CEM case studies being performed with sufficient validity and reliability to meet the burden of proof to generalize from the case-study findings? Meeting the burden of proof is particularly critical in CEM because of the unique, site-based nature of the projects and industry. This paper presents a review of 156 papers employing case studies published in the *Journal of Construction Engineering and Management*, of which the writers identified 33 theory-building case-study-method papers. This subset of theory-building papers was examined to induce a set of requirements and guidelines derived from these case-study research efforts to aid researchers in meeting the burden of proof. The writers anticipate that more methodologically consistent and comprehensive case-study research will yield new lines of inquiry and rich theoretical models that enhance and expand CEM research. DOI: [10.1061/\(ASCE\)CO.1943-7862.0000283](https://doi.org/10.1061/(ASCE)CO.1943-7862.0000283). © 2011 American Society of Civil Engineers.

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Introduction

What Is Case Study Research?

In his definitive work on the case-study research method, Yin (1984) defines a case study as “an empirical inquiry that: (1) investigates a contemporary phenomenon within its real-life context, especially when (2) the boundaries between the phenomenon and context are not clearly evident.” Yin continues his definition with a technical distinction between the method and the characteristics of data collection and data analysis strategies. He argues that with case studies there will be many more variables of interest than data points, and therefore, case studies require collecting and triangulating data from multiple sources of evidence. This broad definition encompasses a variety of research design logics, data collection techniques, and data analysis strategies, including but not limited to demonstrations, ethnography, evaluation, experiments, grounded theory, and quasi-experiments (Yin 1993). Under this definition, the case-study method encompasses both qualitative as well as quantitative methods.

Case-study research questions specific to construction engineering and management (CEM) include how and why individuals, organizations, and markets behave the way they do and require qualitative as well as quantitative methods to understand organiza-

tional and human behavior issues surrounding this work and the industry. Most often, case-study observations are considered as qualitative research; however, researchers from engineering, business, and social science disciplines alike have shown that case studies are often mixed-method projects with both qualitative and quantitative aspects (Esteves and Pastor 2004; Green et al. 2002; Kaplan and Duchon 1988; Yin 1984). A variety of methods can be employed in case-study research to both collect and then analyze complex data. For a discussion of the case-study method in the CEM domain, Yin’s definition of case studies as a research strategy is used to review a specific instance, scenario, or project in-depth wherein a variety of both qualitative and quantitative methods can be used in combination to generate rich data sets and robust analysis of very complex questions (Yin 1984).

Criticism of the Case Study Research Method

One of the main criticisms of case studies is that they are limited to one or perhaps a handful of examples. Hence, criticisms focus on how investigators can justify making generalizations from a limited number of samples (Flyvbjerg 2006; Yin 1984). For those who work primarily in the statistical domain, the limited number of data points is intuitively a “statistical significance” problem. Platt (1992) suggests that cases should be chosen for specific intellectual purposes. They should be selected for their ability to support analytic generalization as opposed to statistical generalization. Platt argues that the logic of sampling should be grounded and that the grounding depends on the theoretical argument investigated (Platt 1992).

A second criticism is that many case-study research projects are executed with insufficient precision, quantification, objectivity, or rigor in which investigators have not followed standard procedures or have allowed a biased view to influence the direction of the findings. Published research in this category has tainted the research method as a whole (Yin 1984). The cause for this criticism, Yin points out, may be a lack of standards for the method and guidance for researchers trying to use the method. Furthermore, critics may confuse case-study teaching with case-study research. When

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developing a pedagogical case, teachers may modify the case to fit the learning objectives and create an optimal example for instructional purposes. Critics that misinterpret case-study research methodologies as teaching cases would reasonably be concerned about the control of bias. However, bias on the part of the researcher can occur and be controlled with any research method.

Discipline-Specific Case-Study Research Strategies

Although Yin (1984) attempts to create a universal definition of the case-study research method, many investigators have refined the application of case-study work specific to their discipline, developed standards, and defined rigor. For example, researchers in information systems observed that their discipline is characterized by constant technological change and innovation, and their industry has seen a shift from technological to organizational questions with a focus on context and technological impact. This resulted in investigators needing to descriptively study organizations and practitioners, and case studies allow them to “study information systems in a natural setting, learn about the state-of-the-art, and generate theories from practice” (Benbasat et al. 1987). In a series of papers, Benbasat et al. (1987) and Lee (1989) proposed rigorous and systematic guidelines for case-study research in information systems and analyzed recent published research utilizing these methods (Benbasat et al. 1987; Lee 1989). In their review of 183 articles from seven major information systems journals, Dube and Pare note that the earlier work of Benbasat et al. (1987) and Lee (1989), specifically, and Eisenhardt (1989) and Yin (1993), more generally, have contributed to the improved application of case-study research in information systems in that “the level of methodological rigor has experienced modest progress,” but investigators still need to improve documentation of data collection and analysis processes (Dube and Pare 2003). Similar efforts in a variety of disciplines, including health services research (Yin 1999), political science (Lees 2006), social work (Gilgun 1994), architecture (Johansson 2003), operations research (McCutcheon and Meredith 1993; Meredith 1998; Voss et al. 2002), and business management (Dyer Jr. and Wilkins 1991; Eisenhardt 1989, 1991; Eisenhardt and Graebner 2007) have defined discipline-specific standards for rigorous application of the case-study method.

The ongoing dialogue among domain-specific researchers improves the overall quality and rigor of research in those discipline-specific communities by making explicit arguments as to how case-study research methods apply to the discipline. These articles and books create guidelines and rigorous standards for both case-study researchers and reviewers of case-study research. Although the CEM domain has similar challenges and research questions as business management and information systems, practitioners have not yet defined case-study research for CEM or assessed the practice of case-study research in the discipline. This dialogue is needed to set guidelines for rigor and improve the quality of case method application in CEM research.

Burden of Proof in Case-Study Research

The writers take the position that case-study research can be a rigorous research method in the CEM researcher's methodological toolbox that can lead to new insights, open up new lines of inquiry, and yield rich theoretical models that can enhance and expand CEM research. However, to achieve these benefits, case-study research must meet a “burden of proof,” a concept adopted as a metaphor from jurisprudence to frame this analysis and discussion. In a legal setting, the burden of proof refers to the obligation to prove a disputed assertion using evidence. This obligation is met in two ways. First, sufficient evidence must be produced for a legal case to go to trial. This is referred to as the “burden of going

forward,” and this obligation is included as the minimum standard for the amount of evidence that CEM case-study researchers should be required to provide. The second aspect of the burden of proof relates to the sufficiency of the evidence provided and is termed the “burden of persuasion.”

This work begins with an assessment of case-study research in the context of the CEM domain, including a description of how case-study research is used by CEM researchers and an examination of 156 papers published in the *Journal of Construction Engineering and Management* that employ case studies as a research method to evaluate the comprehensiveness and consistency of use. Quantitative analysis was done to identify general trends in the use of case studies for research and to identify the case-study papers to be examined qualitatively. This initial analysis revealed 33 papers that utilized the case-study research method to propose new theoretical models. The methodological approach of these papers was then examined to induce a comprehensive framework for conducting theory-building case-study research in the CEM domain. First, the elements of meeting the burden of going forward are outlined. These are the fundamental evidentiary standards for case-study research that all theory-building case-study research papers should meet. Second, these theory-building case-study research papers are used to establish guidelines on the amount of evidence that should be provided by case-study researchers to meet each prescribed level of the burden of persuasion.

Assessing Case Study Research in CEM

CEM researchers most often receive their graduate education in colleges of engineering that focus on quantitative and experimental methods; consequently, CEM researchers have limited training in the case-study method. Nevertheless, many construction industry phenomena of interest are often too large or too expensive to test in a more traditional experimental fashion and the number of variables in play can be too numerous for a meaningful quantitative analysis. The CEM domain is characterized by large unique projects, projects that can be extremely long in duration (taking sometimes years to complete), temporarily aligned teams of experts, regional variation, and material and technical innovation. Case studies allow CEM researchers to study phenomena in a real-life project where participants are making decisions about real issues that impact such factors as time, cost, quality, and safety. As with other methods, researchers are challenged by (1) access to projects for observation and data collection, (2) access to personnel in the office and field, and (3) access to information that is often considered proprietary or confidential. However, as a researcher establishes a relationship with a case-study project, these barriers are often overcome because the researcher is committed to an in-depth study and can be accepted as part of the project team.

One of the biggest challenges of statistical studies in CEM research is the number of variables that determine the success or failure of projects and the unique nature of construction activities. For instance, correlations between the introduction of new technologies or work processes and the resulting benefits on a project are often very difficult to measure. Researchers at Purdue University identified no less than 42 factors that influence the success or failure of the implementation for web-based project management systems on construction projects (Nitithamying and Skibniewski 2003). Causation is even more difficult to prove, where individual attitudes, group dynamics, local market conditions, luck, and project momentum can impact the performance on projects before variations across business practices, management techniques, and technology applications are even considered. In quantitative

research, variables are often treated as if they have an autonomous existence (Regin and Becker 1992). Case studies (either qualitatively or quantitatively designed) provide context and description for the data and variables collected. This allows for associations or similarities to be observed where they were not anticipated, or it allows investigators to more deeply substantiate the correlations they find in the data. Case studies allow CEM researchers to answer questions of how and why, to observe and document causal factors, to quantify the impact of new technologies or techniques on projects by exploring the details of a particular application, and to capture the participant's own observations about how the case in question is similar or different from other projects.

Furthermore, case-study methods allow researchers to work at a variety of levels of granularity. A case study can be an exploration of national industry standards, a city agency, a company, a project, or an individual (Regin and Becker 1992). In CEM research, this allows investigators to review a company, a project, a government, or an individual. Comparative case studies focus on separate but comparable instances of the same general phenomenon (for example, comparison between Japanese companies and U.S. companies and their approach to web-based project management.) This allows the CEM researcher to contextualize a phenomenon accounting for the complex set of variables characteristic of the built environment, and then define how the phenomenon plays out in the different contexts. Yet collecting comparable data across multiple projects can be extremely difficult in the CEM context where projects studied may be a significant distance from one another, may involve a different network of firms and individuals, and the processes of interest may be occurring across significant and nonoverlapping time-spans because of the extended, even possibly multiyear, duration of many construction projects. All of these reasons make construction projects particularly challenging for conducting comprehensive case-study research.

Case Study Research in the *Journal of Construction Engineering and Management*

The use of the case-study research method in the *Journal of Construction Engineering and Management* has significantly gained in popularity in recent years. The first use of the case-study research method the writers found in the journal was in 1985. Dividing the 25-year period from 1985 through 2009 into five equal intervals, it was found that in the five-year period from 1985 through 1989, the number of papers utilizing the case-study research method ranged from 0 to 2, with an average of 1.2 papers published per year. In the next five-year period the average rose to 2 papers per year, with between 0 and 3 papers published per year. The five-year average increased steadily to 2.8 case-study papers published per year between 1995 and 1999. However, in the five-year period from 2000 through 2004, the average use of cases rose to 8.6 papers per year, ranging between 5 and 19 papers per year. In the most recent five-year period, from 2005 through

2009, the average number of papers using case studies per year increased to nearly 17 papers per year. Comparing the 1985–1999 interval with the 2005–2009 interval, there has been more than an order-of-magnitude growth in the utilization of the case-study research method. Given the increased application of case-study research methods in the CEM domain, a dialogue is needed on the requirements for rigor in executing and publishing case-study research.

Table 1 contains the number of papers published each year in the *Journal of Construction Engineering and Management* that utilized the case-study method from 1985 through 2009 according to an analysis of data collected from the online engineering journal article database Engineering Village. The search was confined in the Engineering Village database to articles published in the *Journal of Construction Engineering and Management* that mention the term “case study” either in the title, keywords, or abstract. The 156 articles identified represent a reasonable sample from which to examine general trends in utilization of the case-study research method and to identify a subset of case-study research papers from which to induce a framework for the comprehensive execution of case-study research in the CEM domain. One paper identified in the search was removed because, although it had the term “case study” in the title of the paper, it did not employ the case-study method.

The growth in the use of the case-study research method in CEM reflects a general trend across the sciences. In a review of papers across the same time period, the number of papers in the ISI Web of Science database that reference the book by Yin on the case-study research method trends upward significantly. In the 1990s, Yin's case-study research method book was cited an average of more than 100 times per year. However, in the period from 2000 through 2005, that average increased to more than 250 papers citing Yin's case-study research method book per year.

In examining the 156 papers published in the *Journal of Construction Engineering and Management* over the past 25 years that utilize the case-study research method, 36 were descriptive case studies, 87 were used to validate preestablished models or theories, and only 33 were used to develop and/or propose new models. Descriptive case studies typically summarize single projects without concern for the ability to generalize the findings to other projects. Case studies used to validate models are designed specifically to evaluate whether the model developed in the paper produces results similar to the studied case. In these instances, the case-study method pursued is idiosyncratic to the model being validated. However, when the case study is the data on which the authors propose new constructs, propositions, or theoretical models, it needs to meet a minimum burden of proof to result in contributions that can be generalized beyond the cases studied. All 87 of the case-study research papers where the case was used to validate a model or framework contained validation that could be used to assess the general applicability of the model. However, of

Table 1. Increase in Case Study Research in CEM (Data Source: Engineering Village)

	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Number of case study research articles published in <i>Journal of Construction Engineering and Management</i>	1	2	2	1	0	3	2	0	2	3	5	2	0	1	6	8	6	5	5	19	11	15	24	14	19

the 33 papers that developed and/or proposed new models, only 21 provided evidence for the underlying validity of the models developed. If the CEM research community is to utilize case studies to propose new theoretical models, validity needs to be carefully considered and included. It is also important to consider that case-to-case differences in construction engineering and management are likely to vary more than in some other industries and therefore studying multiple cases is particularly important to generate insights that can be generalized. Of the 156 case-study papers reviewed, only 47, or about 30%, of the papers studied more than a single case. It would appear that although case-study research is growing in popularity among CEM researchers, that growth is not coupled with a consistent and comprehensive approach.

In the subsequent sections, the components of the case-study research method employed by the 33 theory building case-study papers identified will be used to induce a comprehensive framework for executing case-study research in the CEM domain. These 33 case-study papers were selected for their ability to support analytical generalization, not statistical generalization. In other words, if only a small number of papers employed a specific element of the case-study research method in CEM, it would not indicate that such a research tactic should not be included in a general case-study research method framework. Elements from the 33 theory-building papers were used to induce a comprehensive framework. Therefore, in lieu of quantifying how many theory-building case-study research papers adopted each component in the induced framework, the writers will instead provide representative examples of how theory-building case-study papers implemented each component. By combining these components together into a single framework, the writers hope to begin a discussion about the levels of evidence required to meet the burden of proof in CEM case-study research.

Meeting the Burden of Going Forward

The review of case-study papers published in the CEM domain found the application of the case-study research method to be inconsistent. It would appear that for some papers, the CEM academic community has taken a presumption of innocence approach. Some papers employing the case-study research method have been published without comprehensively addressing how validity was controlled, reliability was ensured, and sufficient data was collected. Erring on the side of accepting theoretical arguments without sufficient proof may be fueling criticisms of the case-study research method in the discipline. In order to achieve the new and expanded lines of theoretical inquiry that the case-study research method can enable, there must be explicit evidence that validity has been controlled, reliability ensured, and sufficient data collected. Subsequent sections outline three fundamental standards that CEM case-study research papers should meet on the basis of evidence from components of the 33 theory-building case studies published in the *Journal of Construction Engineering and Management*.

Air of Reality

In jurisprudence, an initial test in meeting the burden of going forward is whether a defense can be successful assuming all the purported evidence is true. This “air of reality” in case-study research is met by posing appropriate research questions and providing basic information about how validity and reliability were addressed in the research. Generally speaking, research should answer questions, not solve problems (Levitt 2004). Accordingly, identifying appropriate research questions is a prerequisite of a research plan or design. For example, a researcher might ask “How and why do

public agencies that are responsible for the implementation of public-private partnership (P3) programs organize themselves?” or “How do firms in design and construction networks implement technological change in boundary objects?” In a theory-building case-study research paper by Bogus et al. (2005), they ask “How can design activities be characterized in terms of information evolution?” Each of these questions meets the basic criteria for when the case-study strategy has a distinct advantage over other methods since the questions being asked are “how” or “why” questions about contemporary events over which the researcher has little or no control (Yin 1984). Researchers employing case-study research in CEM should clearly outline a research question that is appropriate to the method.

To have an air of reality, case-study researchers must also include validity and reliability strategies in their research design. For validity, researchers must describe how they controlled for construct validity (establishing correct operational measures), internal validity (establishing credible causal relationships), and external validity (establishing the domain where results may be generalized). Construct validity is particularly significant as well as vulnerable in case-study research. Without credible operational procedures, case-study research is likely to be criticized as subjective. This test depends on three key tenets: (1) utilizing multiple sources of evidence, (2) creating a chain of evidence, and (3) reviewing draft case results with key participants/informants. In a theory-building case-study research paper, Chang and Chiu (2005) describe testing a questionnaire with five project managers in advance of data collection to control construct validity. In addition to discussing validity, case-study researchers must discuss how reliability was addressed. Reliability in case studies is achieved by demonstrating that the operational procedures can be repeated to produce the same results. To achieve this, researchers can maintain an indexed set of notebooks from their field research that could subsequently be made available to other researchers (with confidential information and/or information that identifies the case company removed).

Missing Witness Rule

When a prosecutor in a legal case fails to produce a witness, it raises the presumption of inference that the testimony would have been unfavorable. In case-study research this is equivalent to, as an example, studying leadership qualities of successful project managers and focusing case-study data collection only on successful project managers. By sampling on the dependent variable, one cannot be certain that the leadership qualities found in the successful project manager will not be equally evident among unsuccessful project managers. In comparative case-study research designs, contrasting cases must be compared. These might vary by market, such as a liberal market economy CEM project network versus a coordinated market economy CEM project network, but the dimension of variance depends on the research question posed. Some researchers embed a combination of variation and consistency in their research design. Chen et al. (2009) collected data across six case studies to understand project management practices in the Chinese construction industry. However, they also critically examined differences in the perspectives of owners and contractors to sharpen the framework they induced. Analytic replication logic implies at least two cases be examined to capture data at the two analytically determined extremes.

There are situations where a case study is sufficiently extreme that it warrants single case-study data collection. Some might consider a single case rather indefensible since it is not unlike having a single data point. Single cases are quite justifiable when the case is a vital test of an existing theory, is a rare or extreme event, or

represents an opportunity to observe an event that was previously inaccessible (Yin 1984). The missing witness rule is a legal rule that allows for rebuttal witnesses to be excluded if they are unavailable. Hence, it is not always necessary that case-study researchers include analytical replication in their case-study research design and data collection efforts. However, if a researcher investigates a single case, he or she must clearly argue why collecting data on an analytically different case or set of cases was impracticable. Keast and Hampson (2007) developed a theoretical framework for understanding the role of relationship management in innovation networks by studying a single case in great depth. They argued that the \$500 million (Australian dollar) impact of the network they studied on the Australian gross domestic product over a 15-year period made it a unique case worthy of examination to elucidate how innovation networks function. They carefully managed the depth of data collection by examining nine different companies that participated in the network to ensure they captured the broadest perspective on innovation in the network.

Burden of Production

In case law, the burden of production refers to the act of producing evidence in support of a case. For case-study research, researchers must clearly describe the setting of the case study, describe how they collected the data, and, perhaps most important, include the data in the paper. A critical aspect of case-study research is the unit of analysis; in other words, what is the case under investigation? At its birth, the unit of analysis for case-study research was quite clear, the case was an individual (Platt 1992). In CEM research, the unit of analysis might be an individual (such as CEOs in CEM leadership research), but more than likely the case will be processes, programs, projects, or organizations. The unit of analysis should follow from the research questions posed. Like any other research approach, the boundaries of the unit of analysis must then be established, such as geographic limits and time periods. To meet the burden of production, case-study researchers must describe the case-study research setting in detail. If multiple cases are investigated, researchers must clarify the similarities or differences across the cases and how these relate to the research design. In addition to describing the setting of the cases thoroughly, in multiple case-study research designs researchers should provide a table of descriptive information about the cases. Molenaar et al. (2004) provided such a summary table describing each wastewater treatment facility case studied. They included the name, owner, design and construction cost, design and construction period, and the treatment process and capacity for each case investigated. Hartmann et al. (2008) develop a summary table of their 26 test case projects according to the year, location, type of project, and project size.

Data collection techniques in case-study research are fundamental to achieving defensible outcomes and are an important component to meet the burden of production. Foremost is the case-study protocol, which is more than the instrument for collecting information. The protocol includes the explicit procedures for administration of the instrument. This is particularly crucial for heightening the reliability of the results. Keast and Hampson (2007) describe creating an interview schedule to make sure all questions were completed and to control interviewer-induced bias. Molenaar et al. (2004) also describe developing a data collection protocol, in their case by integrating previous research by the authors, literature review, and input from a research advisory panel. They then explicitly include the data collection protocol in the appendix of their paper. Additional considerations include pilot efforts, sources of evidence, and record-keeping (Yin 1984).

The last and most important element of meeting the burden of production is actually including evidence from the case-study data collected in the paper. Many quantitative studies will provide tables of results with response frequencies and standard deviations to provide supporting evidence for their conclusions. However, often qualitative case-study papers describe the case-study research setting and then move quickly to the findings of the research without producing example quotes from the data. Providing quotes from the research is critical to give the reader sufficient evidence to evaluate the accuracy of the constructs and propositional relationships among constructs in the paper. Letting the data speak for itself is critical to meeting the burden of production in case-study research. Chen et al. (2009) do an excellent job of including quotes from the case data. For each construct they identify in the paper, they provide at least two direct quotes from at least two different cases in their multiple case-study research design. This is an effective approach at providing sufficient data to validate the construct validity while also demonstrating cross-case pattern consistency.

Meeting the Burden of Persuasion

The points raised in the previous section refer to fundamental standards that case-study researchers should address if they are developing theoretical contributions from their case-study research. These are required to meet the “burden of going forward,” or in jurisprudence, the sufficiency of evidence for a case to go to trial. When a legal case goes to trial, there are three measures that define the standards for conviction. In order of increasing evidence provided, these are; “preponderance of evidence,” “clear and convincing evidence,” and “beyond reasonable doubt.” Subsequent sections will propose guidelines for case-study researchers to meet these three increasing levels of evidence persuasion. Although the writers did not identify cases that met the highest level of the burden of persuasion (“beyond reasonable doubt”), it is important to begin a dialogue about all three levels of persuasion in order for case-study researchers in the CEM community to meet the burden of persuasion with case-study research and to strive for the highest levels of persuasion.

Preponderance of Evidence

In legal trials, the lowest level of persuasion is a “preponderance of evidence” and the term is used most frequently in civil cases. To achieve this level of persuasion, the evidence presented must be sufficient to show that the proposition is more likely true than not true. It is often referred to as the balance of probabilities. When researchers seek to make theoretical contributions, this lowest level of persuasion is defined as the depth of case data collected to achieve a minimum theoretical output. The frequency of using multiple case studies to increase depth of data, and hence evidence provided, has increased in recent years. Notwithstanding, in CEM it is difficult to collect data on projects that can involve dozens of firms and hundreds of individuals working in complex tasks and resource-interdependent relationships. In fact, this is the kind of complexity for which Yin (1984) argued that case-study research methods were ideally situated to examine. However, to collect data in this complex scenario, CEM researchers need to strive to deepen their case-study designs.

As described previously, the examination of the 156 papers published in the *Journal of Construction Engineering and Management* between 1985 and 2009 revealed that only about 30% employed multiple case-study research designs. To create a compelling case that the findings from case-based research are applicable beyond a single case, case-study evidence collected

should extend beyond a single case. The need for analytic depth in case-study research designs was previously described; however, there also needs to be depth in replication logic. Because projects can be so different given the customized nature of the products that are built, CEM practitioners need to collect data on multiple analytically similar cases that have depth. Replication can be used to strengthen evidence by repetition and create generalizable theory. For instance, Riley et al. (2005) conducted a case study of mechanical, electrical, and plumbing (MEP) coordination for which they collected data on four cases. They studied a civic arena, a research lab, a classroom office building, and a library. By examining four relatively unique but analytically similar cases they were able to generalize more from their findings than if they had studied either a single MEP coordination case or four MEP coordination cases that were all research labs. Molenaar et al. (2004) also developed a literal case replication research design studying three contrasting yet analytically similar design-build wastewater treatment plant cases. Some researchers expand the number of cases investigated by taking advantage of case data collected over an extended period of time. Hartmann et al. (2008) described generalizing from 26 case studies collected by colleagues over a period from 1996 to 2005 to examine how three-dimensional (3D) and four-dimensional (4D) models are used on construction projects.

Beyond studying multiple cases, there is also an opportunity for CEM researchers to avail themselves of embedded subunits of analysis that may exist to deepen the base of data within a single case or across a set of cases. Additional units of analysis are subsets of the primary unit (Yin 1984). For instance, the case may be an organization's capital program, and its individual projects are further units of analysis, which are sometimes referred to as embedded units. Pulaski and Horman (2005) focused on constructability issues as an embedded subunit in their examination of six cases of how firms organize constructability knowledge, and they were able to identify 77 constructability issues. They increased their pool of analytical data by more than an order of magnitude by focusing on an embedded subunit across the six cases investigated.

Increasing the number of cases or instances under study with the additional dimension of embedded subunits of analysis enables case-study researchers to improve the persuasiveness of their arguments and the extent to which they can generalize their findings. However, there is one more element to meeting this lowest level of the burden of persuasion. For case-study researchers to make a theoretical contribution, it is not sufficient to simply provide sufficient depth of evidence, they must make clear statements of the theoretical contribution of the research. To meet the "preponderance of evidence" level of persuasion, case-study researchers should clearly identify the new or refined theoretical constructs that the depth of evidence supports. Mahalingam and Levitt (2007a) refined a set of existing constructs in their study of institutional differences on global projects by adding a dimension of the type of institutional conflict that, they argue, may be a critical step in developing an institutional theory framework for understanding cross-national problems on global projects.

Clear and Convincing Evidence

The second standard of the burden of persuasion is "clear and convincing evidence." This describes the situation where an argument is substantially more true than not true. In case-study research terms, researchers should meet the guidelines presented in the "preponderance of evidence" standard and additionally include longitudinal data collection, utilize multiple researchers and/or raters, and triangulate data to meet the clear and convincing evidence standard. Furthermore, researchers seeking to meet this burden

of persuasion should formally combine constructs into new or refined propositional statements.

Case-study research is an opportunity to describe the process by which a complex phenomenon unfolds. In CEM research, there is complexity at many levels. The writers have observed complexities such as conflicting obligations at the level of teams in studies of subcontractor coordination with building information models. At the level of the organization, there is observed complexity in public-private partnerships and cross-national differences in innovation alignment. Individuals interviewed in case-study research may not be able to describe the many details that bear on the focal examination of the case. To deal with this complexity, researchers should pursue longitudinal data-collection strategies. Interviews should be conducted at multiple points in time and, if possible, include periods of direct observation. In a theory-building case-study research paper, Herbsman (1986) collected 60 to 100 observations over a 7-month period for each of 12 construction input factors they studied. Mahalingam and Levitt (2007b) described spending four months on the four project cases they studied and in the process interviewed 77 individuals from 12 countries. Since they were studying safety issues in cross-national collaborations, it was critical to be on the international project site for sufficient time to observe worksite safety to identify and interview the relevant stakeholders.

Often initial discussions with the participants in case-study research are focused on addressing issues of confidentiality. Multiple interviews with the same interviewees and with multiple individuals from the same organization should be planned to allow time to get past initial concerns of confidentiality and for the researcher to develop a rapport with the interviewees and with the organization or project team being examined in the case. El-Tayeh and Gil (2007) described collecting data from five different individuals with different job roles to overcome biases. Chen et al. (2009) also describe collecting data from between seven and 12 individuals across three role responsibility levels in their study involving six case studies. They described the purpose of collecting multiple interviews from the same firm as an effort to capture the organizational rather than the individual perspective of project management practices. By collecting data from multiple sources and by collecting it over time, the researcher can improve the internal validity of the findings when consistent patterns of responses are observed across interviewees and over time.

In addition to depth in the number of individuals interviewed, it is also important that multiple individuals perform the interviewing and/or rating of the data. Involving multiple researchers in the data collection can allow a research team to be in more than one place at one time. This is critically important in some comparative case designs where the two cases being investigated may be occurring simultaneously. Pulaski and Horman (2005) describe a case-study data collection effort involving multiple researchers on a case-study research site for three months collecting data. Involving multiple researchers in the data analysis is also a key strategy for refining the constructs and propositions that emerge from the research. If involving multiple researchers in data collection is impractical, then researchers should employ an interrater reliability test (Bers and Smith 1990; Cohen 1968). With this test, a researcher not involved in the research is given a sample of the data points or quotes collected in the research and asked to classify them into the constructs identified by the researcher. The measure of the alignment between the independent rater's categorization and the researcher's categorization is an important measure for the internal validity of the constructs, propositions, and models presented in a paper.

Table 2. Meeting the Burden of Proof Checklist for CEM Case Study Research

Burden of proof	Level of evidence (if applicable)	Research strategy checklist
Meeting the burden of going forward		Pose appropriate <i>how</i> and <i>why</i> research questions Provide strategies for validity and reliability in research design Control for construct validity Control for internal validity Control for external validity Create reproducible operational procedures Employ analytic replication in comparative case-study research designs Select and describe case settings that support research questions Define data collection method and protocol Include data in published work
Meeting the burden of persuasion	Preponderance of evidence	Utilize literal replication logic with multiple cases or subunits of analysis
	Clear and convincing evidence	Define new or refined theoretical constructs Include longitudinal data collection Involve multiple researchers or raters and/or conduct interrater reliability test Triangulate across data types, across cases, and/or across subunits of analysis Formulate new or refined propositional statements
	Beyond reasonable doubt	Link propositions into a cohesive theoretical model that explains a phenomenon Demonstrate the applicability of theoretical model to scenarios outside of case data collected

A third element of case-study research that enables researchers to meet the standard of clear and convincing evidence is triangulation. Triangulation should be performed across data collection types and across cases or embedded subunits within and across cases. In many of the CEM theory-building case-study research papers examined, authors mentioned that they planned to triangulate across multiple data sources. However, such triangulated comparisons were rarely found in the analyses presented. Molenaar et al. (2004) do a clear job of describing the process of triangulating data across three wastewater treatment plant design-build projects. They indicated that for a finding to be included as valid, it had to be triangulated and observed across two out of three cases.

In addition to furnishing more convincing evidence to meet this standard, case-study research seeking to make theoretical contributions must also expand the scope of the contribution to theory. To be clear and convincing, case studies must refine or introduce theoretical propositions. Yin (1984) stresses the importance of moving beyond specification of constructs to the formulation of propositions on the basis of those constructs. To begin to develop new theories or extend existing theories, researchers must be more comprehensive in the approach and include formally stated propositional statements that give an indication of how the constructs identified in the research relate to one another and to already-identified constructs from the literature. A well-formulated proposition should be stated with as much precision as hypotheses are in other forms of research. Propositions should present opportunities for researchers that wish to extend from the work to perform computational simulation models, survey-based statistical research, or other methodological approaches to test the propositions.

In some cases where the concept is in a relatively well defined theoretical area, a researcher might define preliminary propositions. Preliminary propositions can serve two important functions. First, they will provide the researcher with direction, a compass to guide the study. Second, they help identify what evidence or metrics are appropriate for the case study. For instance, a preliminary proposition might be: P3 program administrations are organized to maximize the economic value of projects delivered. While this statement may or may not be true, the proposition acts in many respects like a

hypothesis in a statistical study and guides the data collection. The theoretical contribution can then be couched in terms of providing evidence supporting the proposition or a refinement of the proposition.

In many situations, predefined propositions may not be appropriate. For research that is preliminary or exploratory, propositions may impose unnecessary constraints. This more exploratory case-study research can lead to the formulation of new propositions that the CEM community can subsequently test through hypothesis-driven research. For example, a proposition that emerged from case-based theory-building research on forecasting design-related problems was as follows: “profile curves of different disciplines predict the pattern of problems throughout that discipline’s progress” (Glavin and Tucker 1991). In a case study of coordination strategies to address overlapping tasks, Gil et al. (2008) induced several propositions including the following proposition: “if the promoter can better spell out the extent to which preliminary information about fit-out is ambiguous or uncertain, or both, and when the fit-out concept is likely to become frozen, it may be easier for base-building designers to determine the most suitable coordination strategies needed in order to efficiently overlap design with construction.” Propositional statements move beyond the definition of constructs to articulating propositional causal relationships among the constructs supported by the case data. These relationships can also be examined across the data set. For example, Fang et al. (2006) used factor analysis and logistic regression methods to analyze relationships among the constructs of safety climate, personal characteristics, and individual safety behavior. Researchers seeking to provide clear and convincing evidence should expand beyond the formalization and refinement of constructs to the development and refinement of theoretical propositions.

Beyond Reasonable Doubt

The highest standard of persuasion in jurisprudence is for the evidence to prove an argument “beyond reasonable doubt.” The writers do not believe that most case-study research, particularly exploratory research, can realistically meet this standard. This

belief stems from the great deal of variability from case to case given the uniqueness and site-based nature of production in construction, as well as the diverse range of specialists involved in projects. However, it is useful to begin a dialogue on what burden of persuasion would be required to meet this standard. At this level, the burden relates not to providing additional evidence, but rather to the persuasiveness of the arguments. Theory-building case-study researchers seeking to meet this standard should link propositions developed or refined in the paper to a cohesive theoretical model that explains a phenomenon. The critical element of meeting the standard of persuasion is not the model itself, but rather the extent to which the researchers argue and demonstrate the external validity of the model. To argue the external validity, the researchers must comprehensively situate the theoretical model developed in established theoretical models in the literature. The researchers should demonstrate the applicability of the model by describing scenarios outside of the case data collected that can be described by the theoretical model developed or refined in the paper.

Conclusions

This study assessed the use of the case-study research method in the CEM research community and more broadly. The case-study method is growing in popularity across disciplines and specifically within the CEM research community. However, the application of the method in CEM was found to be inconsistent. If practitioners are to achieve the advantages of the case-study research method and respond to critics of the method, then they must improve the consistency and comprehensiveness with which case-study research in the CEM research community is executed. Adopting the metaphor of meeting the “burden of proof” from jurisprudence, this study induced a set of requirements and guidelines for case-study research in CEM on the basis of 33 theory-building case-study research papers published in the *Journal of Construction Engineering and Management* over the period from 1985 through 2009. To meet the “burden of going forward” a standard is proposed that all case-study research papers should utilize appropriate research questions, provide sufficient details about the case studied and data analyzed, and address validity and reliability. The writers further propose that to meet the “burden of going forward,” case-study researchers should employ analytical replication logic in comparative case-study research designs or, if this is impractical, argue convincingly why comparative cases are not presented.

The concept of “burden of persuasion” was borrowed from jurisprudence to describe guidelines for meeting three levels of persuasion with theory-building case-study research. At the lowest level, case-study researchers should employ literal replication depth in their research design and/or identify embedded subunits of analysis within and across the cases investigated to expand the base of data from which to develop theoretical constructs. To provide clear and convincing evidence for a medium level of persuasion, it is suggested that theory-building case-study researchers collect data longitudinally, involve multiple researchers in the data collection and/or analysis, and meaningfully triangulate across data collection types and cases to develop or refine formally stated propositions. Finally, the writers propose that meeting the highest level of persuasion, which in the legal field is referred to as “beyond a reasonable doubt,” is beyond the scope of most case-study research projects in the CEM domain. Nevertheless, theory-building case-study researchers seeking to achieve this highest level of persuasion should consider integrating the developed or refined theoretical propositions into a coherent theoretical model and comprehensively arguing how the theoretical model applies to scenarios

outside of the cases studied and integrates with existing theoretical models in the literature. Table 2 contains a summary check list for meeting the burden of proof using the case-study research method in the CEM domain.

The previously proposed standards and guidelines were derived from an assessment of 156 published CEM case-study papers and an analysis of 33 theory-building case-study papers. Notwithstanding the number of papers investigated to arrive at the proposed standards and guidelines, the writers’ intention is for this paper to be the first in a conversation about how to improve the consistency and comprehensiveness of case-study research in CEM. Yin (1984) has argued that the lack of standards and guidelines may be the root cause of many criticisms of the method in different fields. The writers hope to initiate a dialogue within the CEM academic community about how to collectively improve the rigor of case-study research within the CEM domain as other domains have successfully been able to achieve. Improving case-study research rigor will both enhance the ability to generalize from case-study research findings and respond to critics who find the application of the method in CEM research to be lacking in rigor. If researchers can meet the burden of proof, then theory-building CEM case-study research has the potential to yield new lines of inquiry and new theoretical models to enrich CEM research across all methodological approaches.

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