

Exploring the emergence of lock-in in large-scale projects: A process view

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Manuscript Details

Manuscript number	JPMA_2019_293_R1
Title	Exploring the Emergence of Lock-in in Large-Scale Projects: a Process View
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Abstract

The purpose of this paper is to investigate the emergence of lock-in in large-scale projects. Although large-scale projects have been studied for decades, most studies have applied economic or psychological perspectives to emphasise decision-making processes at the project front-end. Of those studies, some have focused on poor decision-making due to lock-in and the escalating commitments of decision makers to ineffective courses of action. However, little is known about the way that project decisions are affected by organizational and inter-organizational contexts and the actors involved. Understanding decisions from a process viewpoint with a long-term (inter-) organizational perspective will lead to a better understanding of lock-in and the overall performance of large-scale projects. This qualitative research is based on a case study. The research setting is the multi-actor Madrid–Barcelona High-Speed rail Line (HSL) project in Spain. Through observations, interviews, several project documents and report analysis, we explore the processual nature of the choices made during the course of the project. We consider the contextual conditions that give rise or support the emergence of lock-in in relation to pre- and post-project effects, institutional influences and management practices that create action spaces at the project level. Our findings suggest that lock-in emergence requires the recognition of the long-term (inter-) organizational perspective regarding mechanisms and effects rather than confining decisions to the individual or single actor control in the front-end of projects. Based on organizational theory, the main contribution of this paper is to enrich our understanding of the emergence of lock-in using process theories.

Keywords	lock-in; path dependence and creation; decision-making process; large-scale projects; temporary inter-organizational setting; process theory;
Taxonomy	Contextual Approach, Decision-Making Process
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Order of Authors	Ermal Hetemi, Anna Jerbrant, Joaquín Ordieres-Meré

Submission Files Included in this PDF

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point-by-point_190717.docx [Response to Reviewers (without Author Details)]

Highlights.docx [Highlights]

Title_page.docx [Title Page (with Author Details)]

190715_Paper_CLEAN_REVISED.docx [Manuscript (without Author Details)]

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Manuscript title: "Exploring the Emergence of Lock-in in Large-Scale Projects: a Process View"

Manuscript #: JPMA_2019_293

Suggestion, Question, or Comment from the Editor	Author's Response	Change in the Manuscript
Although two reviewers offer very short feedback, they are very well in line with what the third reviewer is proposing. A lot of the feedback deals with argumentation and understandability - how to make the key issues understandable to readers. Personal note: I do not think there is a need to add the methodological approach to the title (as one of the reviewers suggest); that is not really typical in our journal anyway.	We are grateful to the reviewers for their time and constructive comments on the manuscript. Indeed, they have raised important points and offered immensely helpful suggestions improving the manuscript, particularly reviewer #3. We did our best to address the issues the reviewer's raised and to revise the manuscript. In the following we go through the comments by the reviewer point by point (as advised from you)	See below...

Suggestion, Question, or Comment from Reviewer #1	Author's Response	Change in the Manuscript
I recommend publication of the paper, but there are a few aspects that could be improved and/or explained better before the paper can be approved: [Title] The term "Case Study" needs to be added to the title.	We largely agree with the points raised by reviewer #1 and considered many of them in the revised version of the manuscript. However, regarding this particular point and following the editor's advice we decided not to include the term "case study" in the title as this is not very typical to the International Journal of Project Management	n/a

[General] The authors need to elaborate how the conceptual process framework is generalizable to other settings rather than the analyzed case study.	We agree to this point; this limitation is critical when performing a single-case study and needs to be discussed. Can a single case study be generalized and be valid for other cases? This is a well - debated question within the literature on methodology, and has been answered with a “yes”, by several authors, who have also pointed out that the purpose of a case study is not to develop statistical generalizations, but analytical generalizations (Merriam, 1988; Flyvbjerg, 2006). It could thus be argued that the case studied here, the HSL project, may thus be used to advance theory, through the heuristic nature of the case study, which widens the readers’ understanding of the issue at hand – the emergence of lock-in in large scale project (Merriam, 1988) We addressed the issue under section 5.4 Limitations and areas for future research accordingly.	see between lines 1071-1101
[Introduction] “When large-scale infrastructure projects are executed by LSTOs, performance problems—such as budget overruns and slipping schedules—are the norm...”. The issue should be explored in	We are grateful to the reviewer for the literature suggestion, it has helped us to better posit the paper – improving the argumentation and understandability. We have added the paper entitled: “Integrated	see line 30

the broader context of literature. The citation and discussion here are insufficient; see for example ...	management of on-site, coordination and off-site uncertainty: Theorizing risk analysis within a hybrid project setting” to the following citation. We believe it to fit into our argument but not the second paper suggestion unfortunately.	
[Tables & Figures] Should be discussed in more details.	We completely agree with the comment made by the reviewer. 1) We have discussed the tables and figures into more detail and referred to them in particular and more often: we included a new table (table 1) ensuring the high validity and reliability of our findings 2) We have also included a new Figure (Fig. 1) showing the criteria for interviewee selection, contingent on their profile, organization background and their involvement throughout the project life-cycle (see between lines 743-748); 3) we have further discussed Fig. 2 4) we have particularly emphasized Fig. 3 and discussed it in much detail under the discussion conclusion section	1) see between lines 537-545); regarding table 1 2) see between lines 403-415 and between lines 1061-1068; regarding table 3, (see between lines 975-988) 3) see between lines 682-690 4) see between lines 922-944

[Conclusion] Should highlight most significant findings.	We completely agree with the comment made by the reviewer. We have distinguished the most important contributions of our study; Our study makes an important threefold contribution to project management scholarly knowledge and to path dependence/ creation research that explores path related processes and lock-in's emergence	see under section 5.2 between lines 991-1043
[References] Should be updated (use more recent references).	We completely agree with the comment made by the reviewer. We have updated our references;	n/a

Suggestion, Question, or Comment from Reviewer #2	Author's Response	Change in the Manuscript
There appears to be a good source of materials that could lead to a relevant paper. However, in my opinion this paper is not yet finished. My main issues are: This approach requires a better discussion of theory (what are you looking for). The current theory design is vague, not sufficiently specific. Definitions are poor or lacking and the framework design should be much clearer. I feel this clarity is achievable, since the analysis follows a clearer path (although this could be	We are grateful to the reviewer for the time and constructive comments on the manuscript. Indeed, the reviewer has raised important points and offered immensely helpful suggestions improving the manuscript 1) We agree to this particular point and we have changed the theoretical framework section significantly; we discuss in much detail path dependence and the concept of lock-in; we also discuss the growing interest in considering the subtle relation among path dependencies and	1) see section 2 2) see between lines 180-200, 3) see the updated section 1 4) see the updated section 2.3

strengthened as well). Preparation for this path is currently insufficient.	path creations into the dynamics of self-reinforcing processes (Bassanini and Dosi, 2001; Sydow <i>et al.</i>, 2009; Garud <i>et al.</i>, 2010; Aaltonen <i>et al.</i>, 2017). In our view, we have improved the discussion by bringing new literature related also to the path-creation and 2) overall, we have added more recent literature aligning the paper to the current discussion of path-related processes in project studies; 3) we have also worked to improve the argumentation and the understandability; to this point we have completely rewritten the introduction, and 4) we have also among others rewritten completely section 2.3 under theoretical framework.	
The methodology needs better description. Qualitative research i.m.o. deserves a solid discussion of the approach and its strengths and weaknesses. A discussion of issues such as quality, rigor and trustworthiness of research design is currently mostly missing. Similarly, this discussion on this issue is too limited.	We completely agree with the comment made by the reviewer. We have provided a detailed description on the: 1) method choice, and 2) we have added the argumentation on the main criteria for the specific case selection; 3) in addition, we have included a new Figure (Fig. 1) showing the criteria for the interviewee selection,	1) see between lines 296-302, 2) see between lines 303-321, 3) see between lines 403-414, 4) see between lines 537-544, 5) see between lines 500-518, and 6) see between lines 1071-1101.

	contingent on their profile, organization background and their involvement throughout the project life-cycle and 4) regarding the issue concerning the rigor and trustworthiness of the research design, we discussed it under a particular section entitled “reliability and validity.” Here we draw on a broader criteria from social science research (Denzin and Lincoln, 2011; Yin, 2013), into ensuring the high validity and reliability of our findings. Thus, eight trustworthiness criteria were employed to ensure the rigor of the study: reliability, external validity, dependability, confirmability, and integrity, taken from interpretive view (Denzin and Lincoln, 2011; Yin, 2013) and fit, understanding, and generality taken from grounded analysis respectively (Gioia et al., 2013); In this regard we have included a new table (table 1) discussing the steps to address the criteria in specific 5) regarding the analysis part, we discuss in much detail our empirical analysis and in line with the purpose of process studies, we added the	
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	concept of ‘temporal bracketing’ (Langley, 1999), decomposing three distinct periods T1 (1990-1998), T2 (1999-2008), T3 (2009-2017) to sequence the processes and events chronologically for analytic purpose; 6) finally, we discussed if the findings from our single case study can be generalized (with caution) and be valid for other cases? This being a well debated question within the literature on methodology, and has been answered with a “yes”, by several authors, who have also pointed out that the purpose of a case study is not to develop statistical generalizations, but analytical generalizations (Merriam, 1988; Flyvbjerg, 2006). Thus, we argued that the case studied here, the HSL project, may be used to advance theory, through the heuristic nature of the case study, which widens the readers’ understanding of the issue at hand – the emergence of lock-in in large scale project (Merriam, 1988)	
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Suggestion, Question, or Comment from Reviewer #3	Author’s Response	Change in the Manuscript
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I thank for the privilege to review the paper. I personally see that the paper touches on an important theme relating to bounded rationality in decision-making processes of large (as well as small) scale projects. Hence, I see that the paper could have great potential to advance the field of project management. Unfortunately, in its current form I see many serious shortcomings in the paper mainly related to the use of concepts, reporting of empirical findings as well as final theorizing efforts. In addition, some parts are plagued by myriad expressions and too concept-focused language (i.e. academic jargon) which made reading parts of the paper a somewhat burdensome effort. I have tried to follow the structure of the paper to point out my more detailed comments as well as suggestions about potential developmental efforts.	We are grateful to the reviewer for the time and constructive comments on the manuscript. Indeed, the reviewer has raised important points and offered immensely helpful suggestions improving the manuscript.	n/a
On the definition of a lock-in. I think this is the most problematic shortcoming of the current manuscript. You define lock-in as “decision makers’ courses of action, which generally reproduce the	I am deeply impressed about this observation; it has helped us to better posit the paper – improving the argumentation and understandability. Thank you very much!	See section 1, particularly between lines 93-104 where we empirically define lock-in

status-quo in project outcomes by hindering inter-organizational coordination, learning processes and overall project success.” This is a really charged definition. Why lock in would automatically hinder inter-organizational coordination? If I understood your definition correctly lock-in is somehow related to managers’ limited decision-makings capability (i.e. bounded rationality) which leads to a tendency to use the current “resources” (being them organizational such as known suppliers or cognitive such as familiar practices). Why would this for instance automatically hinder coordination since isn’t coordination at least partly based on routines and other known structures?	We agree to this point and in the revised version of the manuscript we deleted this sentence and changed not just that but the introduction significantly, among others.	
Somehow, I just get a feeling that the authors are so enthusiastic about lock-ins that they forget to explain that what the concept really means to them. Sometimes it is referred as “a process” sometimes as “a state”. You keep citing Sydow’s work here but unfortunately not every reader is familiar with	As indicated earlier, we agree to this point and in the revised version of the manuscript we have defined lock-in empirically;	See between lines 93-104

his specific articles. Hence, it is really difficult to understand what you mean by the concept of lock-in. I think you just need to be selective here and craft your own clear definition by honouring the past work but also to explain that what it would mean in empirical terms and why is it even relevant to project management.		
When doing so (and overall) pay special attention the language. Unfortunately, the paper is plagued by myriad expressions which make it really difficult for the reader to follow the argumentation. Try to avoid following kind of expressions: <i>“In defining LSTOs, we essentially draw on the literature on projects as ‘temporary organisations’ (Lundin & Söderholm, 1995; Bakker et al., 2016) with an emphasis on large-scale infrastructure projects with an ‘institutionalised termination’ (Grabher & Thiel, 2015) and ‘inter-organisational facet’ (Sydow & Braun, 2018).”</i> Or <i>“Lock-in is a ‘time based theoretical concept’ differentiating between different states of flexibility or choice and stability or determinism,</i>	Again, we fully agree with the reviewer’s suggestion, and in the revised version of the manuscript we deleted all those sentences and try to simplify overall the argumentation	See between lines 111-115 among others

respectively (Sydow et al., 2009, p.698)."

Such sentences rely on past work but unfortunately as such are not understandable for a reader who has not familiarized oneself with these specific papers. Neither they really develop your argumentation towards anything. Academic prose is not about to showing off one's brilliance (i.e. I have read this paper and that paper) but about developing and delivering a logical argument.

Please, note that those were just couple examples but the same applies throughout the paper and does not concern just single sentences but the structure of the whole paragraphs and sections.

You need to be much more structured in your argumentation. For example, the introduction section is really "bouncing around" from lock ins to path dependence all the way to process studies and rational ontology. It is really difficult to understand how these varied streams tally up at the end. It is the job of the author to explain all this in such a manner

As indicated earlier we have completely rewritten the introduction section. Apart from it, we have added more recent literature aligning the paper to the current discussion of path-related processes in project studies;

See section 1

that the reader is not left out in the woods alone.		
On other concepts and theoretical background. I do not fully understand the author's explicit focus on discussing the generic characteristics of temporary organizations in sub-section 2.3. The sub-section is overly descriptive and gives just empty clauses about temporary organization and does not really forward the authors' argument on lock-ins. To put it bluntly, what exactly is so special in temporary organizations compared to more traditional or permanent setting? I think the authors should make much better job convincing the reader and avoid overly descriptive and "snobby" language through citation.	Again, we fully agree with the reviewer's suggestion, and in the revised version of the manuscript we have completely rewritten section 2.3 under theoretical framework.	See section 2.3
The final comment on the used language. I do not see much point in using the abbreviation LSTO if the authors do not specifically explain why large-scale is somehow important here. Such an abbreviation once again makes the reader to struggle.	We agree to this point and in the revised version of the manuscript we do not use the abbreviation LSTO; However, to us the empirical setting matters; The central argument in this paper is that the emergence of lock-in in large-scale projects requires a reflection on the nature of projects and their environment as dynamic, ever-changing which is partly recreated	n/a

	between actors involved in a consecutive project pattern. In other words, Large-scale projects are multi-organizational settings involving divers' actors (including public and private actors) however, the issue of lock-in through the reductionist view (which we seek to complement) involves at best the dyadic relationship among the actors involved which completely downplays their project nature—its temporality and the (inter-)organisational context (Artto <i>et al.</i>, 2016; DeFillippi and Sydow, 2016; Aaltonen <i>et al.</i>, 2017)	
On data and methods. You mention that the used approach leans on abductive reasoning and theory elaboration. If this is the case, you should more carefully pinpoint that what is actually the theory you are elaborating or what is the “anomaly” you found through your abductive analysis which the current theory does not fully explain (forming the grounds for its elaboration).	Thank you for your suggestions concerning this point, again it has helped us to better posit the paper and streamline our contribution. In the revised version of the manuscript most of the uncertainties should be clearer by now. We made it clearer: 1) that we use path dependence theory and path creation perspective; 2) in addition, we have changed the theoretical framework section significantly; we discuss in much detail path related processes and the concept of lock-in; we also discuss the growing interest in	1) see between lines 74-87, 2) see section 2, 3) see section 5, particularly between lines 903-944

	considering the subtle relation among path dependencies and path creations into the dynamics of self-reinforcing processes (Bassanini and Dosi, 2001; Sydow <i>et al.</i>, 2009; Garud <i>et al.</i>, 2010; Aaltonen <i>et al.</i>, 2017). 3) the elaboration part is the unearthing of contextual conditions: the mechanisms and effects – informed and shaped by our empirical analysis. In other words, by means of empirical examination of temporary inter-organizational networks we show how mechanisms and effects of path dependence/ creation actually take place in large-scale project settings. We empirically examine how these contextual conditions (path dependence/creation mechanisms and effects) affect the multi-actor project's overall scoping process and goals, adding to the limited knowledge of path-related processes in projects (Manning and Sydow, 2011; Levering <i>et al.</i>, 2013; Aaltonen <i>et al.</i>, 2017). In this regard part of our mechanisms and effects related to the case context: the	
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	project nature—its temporality and the (inter-) organisational setting (in particular, the shielding effect, the temporary fix effect, and the pre/post project institutional effects) were not a priori identified (see Ketokivi and Choi, 2014, p. 236). In our view, we yield nascent theorizing on how the temporary and (inter-) organizational nature of large-scale projects affects the emergence of lock-in, and foremost how the organizing and decision process is continuously shaped by project actors in certain direction over time, thus contextualizing the phenomena. Our study supplements the recent integration of research on path dependence and path creation (Sydow <i>et al.</i>, 2012; Aaltonen <i>et al.</i>, 2017; Sydow and Koll, 2017)	
Furthermore, your discussion on the unit of analysis is myriad. First you say that the unit of analysis is “intersection between the decision-making and the organization” then you state that “the unit of analysis is the organizing of the project as nexus activity...”. Once again try to avoid	We agree to this point and in the revised version of the manuscript we tell in clear terms what actually is the unit of analysis in this empirical study.	See between liens 304-305

such cryptic concept-plagued language and instead tell in clear terms that what did you actually analyze. Now it is not clear at all.		
When describing your empirical case avoid unnecessary abbreviation such as HSL and ADIF. When I began reading the case background, I needed use search function to actually find the definition. Apparently ADIF is just the original name of the organization but if it is written in capital letters the reader easily assumes it to be an abbreviation.	We agree to this point and in the revised version of the manuscript we simply refer to 'Adif' – as it is the original name of the organization. However, we do keep the abbreviation of HSL, in our view it simplifies the language during the case description, and we hope that this point is clearer in the revised version	See the abstract, between lines 10-11 and between lines 106-108
The used data as well as the analysis approach are somewhat convincing. I especially like the way you present your coding and raw data. However, it is not purely clear that who were actually interviewed or what was the role of the informants in the project. You emphasize a lot the inter-organizational context but currently it is not clear that who actually were the different parties of the project and how well their representatives were heard (table in the appendix gives some clue though).	We agree to this point and in the revised version of the manuscript we have clearly explained the primary sources; we have included a new Figure (Fig. 1) showing the criteria for interviewee selection - contingent on their profile, organization background and their involvement throughout the project life-cycle; we also acknowledge that due to practicalities we did not cover all of project participants/ actors e.g., local governments, other subcontractors and local construction firms, potential users etc. To partly overcome this limitation, we relied on document analysis and newspaper reports on the HSL project.	see between lines 403-414

In addition, it is not clear at all that what was actually the time span on which you base your findings. You argue that the project was initiated in 1980s and finished in 2009 but that you did observations in 2016. This just does not make any sense. You should do much better job in explaining on which grounds and sources you actually base your findings (and which period did you had data about and analyzed and how). Additionally, if the events which you analyze are really those taking place over 30 years ago (the front-end) you should explain how you took into considerations the high risk of retrospective bias. Please note that if it is really the case that you base your findings on those early events of the project it is naturally ok to do some participant observation in the current organization to understand better the context but then this would not be primary data on the actual events leading to the lock-in. Hence, please explain more thoroughly the data on which you base your findings and	Again, thank you for bringing up important points; in this regard however only part of our analysis relates to the front-end of the project and the project concept was actually discussed in 1985. 1) to begin with, in the revised version of the manuscript we discuss in much detail our empirical analysis and in line with the purpose of process studies, we added the concept of ‘temporal bracketing’ (Langley, 1999), decomposing three distinct periods T1 (1990-1998), T2 (1999-2008), T3 (2009-2017) to sequence the processes and events chronologically for analytic purpose; 2) we have indicated that our data collection relies in two different intervals, first between (1996-2010) and the second between (2015-2018) and clearly indicated that our case study includes the reinterpretation of the data sets; 3) at some parts when the view is considered partly retrospective, we also explain that we interviewed key people participating in those decisions (project proponents –	1) see between lines 501-518, 2) see between lines 387-402 and between lines 1071-1076 3) see between lines 442-451 and between lines 493-498 4) see between lines 513-518
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justify why you collected such data from a project implemented a long time ago.	two of them and the Adif Project Coordinator). To this end, we have indicated how we took into consideration the potential informant bias; following Eisenhardt and Graebner's (2007) suggestions when considering retrospective views of the case data, data collection approaches that reduce recall bias should be used: to interview highly knowledgeable informants who view a phenomenon from different perspectives; considering that in the ADIF management division we interviewed two kinds of respondents: project portfolio managers' (PPMs) responsible for multiple projects (high-level interviews), and PMs, responsible in some capacity for a single project (low-level interviews). In addition, we interviewed two different PM contractors/ suppliers and project proponents (actually part of this argumentation was in the former text, but we have emphasized it – as we also consider to be important) 4) lastly, we make it clear that we build our	
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	analysis and reasoning for the former periods T1 & T2 while relying mostly upon the first interval (1996-2010) of data collection sources, the interviews, participant observations and data reports. Whilst we rely upon the second interval of data collection sources (2015-2018), the observations and interviews for the latter period T3. We have also added the interview dates to help the readers' understanding.	
On findings. Overall, I think that the case you present is really interesting but unfortunately it is bit difficult to really follow your storyline and connect it to your findings and theorization. First of all, when you initially discuss about lock-ins you emphasize the front-end phase of a project. In your case this must have taken place in late 1980s. However, some of your findings and hence theorizing on lock-ins is based on much more recent events (e.g. you mention public procurement law established in 2007). You also tend to provide	We agree to this point and in the revised version of the manuscript we tell in clear terms the basis we rely upon throughout the analysis of the process; In the revised version of the manuscript most of the uncertainties should be clearer by now. E.g., we make it clear that our observations at the project level unearthing part of our mechanisms (in particular, the shielding effect, the temporary fix effect) they are related in specific to the first line segment and that we indicate clearly during the case description that part of works related to the central station in Madrid (Atocha station) were ongoing	See among others between lines 364-384 and 430-433

some anecdotal evidence as comparison of the old and the new (e.g. the quote on page 17). Unfortunately, such comparisons are rather thin when your “case” should be the analyzed project not the current practices used by ADIF. If it is the latter, you should completely alter your research design.		
The reader’s sensemaking is further complicated by your mixed usage of past, present and passive tone. For example, in sub-section 4.2.1. you describe some kind of generic approval process for public infrastructure process. However, this is written in passive tone and you refer to a myriad figure in the appendix. Hence, it is not clear that did the HSL project really follow such process and when it happened (I assume the process in 1980s must have been slightly different). Overall, you should do much better job in binding your narrative to the actual timeline of events as well as explaining who actually did what and when (avoid using passive tone). Now it is overly difficult for the reader to understand that on which phase of the project you based your theorizing as well as on	We agree to this point also and in the revised version of the manuscript: 1) we have improved the case narrative (providing more details), and the revised version of the manuscript has been carefully edited by the professional language editing service. So, most of the uncertainties should be clearer by now. 2) we have also indicated in clear terms where we based our theorizing and the basis we rely upon throughout the analysis of the process,	1) See between lines 323-384, 2) See between lines 500-518,

what kind of evidence you actually have on such a phase.		
On theoretical contributions / conceptualizations. I salute your determination towards theorizing. I believe that this would be the source of the true contribution here. However, I feel that the theorizing efforts here are still too immature. You seem to handle pretty well the past literature but as said it is presented in far too cryptic manner to the reader. This applies also to the actual theoretical contributions as well as the developed conceptual model. Unfortunately, after reading the paper couple of times, I cannot still fully understand what do you mean and want to accomplish by the term lock-in and how does it benefit project managers.	We thank you for your considerations concerning this important point, again it has helped us to better posit the paper and streamline our contribution. In the revised version of the manuscript we have rewritten and re-organized our concluding discussion and most of the uncertainties should be clearer by now.	see section 5
The conceptual model "Figure 2" feels also too inclusive indicating that "everything" has an effect on lock-in, which then seems to affect everything as well. You should be much more precise here and truly argue to the reader that what are actually the	We agree to this point, in the revised version of the manuscript we have completely reworked fig. 2 which in our view, now fits better the analysis, and the argumentation along the text and in a true process promises as it is the core of the paper. Please find the new figure	See between lines 918-945

negative as well as positive consequences of lock-ins as well as the key mechanisms behind it. I do neither see any “process” in the figure despite your promises on changing PM scholarship through process studies. Yes, there is a time “axis” there but I do not see any chronological pattern in the model itself. If you want to emphasize so heavily the process nature, please do as you preach otherwise leave the process-centricity out	labeled as fig. 3 due to new adding’s in the paper. We have discussed the figure in much detail under the discussion conclusion section	
To summarize, I see great potential in this paper. The authors definitely have done great work so far but in my opinion lot more is required to really push the envelope here. Despite the great promises at the outset of the paper, I feel that currently it accomplishes quite little. The acclaimed contribution is quite intuitive and not very novel (i.e. the institutional factors affect project organizing and that lock-ins are important). I think that the relatively rich case is lost in this process when it does not really report a clear “anomaly” which could allow theory elaboration. This means that through the claimed abductive	We thank you for your suggestions and consideration concerning this important point. In the revised version of the manuscript we have, in our view, addressed all uncertainties and the draft should be clearer by now!	n/a

process the authors are left with rather little to say about the topic despite the promises and great potential.

Furthermore, the trustworthiness of the findings is plagued by lack of transparency of the presented storyline (e.g. how the authors were able to probe into events over 20 year's time span). I do not want to doubt the data sources and believe that fixing these flaws is just matter of writing and expressing oneself. Unfortunately, I see that there is high risk that improving them lays beyond a single review process. However, I wish the authors all the best with their development efforts and thank for the possibility to review the paper.

Highlights

- Empirical research based on the multi-actor Madrid–Barcelona High-Speed rail Line project
- Grounded on organizational theory, the main contribution of this paper is to enrich our understanding of the emergence of lock-in using process theories
- Lock-in has been contemplated either as a starting point or an outcome but the process logic that give rise or support the lock-in emergence remains under explored
- The paper disentangles some of the contextual conditions that give rise to or support the emergence of lock-in
- The paper affirms that lock-in emergence requires the recognition of the long-term (inter-) organizational perspective regarding mechanisms and effects rather than confining decisions to the individual or single actor control in the front-end of projects

Exploring the Emergence of Lock-in in Large-Scale Projects: a Process View

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Abstract

The purpose of this paper is to investigate the emergence of *lock-in* in large-scale projects. Although large-scale projects have been studied for decades, most studies have applied economic or psychological perspectives to emphasise decision-making processes at the project front-end. Of those studies, some have focused on poor decision-making due to lock-in and the escalating commitments of decision makers to ineffective courses of action. However, little is known about the way that project decisions are affected by organizational and inter-organizational contexts and the actors involved. Understanding decisions from a process viewpoint with a long-term (*inter-*) *organizational* perspective will lead to a better understanding of lock-in and the overall performance of large-scale projects. This qualitative research is based on a case study. The research setting is the multi-actor Madrid–Barcelona High-Speed rail Line (HSL) project in Spain. Through observations, interviews, several project documents and report analysis, we explore the processual nature of the choices made during the course of the project. We consider the contextual conditions that give rise or support the emergence of lock-in in relation to pre- and post-project effects, institutional influences and management practices that create *action spaces* at the project level. Our findings suggest that lock-in emergence requires the recognition of the long-term (*inter-*) *organizational* perspective regarding mechanisms and effects rather than confining decisions to the individual or single actor control in the front-end of projects. Based on organizational theory, the main contribution of this paper is to enrich our understanding of the emergence of lock-in using process theories.

Keywords: lock-in; path dependence and creation; decision-making process; large-scale projects; temporary inter-organizational setting; process theory;

1. Introduction

Large-scale projects are multi-organizational settings involving diverse public and private actors whose interactions shape the scope of the project, locking it into a path that is influenced by the project actors' shared history (DeFillippi and Sydow, 2016; Aaltonen et al., 2017). Mainly because of their long timespan, which is often decades (Flyvbjerg, 2014), this type of project is developed through a series of decisions that involve interdependencies between strategic and complex tasks at multiple points in time among disparate actors, whose visions for the project sometimes conflict (Scott and Levitt, 2017; Pitsis et al., 2018). Consequently, the disparate contractual actors have different risk perceptions (Davies and Brady, 2016; Arashpour et al., 2017) and value creation approaches (Morris, 2013; Samset and Volden, 2016). On one hand, owners focus on the long-term project's lifecycle. On the other hand, contractors, subcontractors and other suppliers have a short-term perspective. Large-scale projects thus entail dynamic boundaries and contexts since the scope of their work is constantly negotiated, and the number of project participants is in constant flux throughout the project's lifecycle (Artto et al., 2016).

Because of the clear understanding of the current state but the limited foresight regarding the (*inter-*) *organizational* context (Sanderson, 2012; Artto et al., 2016) and the changing environment that characterises large-scale projects (Kreiner, 1995), management choices may become locked into a particular path that in the long-term may cause underperformance. In this regard, there are challenges involved in achieving consensus among the diverse actors, who have divergent modes of collaboration and differing project experience regarding the project's vision and their contributions. There is abundant evidence of governance failure in coordinating decision processes in large-scale projects (Flyvbjerg, 2014; van Marrewijk et al., 2016). In most cases, however, these failures have been attributed to the poor decision-making due to *lock-in* (Miller and Lessard, 2000; Cantarelli et al., 2010) and the escalating commitments of decision makers to ineffective courses of action (Jani, 2011; Winch, 2013). Lock-in has been contemplated either as a starting point or an outcome (e.g., Cantarelli et al., 2010), but the process logic that give rise or support the lock-in emergence remains under explored (Aaltonen et al., 2017). Hence, the process of decision-making and lock-in in large-scale

projects has been examined largely in relation to front-end decisions made by a single actor and the effects of the latter's poor performance (e.g., Cantarelli et al., 2010; Flyvbjerg, 2013). Researchers have examined the techniques and models designed to identify, assess and optimise management choices at the project's front-end (Williams and Samset, 2010; Flyvbjerg, 2013). Consequently, in previous research, the perspective has been predominantly reductionist (e.g., Cantarelli et al., 2010; Flyvbjerg, 2013). Moreover, extant literature has taken somewhat ahistorical view and has made little attempt to examine the emergence of lock-in in large-scale projects when considering that project choices are affected by the (inter-) organizational context. Relatively little attention has been paid to the potential for decision-making to be understood from the analytical perspective of process studies (Langley et al., 2013). Thus, the vital distinction made by process scholars between *owned* and *unowned processes* has been overlooked (Mackay and Chia, 2013). Aaltonen et alia, and Matinheikki et alia, are notable exceptions in this context (see Aaltonen et al., 2017; Matinheikki et al., 2018).

This papers' point of departure is the criticism of the 'reductionist view' (Stingl and Geraldi, 2017, p. 132), and its underlying rational kernel which is grounded upon the following implicit three-fold assumption. Firstly, decisions cause action, an assumption that also seems to be underlying the normative project management (cf. Cohen et al., 1972; Lundin and Söderholm, 1995; Engwall, 2003; Steen et al., 2017). Secondly, many large-scale projects are initiated with unclear specifications, i.e., revolving project goals that change during the project implementation due to deficient contracts (cf. Engwall, 2002; Steen et al., 2017). Thirdly – and mainly that plentiful choice options are available to the project actors (cf. Sydow et al., 2009; Aaltonen et al., 2017; Stingl and Geraldi, 2017).

The central argument in this paper is that the lock-in emergence in large-scale projects requires a reflection on the nature of projects and their environment as dynamic and ever-changing, which is partly recreated by the actors involved in a consecutive project pattern. We regard the concept of organizational *path dependence* (Sydow et al., 2009) as a promising starting point for developing an understanding of the lock-in emergence. The fundamental idea from path dependency to lock-in, at its simplest, rejects the notion that regardless of the starting point and the actors involved, the process

will gravitate to the same equilibrium (Grabher, 2005). Recently, there is a growing interest in considering the subtle relation among path dependencies and path creations into the dynamics of self-reinforcing processes (Bassanini and Dosi, 2001; Sydow *et al.*, 2009; Garud *et al.*, 2010; Aaltonen *et al.*, 2017). In this context, there is an attempt for considering the concept of path dependence in a thorough and rigour way beyond the metaphorical usage of ‘history matters’ (Bassanini and Dosi, 2001, p. 41). Building on them, we proceed to disentangle some of the contextual conditions that give rise to or support the emergence of lock-in. This endeavour seems relevant, timely and necessary in considering the recent calls for more empirical research that examines path-related processes in the temporary inter-organizational context such as large-scale project (Hellström *et al.*, 2013; Levering *et al.*, 2013; Aaltonen *et al.*, 2017). Therefore, we pose the following research questions:

RQ1: How and why does lock-in emerge in large-scale projects?

RQ2: What are the underlying mechanisms and effects that affect lock-in in these settings?

In our aim to complement the reductionist view, we contend that the emergence of lock-in processes in large-scale projects is a behavioural pattern grounded in prior ties and the interactions of the actors involved (Aaltonen *et al.*, 2017). We empirically define the choices in large-scale project settings, as partly restricted at the beginning of the process and then continuously influenced by various changes in industrial features and processes at the project level. We argue that lock-in is a process that provides the basis for promoting actions in project development through choice formation and shaping. Specifically, the lock-in process provides the necessary ongoing social construction during the project arrangement and the negotiated mission throughout the project. Our view does not undermine the significance of value-adding elements in the project’s front-end (Artto *et al.*, 2016; Liu *et al.*, 2019), nor does it intend to portray the arrangements in the early stage of the project as inept or lacking in purposive action but we do recognise that the choices made by project actors are possibly partial. In our view, the emergence of lock-in is subject to events that are influenced both externally and internally and are deeply intertwined with historical events, the actors’ desired outcomes and the (inter-) organizational practices in projects.

The purpose of this paper is to explore the emergence of lock-in in a large-scale project context by empirically investigating the multi-actor Madrid–Barcelona High-Speed rail Line (abbreviated as HSL) project. The major construction works in the project lasted for two decades (1990-2008), however and due to immense with drawn contracts and suspensions during which time (2009-2017) the project's network organization sought and continuously rearranged the design and plans of the project; redefining the project's scope. To understand the processes in large-scale project settings, we draw on the literature on project networks (DeFillippi and Sydow, 2016; Steen et al., 2018) and that in which projects are considered temporary organizations (Lundin and Söderholm, 1995; Bakker et al., 2016). Based on this literature, we apply a coherent (inter-) organizational lens (Sydow and Braun, 2018). We develop a conceptual process framework to explain the emergence of lock-in in large-scale projects through the influence of different (inter-) organizational mechanisms and effects. In addition, we discuss the importance of expanding the scope of previous research through the process view by including the nature of the project—its temporality and the (inter-) organizational context—to enable a fine-grained understanding of the emergence of lock-in. Apart from this introduction, our paper consists of four sections. Section 2 provides the theoretical framework, followed by the research design and methods in section 3, which describes the research approach and data analysis. In section 4, we discuss the contextual conditions that give rise to or support the lock-in emergence, as we identify the mechanisms and effects by applying the process perspective. Section 5 concludes the paper by discussing the theoretical and managerial implications of our findings, the limitations of the study and suggestions for future research.

2. Theoretical Framework

Over several decades, project management studies have discussed the challenges associated with the implementation of large-scale projects within the framework of infrastructure establishments (Morris 2013). In the early literature, the underestimation of costs at the planning stage, the political sensitivity regarding costs and benefits, and the difficulty of halting unsuccessful projects were recognised as key challenges (Staw, 1981). Historically, the major challenges in carrying out infrastructure endeavours were primarily technical and financial in nature (Morris, 2013). Although

most of these economic and engineering problems have been tackled (Samset and Volden, 2016), the complex (inter-) organizational and social misalignments of projects as well as the widely diverse actors in them remain under-studied (Artto et al., 2016; Pitsis et al., 2018).

2.1. Lock-in and self-reinforcing mechanisms revisited

Path dependence is the type of self-reinforcing process that is discussed the most in management studies (Sydow and Schreyögg, 2013). The fundamental point in the intuitive notion of path dependence is that history matters (Bassanini and Dosi, 2001). In organizational research, understanding how and why historical mechanisms take place in organizational life has become of critical interest (Sydow et al., 2009). In particular, the concept of path dependence and lock-in (Arthur, 1989), which originate in evolutionary economics, has gained prominence. In this regard, although lock-in often entails technological lock-in (Arthur, 1989), we are concerned with its organizational, institutional or behavioural form (Sydow et al., 2009). Nevertheless, in addition to appealing to both social and natural sciences, the concept of path dependence has been criticised for its ambiguity (Garud and Karnøe, 2001) and its disregard of human agency in the creation of new paths (Bassanini and Dosi, 2001; Garud and Karnøe, 2001). To address these criticisms, Garud and Karnøe (2001) proposed the perspective of path creation, suggesting that actors (i.e., individuals, organizations, and fields) affect social phenomena and may alter and/or deviate from their expected paths. In addition, the metaphorical and vague labelling of many history-dependent processes, such as path dependence, have been considered in organizational studies (Sydow et al., 2009) and project studies (Aaltonen et al., 2017). To this end, Sydow et al. (2009) developed a dynamic model that categorised the path dependence process into three phases: 1) pre-formation, 2) formation and 3) the lock-in phase. In essence, these authors suggested that the process of path dependence starts with a singular historical event, which under certain conditions may become a self-reinforcing dynamic and possibly end in an organizational lock-in (Sydow et al., 2009). Hence, a lock-in is understood as the end-phase process of organizational path dependence, and the theory of organizational path dependence stresses the lack of any realistic alternative in the lock-in phase (Sydow et al., 2009; Sydow and Koll, 2017). In management studies, the notion of path dependence has been used to

describe decision-making as not only a point in time but as a process: a behavioural pattern that over time renders a corridor of a limited scope of action that is “at least potentially” (emphasis in the original) strategically inefficient for management (see Sydow et al., 2009, p. 704; Schreyögg and Sydow, 2011).

The path dependence process can be conceptualised as one or a combination of several mechanisms, such as coordination effects and learning effects (Sydow et al., 2009). Hence, this self-reinforcing process is particularly interesting, as path dependencies do not concern only one type of self-reinforcing process. According to Sydow and Schreyögg (2013), self-reinforcing processes are jointly related at the origin of the concept. Indeed, the combination of self-reinforcing processes (i.e., irreversibility) and non-linearities are inherent in path dependence (Bassanini and Dosi, 2001). In addition to path dependence, the escalation of commitment is another self-reinforcing process that has received attention in behavioural decision-making studies (Stingl and Geraldi, 2017). The escalation of commitment refers to a course of action that occurs when an initial investment decision has negative results, but the decision-making body continues to invest further funds and support the same course of action in order to justify the costs in the hope of recouping the initial investment (Staw, 1981; Sydow and Schreyögg, 2013).

Recently, rigorous attempts have been made to consider the role of historical events and prior ties related to the decision processes or design choices in temporary (inter-) organizational contexts (DeFillippi and Sydow, 2016; Aaltonen et al., 2017). In particular, there has been a growing interest in considering the subtle relationships among path dependencies and path creations into the dynamics of self-reinforcing processes (Sydow et al., 2009; Garud et al., 2010; Aaltonen et al., 2017). It is noteworthy that the concept of path creation builds on theorising path dependence, particularly the increasing convergence between the two concepts in organizational and regional studies (Sydow and Koll, 2017) as well as project studies (Aaltonen et al., 2017). This concept may also be applied to large-scale project settings. In such contexts, mechanisms and effects are suitable ways to tackle the complex nature of decision processes compared to conventional approaches characterised by the focus

on a single actor (cf. Pajunen, 2008; Sydow and Schreyögg, 2013). The reason is that the emergence of lock-in entails a process that is triggered by a combination of constituents rather than single activities (Sydow et al., 2012). The focus on mechanisms and effects reveals the interdependencies of processes that generate outcomes and provides a powerful explanation, thus contextualising the emergence of lock-in (Pajunen, 2008). Hence, mechanisms and effects are powerful contextual conditions in the process of lock-in emergence compared to statistical cost-benefit analysis based on an outsider's perspective (Flyvbjerg, 2013), in which lock-in is explained by focussing on the input variable and outcomes but disregarding the process and the contextual conditions. Thus, the reductionist view (e.g., Flyvbjerg, 2013; Cantarelli et al., 2010) is concerned with the determinants of project failure and success more than with the multi-actor's interactions that actually shape the decision process (Steen *et al.*, 2017).

2.2. The process perspective

We have based the paper on the process literature (Langley, 1999; Langley et al., 2013) and the organizational path dependence and path creation perspective (Sydow et al., 2009) with a focus on the decision process. We therefore adopted the unowned process perspective, which resonates with path dependence theory's recognition that context and manifold peripheral processes influence choices (Sydow et al., 2012). The process perspective has been widely recognised and used in the theoretical organizational literature (Nicolini, 2012; Langley et al., 2013). According to Nicolini (2012, p. 11), 'in the last three decades the focus of organization studies has, in fact, shifted from the examination of organizations as entities (organizations as things) to the examination of organizations as theoretical discourses (organizations as phenomena), to the study of organizing as a social process'. The mainstream project management research that has applied organizational theory has also paid attention to how particular organizational actions occur and how processes work in projects. Examples are the process of transition (Lundin and Söderholm, 1995), the process of temporary hybridisation (Matinheikki et al., 2018) and the process of translation in the governance of large-scale projects (Brunet and Aubry, 2017).

In our study, we argue that, by taking a process approach to decision-making, project studies can benefit greatly from recognising the vital distinction made by process scholars between owned and unowned processes (Mackay and Chia, 2013). From the owned perspective, according to Mackay and Chia (2013), chance, nonlinearity and unintended consequences (i.e., consequences not intended by managers coping with a chaotic and messy reality) are diminished. By contrast, according to Langley et al. (2013, p.5), in the unowned process perspective, ‘context is not a constant and outside the changes being analysed but is itself continually reconstituted with and by a process of interaction over time, generating unexpected and largely uncontrollable chains of activity’ in which actors, environments and organizations are all constantly and mutually interacting. The unowned process perspective, therefore, refrains from allocating heroism or expertise and incompetence to leaders (e.g., Eweje et al., 2012; Flyvbjerg, 2014) and instead favours eventualities of the unexpected and the (inter-) organizational project context, which influence the processes in the project and organization. This view, however, does not preclude that managers, as conscious agents, can act purposively; it recognises that the choices and actions they make are necessarily partial (Mackay and Chia, 2013). In this context, project failure or success cannot be ascribed entirely to the deliberate choices of single actors or to pre-existing environmental forces.

2.3. The reductionist view and the futile dream of the perfect goal for large-scale projects

Both lock-in (Cantarelli et al., 2010; Williams and Samset, 2010; Levering et al., 2013) and the escalation of commitment (Jani, 2011; Winch, 2013) are typical issues in large-scale projects. They have been discussed in project studies that focused on behavioural decision-making (Aaltonen et al., 2017; Stingl and Geraldi, 2017). In a recent publication, Flyvbjerg (2016) portrayed a murky environment: he described ‘malevolent Hiding Hand’ to orchestrate decisions underpinning a ‘rational ontology’ that sees strategic misinterpretation and deception as part of the decision-making process in large-scale projects (cf. Stingl and Geraldi, 2017). In the extant literature (e.g., Flyvbjerg, 2006b; Flyvbjerg, 2013) that considers lock-in control-oriented by single actors, reference class forecasting has been proposed based on the view that it is a form of de-bias emerging from behavioural economics studies (Lovallo and Kahneman, 2003). However, to understand what influences decision-

making processes and lock-in emergence, reference class forecasting offers possible cures (e.g., Flyvbjerg, 2013). Therefore, efforts are still grounded in the reductionist view, in which correct decisions are made in an objective manner (Stingl and Geraldi, 2017). Thus, in the reductionist view, the issue of lock-in involves at best the dyadic relationships between the actors involved, which downplays the project's nature, including its temporality and the inter-organizational context (Artto et al., 2016; DeFillippi and Sydow, 2016; Aaltonen et al., 2017). More importantly, the reductionist view (e.g., Cantarelli et al., 2010; Flyvbjerg, 2013) is supported by the owned process perspective (Mackay & Chia, 2013), which leads to the privileging of decision-making as ahistorical, occurring at points in time at which strategic misinterpretations or incompetence rather than choices, chance and project circumstances are considered to shape the emergence of lock-in. As indicated earlier in this paper, the reductionist view focuses on the input variable and the outcome of the lock-in process rather than the process itself. Thus, it is a decontextualised and static approach that focuses on cost-related issues and emphasises performance as the ultimate independent variable.

Although many organizational project management scholars (e.g., Andersen, 2008; Lundin and Söderholm, 1995) have referred to the concept of limited rationality (Simon, 1955, p. 113), the reductionist view considers that an action is the consequence of decision-making. Nevertheless, many studies have shown that an action is not always a consequence of decision-making and that more often than not, the opposite occurs (Cohen et al., 1972; Langley et al., 1995; Steen et al., 2017). Thus, because of the nature of processes and the unpredictable antecedents of actions, the decision-making processes in large-scale project contexts cannot be controlled by the individual project manager (PM) or any single project actor (Aaltonen et al., 2017). Hence, processes are emergent, and because they comprise actors' process interdependencies, they demand reflection on the project's inter-organizational context (DeFillippi and Sydow, 2016; Sydow and Braun, 2018). Particularly because of the latter, according to the descriptive stream on project studies, it has been established that a project's goals, objectives, design options, and scope will change over time (Artto et al., 2016; Aaltonen et al., 2017; Steen et al., 2017), and that it is a myth that large-scale projects can have clear goals and controlled objectives beginning in the early phase of the project's lifecycle (Engwall, 2002).

In the project's context (Engwall, 2003) and networks (Manning and Sydow, 2011; DeFillippi and Sydow, 2016), various actions combine to influence project choices and chance matters (Mackay and Chia, 2013). Consequently, there is a need for a social understanding that complements the psychological orientation of the reductionist view as well as a need for a process view in exploring decision-making processes by tracing wide-ranging effects in the long-term (inter-) organizational context. This latter point will be explored in this paper. As we will show, if the research scope is expanded beyond the individual decision-maker and the single actor to account for the project's nature, its temporariness and the (inter-) organizational context, a fine-grained understanding of the emergence of the lock-in could be derived.

3. Research Design and Methods

In the following section, we present the analysis of the data collected from the in-depth qualitative case study (Rowley, 2002) on the processual nature of choices made in the HSL project. In this study, we aim to understand the emergence of lock-in through the dynamics of the large-scale project lifecycle as temporary yet embedded in a network (DeFillippi and Sydow, 2016; Braun and Sydow, 2019), thus privileging processes over causes in contemporary project management theory. This research is abductive in nature because the starting point is the empirical context; that is, it builds on the case research in a process of 'theory elaboration' (Ketokivi and Choi, 2014, p. 236). Thus, we engage in an iterative process that considers both empirical data and theory. We explain this approach in detail in sub-section 3.4.

We chose a qualitative, single case study method (Rowley, 2002), first to gain insights into the processual nature of the decision-making process by seeking empirical richness (Flyvbjerg, 2006a) and internal consistency (Gioia et al., 2013). Second, an explorative inquiry and qualitative case study enable the investigation of lock-in emergence (Sydow et al., 2012). Third, the qualitative case study involving observations, semi-structured interviews and the collection of secondary data allowed us to understand how actors make choices at different levels and how these choices are related (Mathieu and Chen, 2011).

3.1. Case selection and description

The unit of analysis in this empirical study was the multi-actor Madrid–Barcelona HSL project (1990–2017). The organizing of the project was a nexus activity that allowed multiple organizations to collaborate. Therefore, we considered the Adif organization and other actors (e.g., project proponents, contractors and other suppliers) important in scrutinising the inter-organizational facet to understand the emergence of lock-in and make sense of the actors’ project choices (Sydow and Braun, 2018). We selected this specific case through theoretical sampling (Eisenhardt and Graebner, 2007) because we considered it particularly suitable and revelatory in the light of path dependence and creation constructs. The HSL case, which had an investment budget of around €9 billion, is still considered iconic in terms of infrastructure investment. It was extensively reported, and a considerable amount of documentary evidence is available in newspapers, audits and official reports (Report, 2003, 2010, 2013, 2017; Ministry of Infrastructure, 2005). Thus, we used two main criteria to select this specific case: 1) it provided access to potentially rich critical data (Flyvbjerg, 2006a), as it involved multiple actors and interrelated network-level processes, thus providing a fruitful context for observing the process of lock-in emergence; 2) and mainly because the project under study had undergone considerable centralisation and decentralisation over time under the infrastructure market processes within European umbrella (Geyer and Davies, 2000). Thus, the case study we examine here illustrates choice formation that is driven by both inter-organizational actors and project management practice adaptation to the project’s institutional norms.

The ambitious Madrid–Barcelona HSL project, which was initiated as a public–private partnership (PPP) that was conducted from the early 1990s to 2017, it was planned and designed to reach speeds of 350 km/h in connecting the Spanish capital of Madrid with the city of Barcelona (649 kilometres). It was considered prestigious because it would connect Spain to the European high-speed rail network. The HSL project was intended to replace the existing air traffic route. The concept of the HSL project started in the mid- 1980s. On 8 December 1987, the Spanish Council of Ministers granted approval to proceed with the project. As indicated earlier, the HSL project being embedded in the transportation sector has undergone considerable centralisation and decentralisation over time

(Geyer and Davies, 2000). On 17 November 2003, during the HSL project, the reorganization of railway sector occurred, laying down the bases so that there could be a progressive entry of new players in this market. Adif¹ was created, which is a governmental public agency that acted as the project owner. All this occurred because of the necessary reestablishment and separation of the activities of infrastructure administration and of the provision of the services established by the Law 39/2003, on the Railway Sector.

First, GIF² and then Adif as the HSL project owner responsible for the management of infrastructure developed the project scope in three major phases. The first phase was Madrid–Lleida (443 kilometres), which was carried out from 1995 and completed on 11 October 2003; during this period GIF was responsible for the project work and the operation of the first line segment. The second phase was Lleida–Tarragona (108 kilometres), which was completed in December 2006; the third phase was Tarragona–Barcelona (98 kilometres), which was completed in February 2008. The project investment was co-financed by the EU and the Spanish government; the European Investment Bank was crucial collaborator in the funding of this project³, where the necessary public contribution was between 30% and 42% of the total investment.

The HSL project involved multiple contractors and suppliers. The procurement occurred at different points in time, considering that the line was segmented line in three major phases and the project

¹ Law 39/2003, of November 17 establishes that the RENFE public business entity is renamed Administrator of Railway Infrastructures (Adif) and assumes the functions assigned to the Railway Infrastructure administrator in the Law. To this end Adif extinguishes the GIF, subrogating the public entity Adif in all its rights and obligations. In addition, new public body was created, the public business entity RENFE-Operator. Law 39/2003, of November 17, has been expressly repealed by the current Law 38/2015, of September 29, of the Railway Sector

² The “Gestor de Infraestructuras Ferroviarias” (GIF) [Rail Infrastructure Manager] was created by article 160 of Law 13/1996, of December 30, on Fiscal, Administrative and Social order measures, having as its object the construction and, if applicable, the administration of the railway infrastructures

³ During the period 2000-2006 the HSL project was co-financed by the EU Cohesion Fund which provided €3.34 billion for the construction of platforms, as well as the supply and installation of tracks and power lines, signaling and communications. TEN-T (Trans-European Transport Network) also provided €70.9 million; During the period 2007-2013 the HSL project was co-financed by TEN-T which provided €12.0 million for the implementation of the ERTMS (European Rail Traffic Management System). During the period 2014-2017 the HSL project was co-financed by the “Connecting Europe Facility” (CEF), improvement to the access to Madrid station with a subsidy of €5.0 million and updating the ERTMS to base line 2, version 2.3 for the whole Madrid-Barcelona section, with a subsidy of €2.6 million

involved multiple contract packages. Design Bid Build (DBB) was mainly used and Design Build (DB) was used only for constructing heavy civil infrastructure, such as tunnels and bridges. It is worth noting that at the time of the project's implementation, the Spanish contractors and suppliers were among the largest worldwide, and they employed in-house engineers (Belmonte, 2016; Report, 2017). However, the Spanish public administration tended to protect the consulting and design engineering companies in the country, thus using DBB and an external PM, which is similar to the construction manager agency in the US. The purpose for the adoption of DB mode to heavy civil infrastructure consisting of bridges and tunnels occurred, since Adif expected the contractors and/or specialist suppliers into applying the most innovative technologies in such complex endeavours (Internal document; cooperation agreement, 2006). DB mode involved four main contracts no. 10,14, 23 and 24; two for the 28.7 km Guadarrama tunnel which was completed on 22 October 2007, and the other two to connect different nodes to the existing rail networks (Internal document; financial report, 2009). Each contract was given to independent consortium.

Although the rail infrastructure was already completed in 2009, it came into operation facing many issues (Report, 2010, 2013). That is, the initial tender contracts occurred between 1995 and 1996 after the concept was finalised. However, the term of commencement of the works was delayed in 70% of the contracts, being the average delay of the beginning of the works of 7 months from the signing of the contract. In some case, as in the contract of execution of "works of the platform construction project of the first segment line Madrid-Lleida, section: Santa Coloma de Cervelló - Sant Joan Despí" the delay was 30 months. On many occasions, these delays were due to the start of the bidding of the contracts without having begun the procedures of forced expropriation of the affected lands, leading to the suspension of the start of the works. In addition, there were several problems involving withdrawn contracts and suspensions, such as the one in relation to the building of the central station 'Madrid Puerta de Atocha' in Madrid, which required re-tendering. Thus, the completion of the first segment on 11 October 2003 included only part of the major construction works, and work was ongoing on this segment until the end of 2017. This work was mainly related to the expansion of the Atocha station in Madrid centre, which failed to obtain local approval at initial, first because of

technicalities and then because of multiple contract-related issues (Elpais, 2015; Report, 2017). The HSL project faced uncertainties as the three phases progressed. For example, the 649 kilometres were contracted at a 9% decrease from the tendered amount but then cost 31% more than the amount contracted, which was the tendered amount of €7.55 billion. The project was originally contracted for €6.80 billion, but it ultimately cost a little under €9.00 billion. In Appendix A1, we provide a historical view of the entire project, showing main events and the decision-making points along a timeline.

3.2. Data collection

We collected data through semi-structured interviews, observations and secondary data sources (e.g., internal project folder and audit reports). The data was collected at two intervals, which were carried out under the supervision of the third author, which enabled an in-depth contextual analysis. The first interval of data collection was from 1996-2010 during which the third author provided privileged access to data due to his role as research advisor first to GIF and later Adif on several portfolio issues, and performed group interviews, participant observation and in-depth analysis in relation to the first and second implementation phase of the HSL project. During this interval, over 40 interviews were held⁴. After the first interval of data collection, we felt we had not reached theoretical saturation (Eisenhardt and Graebner, 2007). The first author visited the Adif project offices and site to conduct a second interval of data collection in person, also involving interviews and observation. The data collected in the second interval, which took place between 2015-2018, were codified using the same procedure. The interviewees remained anonymous to ensure confidentiality, but the data reveal the interviewees' project affiliation. In total, including both intervals, we carried out 17 interviews. All interviews were audio recorded with the participants' consent, which resulted 19 hours and 25 minutes of audio-recorded material upon which we draw in this study. We discuss the second interval of data collection in detail in the following section.

⁴ five interviews, however, were useful for the purpose of this study

The primary sources: the 17 interviewees were the most important actors involved in the HSL project and the Adif organization. The interviews in both intervals were semi-structured and lasted 60–90 minutes. Each interview was digitally recorded and then transcribed. Members of Adif⁵, PM and large contractors involved in the project were interviewed several times over the second three-year data collection interval. In addition, between the formal interviews, informal contact was maintained with the participants via e-mail and telephone. The participants included the head of infrastructure projects and the head of systems integration projects at Adif; the PM at Adif, the construction manager (CM), and civil and environmental engineers, including the PMs of organizations A, B and C (large contractors/ suppliers in the project). Fig. 1, show the criteria used to select the interviewees, which were based on their profiles, organizational background and their involvement throughout the project's lifecycle. However, because of practical considerations, we did not recruit interviewees such as local government employees, subcontractors, local construction firms or other potential users.

[INSERT FIGURE 1 ABOUT HERE]

3.2.1. Observations

The embedded case study concerning the second data collection interval was focused on the project management division (Rowley, 2002) for three months between late August and November 2016. The empirical data collection involved an insider/outsider approach (Louis and Bartunek, 1992); that is, one of the authors acted as an insider while performing interviews and observations within the management environment, and the second author acted as outsider, thereby integrating diverse perspectives on the empirical setting. During this interval, the insider spent two to three days per week at the Adif offices in Madrid and conducted seven direct observations of meetings at the management level. Recording the meetings was not permitted. Instead, observations were recorded in extensive note-taking, which, to ensure their reliability, were discussed with the Adif team members during the following interviews. The third member of the research team participated in all stages of the research, while the others performed in-depth analyses in relation to the qualitative data that were collected.

⁵ GIF at times during the initial of the first interval of data collection

The outsider perspective helped the second author particularly, to make sense of the data as well as to scrutinise and challenge the interpretations of the insider. It is worth noting that when the observations took place, some work was performed within the first segment of the project. As indicated earlier, the issues related to the Madrid central station in Atocha involved multiple actors and ongoing work, which provided rich insights into the decision-making process and the project implementation.

3.2.2. Interviews

In addition to the three-month embedded case study (Rowley, 2002) which one of us was an insider in the project organization, during the second data collection interval we conducted interviews between October 2016 and August 2017. During the second data collection interval, we conducted 12 interviews to capture insights and reflections more than five years after the major construction work was completed. Because we could not easily determine if and when this complex project was locked-in (Sydow et al., 2012), we attempted to discover the interviewees' personal points of view (Gioia et al., 2013). However, because the lock-in process was mainly related to the project's early phase, in considering the retrospective views that emerged from the reinterpretation of case data, we used data collection approaches that reduced the recall bias. Following Eisenhardt and Graebner's (2007) suggestions to interview highly knowledgeable informants who view a phenomenon from different perspectives, in the Adif management division, we interviewed two types of respondents: project portfolio managers (PPM) responsible for multiple projects (high-level interviews), and PMs responsible in some capacity for a single project (low-level interviews). In addition, we interviewed different PM contractors, suppliers and the project proponent. The data collected in the second interval of interviews were manually coded by the first author. We provide both a summary of the data collection and the interview design in Appendix 2.

3.3. Data analysis

3.4.1 Identification of the mechanisms underlying lock-in

In accordance with the guidelines for qualitative inquiry (Denzin & Lincoln, 2011), we used both first- and second- order analyses. In the first-order analysis, we wrote the case history (Langley,

1999), which created a thick description (Rowley, 2002) of the managerial choices and emergent processes of the strategic decisions made at the HSL project. We then discussed the detailed description to make sense of the inter-organizational processes, particularly regarding how choices at the industry level influenced the project's organization. We then aimed to understand the influential mechanisms in the context of the Madrid–Barcelona HSL. As indicated earlier, we applied an abductive approach, and our analysis followed Gioia et al. (2013). We reviewed the literature on project studies, path dependence/creation and organizational processes. As our analytical framework, we employed the four underlying self-reinforcing effects on a permanent organizational setting identified by Sydow et al. (2009): coordination, complementary, organizational learning and adaptive expectation. In our view, these four effects could be readily transferred to our analysis. We analysed our interviewees' descriptions and the secondary data (i.e., legal requirements, industry regulations and the entire project folder) to describe how the project issues were dealt with and how the decisions were made. We focused on choices that were considered important and could be traced back several years. Two to five retrospective interviews per decision were considered adequate to capture the key attributes of the process (Langley et al., 1995). In this phase of the analysis, we adopted an iterative method of constant comparison (Gioia et al., 2013), moving between the data and the processual theory developed by process scholars (Langley et al., 2013). We followed their approach in analysing our qualitative data to determine the emergence of lock-in. We discuss the results of this analysis in sub-section 4.1.

Concurrently with the interviews, we studied the project documentation that was available to us in order to continuously valid the data and to inform the interviews. We were granted access to the main project design and the project management folder. At that time, when the first author (i.e., the insider) stayed at the Adif offices, the project documentation comprised over 1,850 pages. We thoroughly studied the various documents, particularly 20 documents that included internal financial and audit reports, HSL intranet, the overview presentations, internal organization charts and escalation matrices, lessons learned, and program tools (e.g., risk logs). Finally, we studied approximately 90 pages of public material drawn from the press coverage of the project. Although the press material could not be

compared with the insights gained from project documents, it nevertheless helped us to (re)direct our focus on key issues along the project timeline. Appendix A2 provides a summary of the richness of the research data collected in our study.

3.4.2 Exploring the influence of effects related to the project and the (inter-) organizational context

In the second-order analysis, we aimed to understand the peculiarities of the (inter-) organizational project context and the implications of the temporary dimension of the emergence of lock-in; thus, we applied an inductive approach (Gioia et al., 2013). In tracing choices through time, we paid special attention to both the intended and unintended consequences—the peripheral events seemingly remote from the project—in creating a storyline of the events (Mackay and Chia, 2013). We are convinced that the recall bias was minimal because all the respondents in our study were still active in the organization in some way; for example, one of our interviewees participated in all stages of the project, first as Engineer (2002-2007), then as PM and technical coordinator (2008–2016) and more recently (post-2016) as part of the senior management involved in finalising the work issues related to the first line segment.

Following the process approach (Langley et al., 2013), we scrutinised the subject of our study, relying on observations. This close perspective throughout both data collection intervals helped us to understand how the management team organized its activities. Moreover, the interviews helped us to further explore how the PMs coped with different issues. However, other choices required a more general view, stepping back to detect the effects of the (inter)-organizational context. According to Langley et al. (1995), in adopting a process perspective, researchers need to step back in order to consider the multiple perspectives on certain events, other processes and the interdependencies among actors over a long period of time, as in the research of Sydow and Koll (2017) and Aaltonen *et al.*, (2017). In line with the purpose of process studies, we used the concept of ‘temporal bracketing’ (Langley, 1999), decomposing three distinct periods T1 (1990-1998), T2 (1999-2008), T3 (2009-2017) to sequence the processes and events chronologically for analytic purpose. To this end, we frame these periods as follows: T1) the period of project front-end decisions and the institutional

setting influencing the design choice path; T2) the period of prior ties as antecedents of path dependence; T3) the period of creation of action spaces at the project level. We build our analysis and reasoning for the former periods T1 & T2 while relying mostly upon the first interval (1996-2010) of data collection sources, the interviews, participant observations and data reports. Whilst we rely upon the second interval of data collection sources (2015-2018), the observations and interviews for the latter period T3. Although we considered certain degree of discontinuity at each period boundaries, we considered continuity within each period.

To understand how the project's (inter-) organizational setting influenced the emergence of lock-in, we employed concepts relating to the organizational mechanisms through which choices were shaped in initiating and performing the Madrid-Barcelona HSL project. We then grouped the findings into categories. Following the suggestions of earlier researchers that adopted a path-dependent approach (Sydow and Schreyögg, 2013), we employed process tracing (Langley et al., 2013) and event structure analysis to identify significant patterns, including the processes at the project entry stage, the prospective views of actors and their implications for the overall project performance. Thus, we identified additional effects by which the project's (inter-)organizational setting influenced the choices and the emergence of a 'soft' lock-in (Sydow et al, 2012, p. 170). After the coding and the emergence of the first-order themes (Gioia et al. 2013), we engaged in axial coding to identify the second-order themes (Gioia et al., 2013). From this detailed case analysis, five other effects emerged, which complemented the data structure displayed in Fig. 2. In Appendix A3, we provide an overview of the empirical results and the data showing how the themes emerged, which enhances the transparency of our analysis.

[INSERT FIGURE 2 ABOUT HERE]

3.4.3 Reliability and validity

We drew broad criteria from social science research (Denzin and Lincoln, 2011; Yin, 2013) to ensure the high validity and reliability of our findings. Thus, eight criteria for trustworthiness were employed to ensure the rigour of the study: reliability, external validity, dependability, confirmability, and

integrity were drawn taken from the interpretive view (Denzin and Lincoln, 2011; Yin, 2013). Fit, understanding, and generality were taken from grounded analysis (Gioia et al., 2013). A similar set of criteria was used in previous case study research designs (e.g., Aaltonen et al., 2017). Table 1 lists the criteria used in the method we adopted in our study.

[INSERT TABLE 1 ABOUT HERE]

4. Findings

4.1 The emergence of soft lock-in in the Madrid–Barcelona HSL project

In this section, we begin by highlighting how the institutional setting created a design choice path. We also explain how the effects at the permanent organizational level occurred and how they shaped the choices made during the HSL project and how the actors created their action spaces in decision-making. Finally, by accounting for decision interactions relating to the temporal relationship between the second-order themes, we propose a conceptual process framework of lock-in emergence (Fig. 3).

[INSERT FIGURE 3 ABOUT HERE]

4.2 Period T1: The institutional setting influencing the design choice path (1990-1998)

4.2.1 Pre-project effects

Political actions in the field of high-speed rail network hark back to a gathering of Spain's Council of Ministers in December 1987. The commissioning of the Paris-Lyon HSL (410 km) in 1981, and its success in the following years, suggested the need for a change of approach to the design for construction of the inter-urban infrastructure. The HSL originally appeared as one of alternatives to address the challenges of the old rail capacity, its technical problems and the loss of passengers and freight due to the quality of the services. Therefore, on 9 December 1987, the Council of Ministers decided that the new infrastructure should be built using high-speed parameters and with the gauge that predominated in other European countries, i.e. 1,435 mm. (the gauge of conventional Spanish lines is 1,668 mm.) Thus, high-speed trains began to be developed in Spain, first with the Madrid-Seville HSL (471 km) that went into operation in April 1992, then the next point was the Madrid-Barcelona HSL project.

568

569 The Council of Ministers, at its meeting of May 23, 1997, attributed to the GIF the construction and
570 administration of the Madrid-Barcelona HSL. In Spain, the formal authorisation of project initiation is
571 given by the Ministry of Infrastructure Development, which instructs the Sub-directorate of Railway
572 Planning to prepare an informative study (i.e., a detailed planning document). This formal letter of
573 approval, the *encargo*, was the formal order for GIF to start the construction of the line, including the
574 search for funds to finance the new HSL, including European funds, which depended on the degree of
575 indebtedness and inclusion of financing in the general state budget. In order for GIF to start the HSL
576 project, the detailed planning document had to be approved. In the Spanish model, however, the
577 detailed planning document is not the responsibility of the line's management (Internal document;
578 Project report, 2002). Instead, it is the strategic input of the system through which GIF received the
579 order to execute a specific HSL project. The planning document then affects the project
580 management's choices.

581

582 The effects of strategic planning on initialising a project are that any element that is not sufficiently
583 defined in the informative study or that emerges during the execution of the line must be subject to a
584 new complementary informative study and submitted to the full process of public information and
585 environmental impact assessment. However, in this case, it was common for GIF to be entrusted with
586 the execution of a line while the information study was still in process and had not yet been approved
587 (Report, 2003). The formulation of the environmental impact statement by the Ministry of
588 Environment was beyond the control of the Ministry of Infrastructure Development, which had
589 already entrusted the execution of the line to GIF. The delays that this process caused in the rest of the
590 project entailed important adjustments that affected its implementation and management. The PM at
591 GIF outlined the implications of the above regulations as follows: 'There is no time to carry out a
592 feasibility study properly or to evaluate infrastructure needs. There is no time to lose because the
593 elections are in four years' time.' (Interview with former HSL PM, December 1997)

594

4.2.2 Institutional effects: The legal boundaries of decision-making

At GIF, a model was established in which the project owner's engineer directs and manages the works and the engineering company executes it accordingly. In order to contract this type of service, the Ministry of Infrastructure Development must sign a report of insufficient means, a requirement that was imposed when the outsourcing of such works began and continues today. This functional position within GIF projects is the facultative director⁶. This position is responsible for the work and the quality approval, which directly influences the incomes of the project contractors, as one of our interviewees described:

'I was responsible for selecting suppliers, initiating project modifications and developing the new components needed. As you know, GIF has a strict hierarchy: huge work packages are delivered to me and I'm accountable for work approval and pricing for our contractors and suppliers, who I do not actually contract and, at times, do not supervise.' (Interview with facultative director, March 1998)

Our observation of this functional position indicated that it involves the contractual maintenance of a specific pattern that is an indicator of the path determined, which leads to a potentially inefficient lock-in. In other words, this function creates lock-in effects because of the lack of support or external oversight. More often than not, the size of the HSL project meant that it was simply impossible for the work approval process to be implemented at every stage. The remedies were simple: other internal personnel from the functional office were sent to observe the work performed and approve it. The problem was that the internal personnel did not have the authority or the required competence to carry out such tasks. The point is that the person holding the functional position of facultative director seeks project controllability, indeed illustrative yet a cautionary tale. However, except the legal boundaries of decision-making and the law of public procurement, other components were important and influenced management decision-making regarding the following:

- Projects for which the client is the GIF/ Adif organization itself
- Prioritisation of simultaneous events

⁶ This form has been continuously enacted throughout the project life-cycle

- Multidisciplinary projects with different technological applications
- The influence of the traditional model on different areas of the project design and the execution of civil works

Because it was under government regulation, the GIF management established a phased review-based model, seeking legitimacy for their project choices. Such a strategy, was followed throughout the project later by Adif. This model provided guidelines for decision-making in the project while considering the project's tendency to adopt best PM practices: that is, the GIF/Adif guidelines included ideas adopted from PM bodies of knowledge, following a linear model. However, and in contrast to their choice guidelines, which prescribed linear decisions based on the logic of consequences and rational decision-making (e.g., PMBOK guide, 2013, p. 516), several events and issues prevented the Adif PM from making a rational decision. In the project context, many modifications indicated the PM's motives. They sometimes ignored the process guidelines or did not consider them thoroughly because they were uncertain. For example, this issue was described during an interview with the construction manager at Adif:

'We were very task-oriented and not behaviour-focused. We needed a giant step to become better organized. There were process guidelines, which described how to run things, but the way we lived life, the project had little to do with them.' (Interview with construction manager, October 2016)

Because many work packages at the project level lacked external observation, we concluded that the Adif management's actions took directions and adopted patterns other than those prescribed and that they were influenced by their environment.

4.2.3 Post-project effects

The post-project effects occurred at both the project front-end and the project level. In the HSL case, project proponents gave meaning to the decision to build by advertising the image of modern transportation and the connection to the European rail network (Ministry of Infrastructure, 2012). Other actions by the project's proponents included advertising the project as being environmentally friendly, but there were situations in which cost/benefit analysis and their influence were simply

brushed aside. These actions illustrate behaviour that has long been recognised in organizational studies (Cohen et al., 1972): for the project proposal to pass the selection process, it must be overly optimistic, and the cost-benefit analysis not fully considered. A project team member described this behaviour during an interview:

‘It is the higher pressure we have—the schedule—due to political influence: they want to start the project. For them (the politicians and proponents involved) it is important to start the project, but not necessarily to get it done. At least, this is the Spanish way.’ (Transcript of the notes collected by one of the researchers during a research related-meeting with GIF management, April 1998)

At the project level, as indicated earlier, the management of GIF/ Adif used a phased review-based model in making their project choices. At the selection stage, which, in the case of the HSL project, often involved a high degree of uncertainty, to gain support for choices, compromises between actors reached through informal interaction were usually necessary. This situation set the scene for negotiated choices, which included project choices in the form of negotiated agreements, even though these choices sometimes undermined efficiency. Some project members blamed the contractors:

‘There are also changes when the design is not done properly. When this happens, contractors and suppliers try to make money. In that respect, they are opportunistic if they have the chance. I believe it is a problem because, when you have a problem and you change the approach from the one agreed, you have to ‘negotiate’ the changes and, foremost, agree on the pricing. When we are over schedule, we usually end up agreeing.’ (Transcript of the notes collected by one of the researchers during a research related-meeting with GIF management, July 1998)

In these conditions, the decision-making process was dominated by negotiations and compromises. Because of the fragmented set of actors in the HSL project setting that presented diverse conflicting interests and business objectives that were difficult to align.

4.3 Period T2: Prior ties enabling fixed choices- the antecedents of path dependence (1999-2008)

The most productive period 1999-2008 saw some changes in the form of organising both internally at the organizational project level and externally at the sector level. In November 1999, the Director of GIF approved an internal guideline that regulated in detail the internal procedures for contracting the Public Entity. In addition, the Law 39/2003 established a complete reorganization of the rail sector, and Adif was created. This strengthened the management position within the HSL setting. During this period, we found patterns of underlying mechanisms and effects in the HSL project, several of which suggested that a soft lock-in had already occurred, and we describe them in detail in the following section. Following the archetypical and interpretative categories provided by Sydow et al. (2012), we clarified some of the contextual conditions in different time scales and different levels of description (i.e., the temporary organization and the project network) that gave rise to the emergence of lock-in. The results of our analysis are summarised in Table 2, which outlines the basic indicators of each effect on the inter-organizational context and influence of the actors throughout the decision process (the Y-axis was taken from Sydow et al., 2009, 2012) and (on the X-axis), showing our interpretation of the empirical constitutive features at work.

[INSERT TABLE 2 ABOUT HERE]

4.3.1 Coordination effects

Our interviewees described situations in which the process guidelines in the project were almost impossible to change, even though they had discovered that the existing rules and guidelines did not provide optimal choices. However, from the perspective of Adif and the private organizations and other actors involved, it was important to have standardised project management models and to comply with them. Actors such as suppliers (e.g., Siemens and Thales) offered their specialised expertise to complete interdependent complex tasks, and the coordination mechanisms were important. Hence, the coordination mechanisms within the project were also affected by industry practices. In the Madrid–Barcelona HSL project, these practices were implemented through the European Rail Traffic Management System (ERTMS 1/2) to ensure compliance with the signalling and safety requirements (Report, 2012). In particular, the Madrid–Lleida section was equipped with

ERTMS level 1, whereas the Lleida–Tarragona and the Tarragona–Barcelona sections (the second and third sections, respectively) used the level 2 signalling system in their networks. As we explain below, our interviewees viewed the work as being highly controlled by a hierarchical structure that influenced their activities and choices; as the head of infrastructure projects put it:

[T]ake the ERTMS system, for example; it has been established for years, and there was a clear understanding of the work to be performed. In my view, it has improved production and maintenance costs while simplifying approval processes in the project by reducing the certification costs. Moreover, the ERTMS system remains the same from project to project, which enables easier installation and manufacturing. (Interview with the Head of Infrastructure Projects at ADIF, June 2008)

When the adoption of standardised industry practices spread from project to project, the actors involved developed a shared understanding, which helped them to coordinate their objectives and accomplish their work.

4.3.2 Complementary effects

As indicated earlier, the tender contracts occurred between 1995 and 1996 after the concept was finalised, but there were several withdrawn contract and suspensions, which created the need for re-tendering. The use and form of complementary management systems (e.g., the use of management standards and national construction regulations in conformity with the national law (in Spain, *Ley del Contratos del Sector Publico* [Ley 30/2007]) explicitly guided the procurement methods, thus restricting the actors' choices. Similarly, the ERTMS system and its corresponding products were supporting tools that reinforced certain choices over others. The management practices at the project level were influenced by both the regulatory framework and the industry practices in the public sector. The public procurement law, *Ley del Contratos del Sector Publico*⁷ (Ley 30/2007), shaped the management's choices by reinforcing work divisions based on cost limitations. Thus, the project was

⁷ Law on Public Sector Contracts - *Ley del Contratos del Sector Publico* (Ley 30/2007, p. 4391). Available from <https://www.boe.es/eli/es/l/2007/10/30/30/dof/spa/pdf>

divided into multiple packages, and the project management had to make regular choices about individual work packages that simultaneously influenced each other. In this context, the management at Adif and the private actors (contractors and suppliers) performed their work through repeated interactions in several work packages. The actors' organizational activity patterns became dominant because they developed through a long-term relationship during the project by sharing common objectives, interests and products. The regulated public procurement and the industry standards had corresponding effects on the contractors, who were focused on becoming more functional by proposing multiple solutions that would require similar choices. By continuously combining and repeating the practices by two or more project actors generated added-value for their own operations but not for the owner or the project in general. The actors in the project developed synergies by drawing on multiple resources concurrently rather than using them in isolation. According to our informants, the actors in the project pursued joint objectives, which helped them complete the work instead of choosing the best available options:

‘We were, in the project, pursuing joint objectives with our partners: we adhered to the usage of complementary management systems set by the owner, even though we were more advanced in some ways—in technology adoption, for instance.’ (Interview with the Engineer at Organization B, June 2008)

4.3.3 Learning effects

The focus of Adif's management is characterised by repetitive interactions, which benefits the learning effect but loses many opportunities. Another aspect of the learning effect, which is evident in the case of the Madrid–Barcelona HSL project, is the actors' competence in large-scale infrastructure delivery. For example, the major contractors had proven competence in infrastructure projects, having taken part in many similar projects worldwide, in which they gained expertise (e.g., the Ferrovial organization's underground projects in London and Hong Kong). These contractors already had a network in place including many contacts that resembled the connections among providers and suppliers, which increasingly pervaded the HSL project environment. In addition, in the case of Adif,

the organization was also engaged internationally in the design and project management of the Lima underground railway project among others⁸.

The cooperation of the actors in similar projects and their specialisation and strengths in infrastructure delivery included the training of technical personnel, which resulted in learning effects. Our project informants highlighted the importance of continuous improvement through learning:

‘My job is to run the development and construction program: to put in place arrangements for developing and implementing projects that enable continuous performance improvement. A very clear objective is to make Adif a modern owner by improving our working routines while learning from projects in the international market, including our projects.’ (Transcript of the notes collected by one of the researchers during a research related-meeting with ADIF management, May 2008)

The Adif managers were aware that repetitive choices enhanced efficiency but made them less able to consider alternatives such as technical options. In this context, we observed a lack of motivation in Adif’s management to make different choices regarding the project. Instead, the behaviour that reinforced repetitive choices gained legitimacy and gained greater acceptance by the project members. The head of infrastructure projects described the importance of continuous learning in the project:

‘Nowadays, it is a different system; knowing the latest technology affects the bridge length, for example, has a big influence. In that sense, it is important to have a strong relationship with the contractor for a smooth delivery of infrastructure and for the purpose of learning. We need to learn more about the capabilities and the behaviour of our contractors. Usually this means more expense for Adif at the beginning, but we learn for future projects.’ (Interview with the Head of Infrastructure Projects at ADIF, June 2008)

⁸ (for further discussion, see the Spanish Government reports on strategic planning and transportation (Ministry of Infrastructure, 2005; Report, 2014).

4.3.4 Adaptive expectation effects.

The Adif management was willing to adopt certain practices and expected others to do the same, including project members who were focused on adopting best PM practices in delimiting their choices during the decision-making process. Because they experienced uncertainty in selection, they felt confident following the preferred methods; thus, a predominant solution emerged. In this context, the project members followed similar processes because the legitimation of their choices was crucial for the implementation of the project. They had to relate to and make sense of different actors' opinions and processes. The Adif PM described how the management was affected:

‘It was challenging to deliver our work chunk in the project. I had to relate to and analyse the work repeatedly and intensively, not only for the task at hand but at the same time at more macro levels of analysis.’ (Interview with ADIF PM, October 2016)

Therefore, the preferences of the Adif management were not individually determined; instead, individuals fitted themselves to the activities and the expectations of others while responding at different levels.

4.4 Period T3: Actors creating action spaces (2009-2017)

4.4.1 Shielding effects

During the period 2009-2017, considerable changes in the project's plans and scope occurred. The project was expanded, with the first line expansion phase involving the Atocha station in Madrid. In addition, the third line segment in the Sants-La Sagrera section was subject to expansion and the project plan altered significantly. Throughout this period, the actors searched for ways to safeguard these drastic changes in the scope of project. Shielding effects manifested as an improvisational action carried out in established structures (Lundin and Söderholm, 1995; Jerbrant and Gustavsson, 2013). Hence, managers tended to distance themselves from tight structures, including regulatory mechanisms that control their choices, such as key performance indicators (KPI) and detailed contracts, gravitating instead to loose structures. This improvisational action was performed both by PMs at Adif and their contractors. We observed this action mainly during the later phases, in the project implementation level. The former engaged in improvisational actions relating to *social*

rentability, referring to the soft objectives and demands of the project, rather than the hard cost-benefit analysis. An interview with the head of infrastructure projects illustrated the issue:

‘We have a factor called social rentability that is valuable! For instance, if you give reasons for a specific part of the project not performing and having problems due to communication, this argument is considered prior to financial rentability.... So, the rentability of the line can rarely be managed as a whole.’ (Transcript of the notes collected by one of the researchers during a research related-meeting with ADIF management, April 2017)

The contractors, in contrast, created action spaces by ignoring the details of the project plan and sending a vague plan to the Adif project controller—the facultative director—for confirmation. This created an opportunity to safeguard choices from external interference. Regarding this situation, the Adif construction manager drew special attention to the contractors’ behaviour: ‘It seems to be a well-known behaviour: contractors tend to be very crafty and disclose information or reveal problems only when they really have to, and it is good for their business’. (Interview with construction manager at Adif, March 2018)

4.4.2 The ‘temporary fix’ effects

The Adif management frequently, and often unconsciously, preferred short-term solutions to their problems entangled in the decision trap. Our data analysis showed that Adif management generally was not responsive to changes to or deviations from the plan (Report, 2013, 2017). However, in some cases, they responded, but the choices they made were usually ineffective in the long run. As indicated earlier, the Adif management based their project choices on a phased review-based model. Following PM best practices, Adif divided the project into smaller components, which resulted in reducing the problems in each subunit. These components challenged the project’s management by further complicating the scope of work and the interactions between the actors involved. A member of the Adif project highlighted the following:

‘Lots of unforeseen issues occur. We experience pressure, and we have to fulfil the work responsibilities promptly. The problem is that the line is segmented, and each segment is

838 subdivided. We provide the platform, and then other actors come along. We are engaged in
839 civil work—not in telecommunications, electrification or signalling, each of which influences
840 the work differently.’ (Interview with a project team member at ADIF, March 2017)

841 One of the main issues in this approach was that in making decisions during the phases, the
842 management needed to play separate roles that required expertise in constant monitoring, such as the
843 quality controllers (i.e., facultative director in Adif). However, Adif was usually understaffed, which
844 was highlighted during the interview with the facultative director:

845 I lack support and human resources to carry out my work with colleagues. We have only three
846 engineers, and it is difficult to cover the whole project—it’s actually ridiculous! It’s
847 impossible to cover the work. I had to cope with five contracts at once and we needed, like,
848 five or six people to take care of the workload in the field. (Interview with the Quality
849 controller at ADIF, April 2017)

850 Given the simultaneity of the various works, the multiple changes in project, and the fact that Adif
851 was understaffed into monitoring the work performed, then a Monitoring Committee was created. The
852 Ministry of Infrastructure Development, Government of Catalunya, Madrid and Barcelona city
853 councils, Adif and Renfe-Operator formed part of the Monitoring Committee (Report, 2017). The
854 Follow-up Commissions were unified in common sessions in which the subjects of all the works in
855 execution are dispatched. All sessions were held at the ADIF offices of Madrid and at time in La
856 Sagrera in Barcelona. Those held were the following: session 1: December 17, 2009; 2nd: January 28,
857 2010; 3rd: April 29, 2010; 4th: September 9, 2010; 5th: November 25, 2010; 6th: March 3, 2011; 7th:
858 June 17, 2011; 8th: March 1, 2012; 9th: July 12, 2012; 10th: November 15, 2012; 11th: March 14,
859 2013; 12th: November 7, 2013; 13th: February 20, 2014. All the minutes are available except the last
860 one (Report, 2010, 2013, 2017). The minutes corresponding to the 2nd, 7th and 12th sessions are
861 unsigned. As can be observed, the Monitoring Committee has not respected the quarterly periodicity it
862 has been pre-established and has not carried out a rigorous follow-up to prevent or minimize the
863 numerous irregularities in the execution of the works in the HSL project and in relation to the
864 contracts in the vicinity of the Madrid and La Sagrera statio. In such circumstances, the Adif
865 management, as a solution to their problem, postponed the decisions they had to make in each phase.

Thus, because of changes and the postponement of decisions, the project schedule began to lag behind, which placed an additional burden on the project management and negatively affected the project's budget. Combined with contextual influences, the schedule slippage became disastrous for the project. The project member at Adif recalled such circumstances: 'Trying to do things faster means exactly the opposite. I don't know.... I guess it is just that, due to political pressure, the management initiates the work packages too soon'. (Interview with a project team member at ADIF, March 2017)

At the project level in this context, other actors (e.g., contractors and suppliers) often influenced the decisions by detecting problems and deciding solutions for the project. During the interview, the contractor expressed the following:

'In my view.... I've seen cases where construction companies go and speak with the local administration with responsibility for that region and ask for changes based on the regulatory territory; so, when changes occur, it is because of the construction organization's manoeuvres.' (Interview with the Engineer at Organization C, June 2017)

Decisions made in the early phases of the project involved concrete actions, agreements (e.g., contracts signed) and design plans. However, during the project and at the project level, the actors' actions affected the decisions made at the initiation phase, thus shaping the direction of the project.

5. Concluding Discussion

The results of the empirical analysis indicated that the Adif management was less likely to alter their decisions or their grounded project practices if the following occurred:

- a) Certain patterns or routines were dominant among the actors, influencing the efficiency of the collaboration (i.e., the coordination effect).
- b) A set of practices and synergies existed, so it was less likely that they would alter choices based on established practice (i.e., the complementarity effect).

- c) The preference for more repetitive choices was accompanied by a lack of motivation to improve the project practices (i.e., the learning effect).
- d) The collaborating actors expected each another to follow PM best practices (i.e., the adaptive expectation effect).

In addition, our observations indicated that because of additional effects related to the nature of the project, such as temporality and the (inter-) organizational context, particularly the shielding effect, the temporary fix effect, and the pre- and post-project institutional effects, the choices were grounded in the initial stages and they were continuously shaped in certain directions during the project implementation. Hence, the decision-making process led to some irreversible situations related to prior ties (i.e., patterns of permanent organizations) and introduced various forms of lock-ins into the project's trajectory. Thus, the understanding of project choices and lock-ins in such settings makes sense if the properties of the aggregate structure of interactions among project actors is considered. Visibility in following a path of choice formation that requires a long-term (inter-)organizational perspective instead of short-term goal setting relies focussing on the process outcome (cf. Engwall, 2002). Accordingly, the decision-making process in large-scale projects is not always under the control of the single actors; more often than not, the opposite is true (Steen et al., 2017). Based on the results of our case study, it could be argued that the emergence of a lock-in needs to be considered in the context of processes that are specific to the (inter-)organizational project and its institutional setting. Regarding links between events at different levels, the results of our analysis confirmed that the decision-making process is subject to both internal and external events and other issues. Influential external events include industrial features (e.g., the ERTMS system requirement and the procurement method), uncertainty as a function of the environmental definition arising because of widely diverse project actors, and contentious interdependencies among the actors have consequences for managing large-scale projects and affect the emergence of a lock-in. Internal events involve mainly task complexity, the level of specialisation, the embedded work practice, the causal-ambiguity of the work organization, and the technology used. The conceptual process framework (Fig. 3) we put forth in this paper examines in-depth the issue of lock-in by structuring such links in a process fashion, the mechanisms and effects, thus contextualising the phenomenon.

The development of this conceptual process framework is an outcome of our empirical analysis of the Madrid–Barcelona HSL project. It is important because it accounts comprehensively for decision process in a temporary organizational setting while considering the multi-level interactions within the HSL project (Mathieu and Chen, 2011). As shown in Fig.3, the conceptual process framework parses the lock-in emergence into three temporal phases (T1, T2, and T3) enabling a better understanding of the importance of more institutional and permanent organization level structure and the interaction between prior ties in the processes of inter-organizational setting. The first temporal phase emphasizes the importance of the institutional patterns influencing the design-choice path. In brief, the first temporal phase highlights that the choices are embedded in institutions, and that they reflect the institutional framing. The second temporal phase of the framework shows the prior ties (i.e., the antecedent of path dependence) and the dynamics of the self-reinforcing processes. The increasing denser backgrounds in fig.3, signifies the structuring of choices, which eventually lead to a dominant decision pattern. The third temporal phase of the framework regarding the actors and their action spaces demonstrates an improvisation on part of the actors when faced with changes in project. The two-sided arrow linking the emergence of lock-ins and the third stage model phase, signifies the duality of the process where the already established soft lock-in influences the actors in the inter-organizational setting, yet the actors also part take in the co-creation and further shape the decisions through the action in project level. The creation of actions spaces builds both in improvised and somehow new practices but also involves existing ones. Therefore, the understanding of lock-in requires the recognition of the contextual conditions that give rise to or support the lock-in through mechanisms and effects resulting from alternative choice paths. Hence, we need to query not only the estimations at the project front-end and/or the cost-benefit analysis but also the previous cooperation of the project actors and how (if it exists) it affects their current choices.

5.1 Lock-in emergence: An ontological divide

The structural factors leading to lock-in in the extant literature, the dominant perspective of which relies heavily on a reductionist view, are insufficient to capture the complexity of large-scale projects

as temporary (inter-) organizational context (see, e.g., Cantarelli et al., 2010). Cantarelli et al.'s (2010) framework provides input variables concerning the major perspectives regarding lock-in, yet it lacks the process interactions that link those variables. Indeed, according to Winch (2013), organizational theory could contribute to the development of a more comprehensive perspective on the processes of large-scale projects by providing core insights into the escalation of commitment. However, Winch's (2013) analytical model is focused on the project's front-end and lacks the project life-cycle consideration (Stingl and Geraldi, 2017). The results of our case study extend the significance of Winch's (2013) organizational perspective and support the input variables identified by Cantarelli et al. (2010). The process perspective that we used in the present research, however, served to enrich the understanding of lock-in. Through our qualitative inquiry, the results demonstrated the influence of several mechanisms and effects not only in the project but also from the project network on the emergence of lock-in in the large-scale Madrid-Barcelona HSL project as well as the implications of its inter-organizational and temporary nature (Aaltonen et al., 2017; Sydow and Braun, 2018).

Our findings indicate that to understand decision-making in large-scale projects, there is a need to change the ontological priorities that underpin the extant research on behavioural decision-making in project management (cf. Stingl and Geraldi, 2017). The reductionist view and its focus on the input variables and the outcomes of the lock-in process leads us to cost-related issues and takes us down paths designated by the owned process perspective, directions from which we must veer (Mackay and Chia, 2013; Pitsis *et al.*, 2018). The lock-in is thus substantially more than a control-oriented final purposive outcome, and the questioning of lock-in emergence should move from 'what is wrong' to 'how' and 'why' it emerges. There is a need to recognise the heterogeneity of large-scale project contexts the multi-organizational setting and their interdependencies in broad project networks; they represent the sources of variety in the desired outcomes (Artto et al., 2016). Moreover, they could never completely lock the choices into a deterministic trajectory. In this regard, we need to consider new and promising theoretical groundings. We suggest the view that recognises the reality of processes (Langley et al., 2013) in the inter-organizational context. Based on the results of our study, in which we applied the process view and built on the prior research on path dependence and creation

(Sydow et al., 2009, 2012), we conclude that initial conditions are not ‘givens’ and that contingencies, mechanisms and effects are emergent contexts of action. In this paper, we have discussed these points using a narrative approach. Table 3 shows the implications of our perspective for conceptualising the lock-in.

[INSERT TABLE 3 ABOUT HERE]

Our findings complement the previous research on path-related processes and lock-in emergence (Hellström *et al.*, 2013; Levering *et al.*, 2013). However, our approach also links the phenomena to the process viewpoint and path dependence and creation through a long-term (inter-)organizational perspective in which different yet promising theoretical groundings are introduced (Aaltonen et al., 2017). Table 3 highlights these differences and their implications, which may be compared with Cantarelli et al. (2010) and Winch (2013).

5.2 Implications for theory

We posed the following research questions: How and why does lock-in emerge within large-scale projects? What are the underlying mechanisms and effects that affect lock-in in these settings? Our study makes an important threefold contribution to the scholarly knowledge about project management as well as the path dependence and creation research that explores path-related processes and lock-in emergence. First, our study relates the concept of lock-in to the important theme of bounded rationality in the decision-making processes in large-scale projects (Flyvbjerg, 2014; van Marrewijk et al., 2016; Aaltonen et al., 2017). The conceptualisation of lock-in emergence through mechanisms and effects as non-purposive revealed another side compared to the reductionist view, painting a circumstantial picture of how prior ties and multi-actor interdependencies in the project and network environment influence the decision-making process in a large-scale project setting. Rather than taking a view that confines decisions to the individual, or single actor control in front-end of projects (e.g., Cantarelli *et al.*, 2010; Flyvbjerg, 2013), we followed the development of decision process throughout the evolution of the project - considering its inter-organizational context (Sydow & Braun, 2018). Our findings showed that large-scale projects entail multiple actors in an inter-

organizational context that comprises a specific form of temporary organization (Sydow and Braun, 2018), which implies a joint past or future particularly when the project is embedded in a network (DeFillippi and Sydow, 2016; Braun and Sydow, 2019).

Based on our findings, we propose that project scholars will benefit from taking an unowned process approach (Mackay & Chia, 2013, p. 210) in exploring path-related processes in such settings. We provide nascent theorizing on how the temporary and (inter-)organizational nature of large-scale projects affects the emergence of lock-ins and how the organizing and decision-making process is continuously shaped in a certain direction by project actors over time, thus contextualising the phenomena. We empirically examined how the contextual conditions that give rise to or support lock-in emergence affected the project's multi-actor overall scoping process and goals, thus adding to the limited knowledge about path-related processes in projects (Manning and Sydow, 2011; Levering et al., 2013; Aaltonen et al., 2017). Based on these findings, we affirm that the management of large-scale projects entails multiple ties with past and future that are necessary to get to grips with, when facing the challenges this specific form of temporary organizing poses (Grabher and Thiel, 2015; DeFillippi and Sydow, 2016). Researchers have already explored the underlying mechanisms that enable the conditions for the emergence of lock-in in permanent organizations (Sydow, 2009; Koch, 2011; Sydow et al., 2012). We complement this previous work by providing a detailed empirical examination of the emergence of lock-in in the project (inter-) organizational network.

Second, by relying on Sydow's (2009) concept of organizational path dependence, we anchored our study in the process literature and the path dependence and creation perspective to focus on the decision process. By linking our findings to the relevant theory, we showed that the conceptual stance we adopted in the process perspective differed as well as the implications of this difference (see Table 3). We consider these differences a valuable contribution to the literature because they could enable project management scholars to position their research more effectively. The issue of lock-in entails phenomenon-based research, which has gained and will continue to gain the interest of diverse scholars, thereby bridging conceptual and disciplinary divides (von Krogh et al., 2012).

Third, our findings extend the recent research on projects by integrating studies on path dependence and creation (Garud and Karnøe, 2001; Sydow et al., 2012). Specifically, we have advanced the recent discussion by Aaltonen et al. (2017) on the contextual conditions that give rise to or underline the emergence of lock-in. By employing a process approach with a long-term (inter-)organizational perspective, our findings revealed that empirical patterns reflected prior ties that were the antecedents of path dependence, the front-end decisions made in the project, and the formation and continuous shaping of choices, thus informing the debate on the decision process in large-scale projects: in other words, between the organizational and the operational management perspectives. In particular, the latter effects where actors created the action space (i.e., the shielding effect and the temporary fix effect) supported previous findings on path creation (Bassanini and Dosi, 2001; Aaltonen et al., 2017).

5.3 Implications for practice

We emphasise that the management of large-scale projects, such as the complex Madrid-Barcelona HSL project, which is embedded in the several local contexts and norms of the actors involved, may become locked into following a particular path in the early stages. Thus, the understanding of the (inter-) organizational elements in the context is an essential feature of project management practice. Hence, our findings have critical practical implications for PMs, such as recognising that in making choices in large-scale project settings, they need to consider and address the requirements of the institutional setting, including the pre- and post-project effects. It is not possible to impose any rule-of-thumb that delineates precisely the extent of the PM's enactment. This seems unsustainable because in a large-scale project setting, the choice path is a non-ergodic process that is shaped overtime, and the soft lock-in is not necessarily purposive. However, in making choices, PMs should carefully consider how the multiple mechanisms and effects may shape their decisions, reinforcing them to continue in certain directions. In addition, our observations of how the HSL project actors created action spaces at the project level revealed the importance of agency in helping practitioners to understand that under certain conditions, they are capable of shaping their own paths. Due to the inter-organizational and temporal nature of projects, PMs must consider and maintain a balance between

controllability and unpredictability in delimiting their choices in large-scale project settings (Kreiner, 1995; Engwall, 2002). Table 2 and Fig. 3 provide PMs with ideas regarding how multiple processes at different levels may influence their project decisions. These ideas are relevant because they lay the groundwork for PMs to extend their efforts beyond the micro-managing of tasks. Furthermore, in considering the multi-organizational setting, we suggest that PMs should work actively to align the actors' desired outcomes by organizing learning events, such as frequent thematic workshops, particularly in the early stages of the project. Such events would enable collective sense making, which is key in creating new ideas and generating commitments within the project network.

5.4 Limitations and recommendations for future research

The limitations of our study include the reinterpretation of the data sets, which were created over 20 years. We tried to address this issue by interviewing multiple actors who viewed the decision process from different perspectives and who had participated at different levels in the HSL project. We also tried to address this issue by going back and forth between the original data sets and the analysis (Rowley, 2002). Part of our analysis relied on the observations we made as several contracts were being fulfilled and the project work was still ongoing. Thus, although our single case study on the HSL project was based on semi-structured interviews, observations and a vast number of documents and reports, our findings should be generalised with caution (Rowley, 2002). In addition, in our application of the single case method, we used only qualitative data. Therefore, the lack of quantitative data in our analysis may be considered a limitation because we were not able to compare the results with other quantitative discourses on lock-in emergence (Koch et al., 2009). Table 3 shows the differences in the conceptual stance needed to understand the emergence of lock-in. Undoubtedly, significant methodological challenges are associated with these differences (Smyth and Morris, 2007). Nevertheless, but a discussion of how these differences might be addressed is beyond the scope of this paper. Finally, our case study and findings lie within a constructivist mode and in general do not show deterministically if a lock-in is always inefficient. In our view, this is a minor limitation because it was not included in the aims of our study. At this point in our research in this area, we have determined that the conceptualisation of a lock-in cannot be considered in isolation by confining

decisions to the front-end of projects controlled by individuals or single actors. Instead, it must consider the prior ties and interdependencies among the multi-organizations in the setting.

Despite these limitations, our conceptual process framework could guide future research on decision-making processes in a large-scale project context. The conceptual process framework could be adopted to explore different empirical contexts, possibly through a longitudinal ethnographic study, which could lead to the deep empirical understanding of the role of contextual mechanisms and effects arising in the emergence of lock-ins. This understanding would enable researchers to empirically investigate and enhance the generalizability of the findings to other project contexts. In particular, future research should consider the mechanisms and effects revealed in our study and acknowledge that they reside not only in the project but also in the project's network. Furthermore, future research should consider the subtle relationships among path dependencies and path creations in continuing to explore the contexts and conditions of de-locking mechanisms.

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Appendixes

Figure 1. Interviewee representativeness, their profile and organization background in relation to the project life cycle

Design Consultant	1	2		
Contractor			2	
Supplier				1
Project owner	3	2	3	2
Project Proponent	1			
	Project Definition	Plan	Execute & Control	Close out/ Operations
Organization background	Project life cycle involvement			

HSL Mad-Barcelona project	17 interviews
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Note: the project life cycle is outlined based on Morris (2013)

Figure 2. Data structure

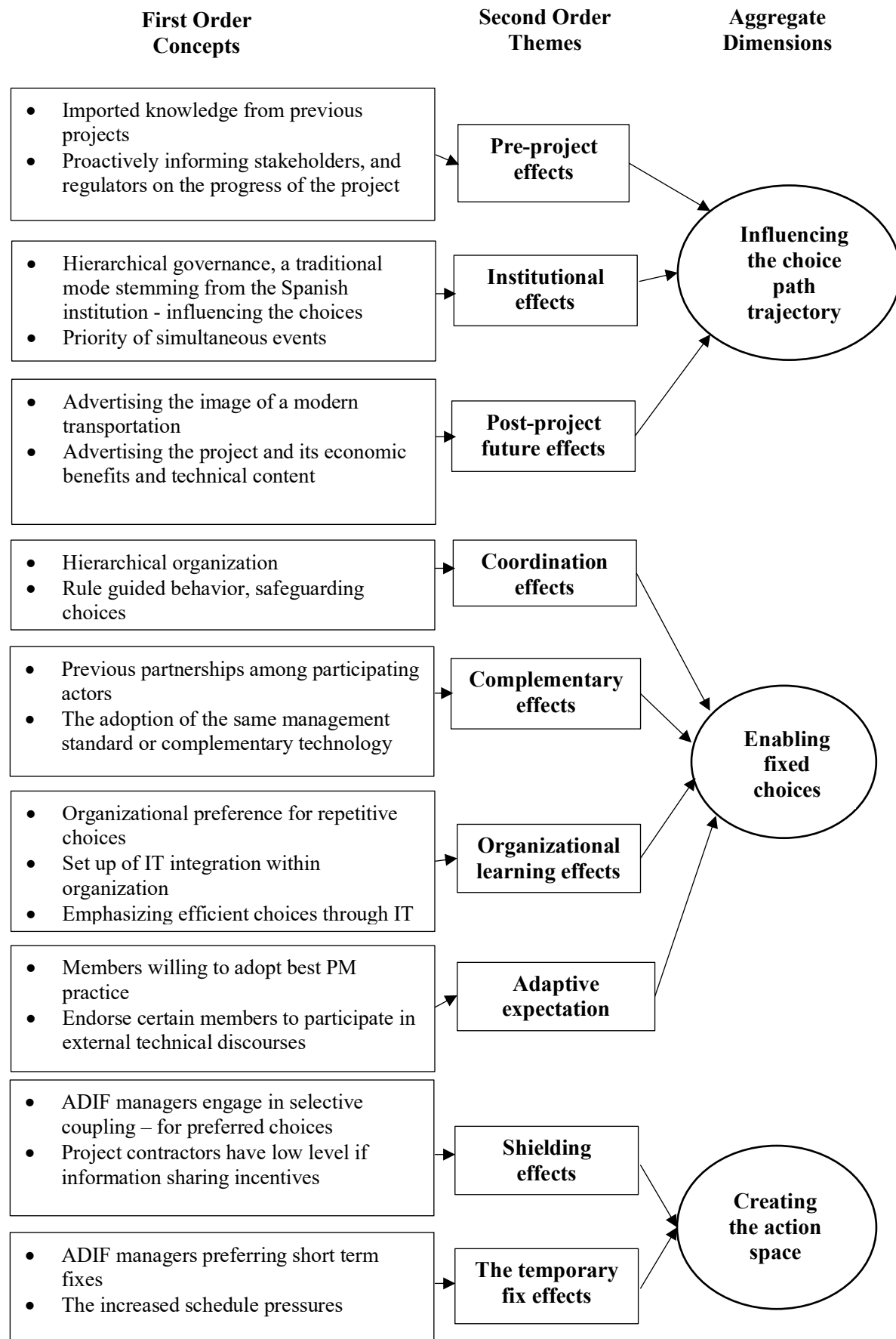


Table 1. Rigor of the study: criteria and steps to address the criteria

Criteria and explanation	Steps to address the criteria
Reliability (extent to which the findings appear to be representations of the data)	The use of the case study protocol and the development of case study report. The case study report was sent to ADIF for their consent to publish; Data were collected from diverse informants, including key actors of the project network who viewed the processes from different perspectives; The interviewees were asked to verify the interpretations of data obtained from direct observations, the interviews and reports; All interviews and result workshops were conducted by several researchers, one led the interview(s) and other complemented the interviews and took notes while alternating between them in the process; Triangulation/ corroboration of data sources between interviews, field notes and reports. In-depth discussion of the analysis to ensure consistency and agreement among researchers. No contradictory evidence was identified via triangulation of data sources;
External validity (extent to which the findings from a study in one context will apply to other contexts)	The use of strong theoretical foundation, from the process literature and path dependence/ creation literature (Langley <i>et al.</i>, 1995, 2013; Garud and Karnøe, 2001; Sydow <i>et al.</i>, 2009) and other reliable studies in the field to compare the findings (Hellström <i>et al.</i>, 2013; Levering <i>et al.</i>, 2013; Aaltonen <i>et al.</i>, 2017) and enabling analytical generalizations; Transparency of the study analysis, enabling the replication of our findings (Yin, 2013, p. 37)
Dependability (extent to which the findings are unique to time and place; the stability or consistency of explanations)	All interviewees are experienced project managers, or engineers that have expertise and knowledge regarding decision practice and management practice in large-scale projects; Interviewees reflected as far back as >10 years; Secondary data, including internal reports was reviewed as far back 15-20 years; Detailed and rich description of the research context and of the Madrid-Barcelona HSL project and events over time, establishing the boundaries for analytical generalization and for transferability of the theoretical ideas;
Confirmability (extent to which interpretations are the result of the participants and the phenomenon as opposed to research bias)	Data were collected from diverse informants, including key actors of the project network who viewed the processes from different perspectives; Triangulation and pattern matching among the data including observations, interviews and other reports; The interviewees were asked to verify the interpretations of data obtained from direct observations, the interviews and reports;

Integrity (extent to which interpretations are influenced by misinformation or evasions by participants)

No contradictory evidence was identified via triangulation of data sources;

Confidentiality of obtained data was assured to all interviewees through the signed confidentiality agreement with ADIF at the study initial;

Fit (extent to which findings fit the substantive under investigation)

Ensured by reliability, external validity (in comparison with the extant theory) and confirmability of the study;

Understanding (the extent to which the interviewees and other participants accept the results as possible representations of their world)

The interviewees were asked to verify the interpretations of data obtained from direct observations, the interviews and reports;

The case study report was sent to ADIF for their consent to publish;

Generality (extent to which findings cover multiple aspects of the phenomenon)

Observations through the insider-outsider approach (Louis and Bartunek, 1992) over 3 month period, together with the first interval of data collection, interviews lasting between 60-90 and the review of reports each enabled in-depth insights to the project practice; both allowed for flexibility in the discussion;

Figure 3. The lock-in emergence in large-scale project as temporary inter-organizational setting: a conceptual process framework

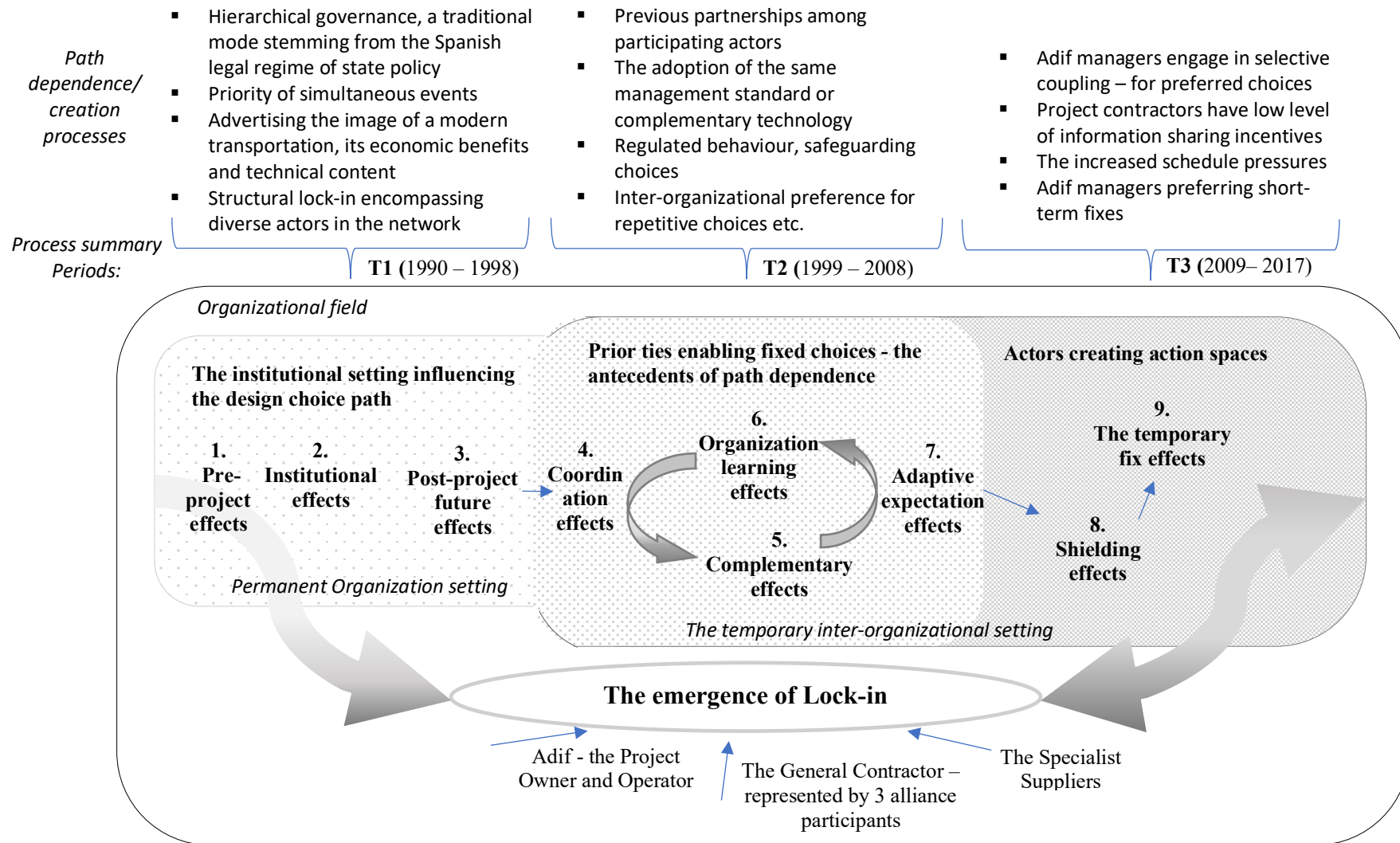


Table 2. Summary of mechanisms and effects identified in the context of Madrid – Barcelona HSL project

Lock-in mechanisms	Coordination effects	Complementary effects	Organizational learning effects	Adaptive expectation effects
Level of interrelatedness	Rule guided behavior, the HSL project has adopted hierarchical governance structure to control and monitor the project. This also implied a mode for justification of internal investment decisions and help contractor's engagement	The actors (including the operators and suppliers) involved in the project have been working together recurrently in the European market. There are indeed strategic choices, commitments among them.	Self-reinforcing learning effects could be detected at various levels at ADIF. A noticeable tendency or preference for repetitive choices. In a field context, a wide range of private actors – suppliers build knowledge on infrastructure operation.	In the project context, members were willing to adopt best PM practices in choices selection. Since members were uncertain for the choice selection, they felt safe in following the preferred choice, thus a dominant solution emerged.
Triggering event	The adoption of joint rules in the ADIF organization, the model continued to replicate in similar projects, and it became fixed. Even though project members recognized challenges with time in the governance structure, they simply failed to change the practices	The design and the use of the same complementarily technologies, e.g. the use of management standards with regard to organizational arrangement, e.g. certified actors by professional associations, or the possibility to use the same operations – drawing upon joint resources; or the use of BIM modeling among the actors to facilitate their work;	A lack of motivation to improve everyday choices in the project, and in the organization level. Instead the behavior to stick to the same choices was likely to gain more legitimacy and triggered more acceptance.	A strong emphasis on control framed management decisions in the project. This was reinforced by further industrial specialization: e.g. the development of ERTMS.
Multiple actors	The HSL project as an inter-organizational setting - multiple actors serve to engage in joint objectives. The more efficient the interaction among the actors in the project, the more efficient the choices they made. To some extent their choices became anticipated. For them, it is more attractive to adopt to the rules – e.g. profit maximization by private contractors.	Actors in the project relate to synergies from drawing on multiple resources concurrently rather than making use of them in isolation	Actors focus is underlined by simplicity in interaction, exploiting the strength through gaining learning effects while losing the opportunities. Thus, choices became easier, and narrowly focused. Strengths of public operators have been important – driving choices in the project.	Actors were likely to adhere to the industry guidelines (ERTMS standard) defining the construction and operational practices.

Table 3. Comparing conceptual stance of lock-in emergence with past research

Constitutive feature	Lock-in ^a	*Escalating Commitment ^b	Lock-in ^c
Initial Conditions	Given	Decision based	Constructed, important trigger, but with inconclusive affects to the outcome
Contingencies	Not so important, form basically shaped through external process	Exogenous and non-purposive	Emergent and non-purposive
Governance of process	Reproduction, primarily exogenous	Holding on to former decision, endogenous	Self-reinforcing mechanisms, endogenous effects, in the presence of exogenous forces
Self-reinforcing mechanisms	Given, and non-elaborated	Project embedded in organization	Shaped from experience, project embedded into (inter-) organization network and at times strategically manipulated by actors
Predictability	Given	Given after establishing a successful pattern	Not given, becomes clearer with path formation
Level of Analysis	Industry level	(Project) Organization	(Inter-) Organization, sometimes field level
Outcome of process	Persistence and absolute in-efficiency	Persistence and in-efficiency	Path dependence/ creation, potentially in-efficient lock-in

^a conceptualized by Cantarelli et al., (2010)

^b conceptualized by Winch (2013)

^c conceptualized by this research study and Aaltonen et al., (2017)

* Note: the inclusion of the concept of escalation of commitment into analysis is done on the basis that: the escalation of commitment is also a form of self-reinforcing processes and closely related to lock-in (cf. Sydow & Schreyögg 2013)

Supplemental material

Appendix A1. Historical view – A timeline of main events in the construction of the Madrid–Barcelona

Events	Date
Policy analysis framing the concept of the HSL in the transportation sector	1985
The HSL project declared priority by the council of ministers	1987
Termination of the Madrid-Seville HSL project	1992
Agreement on the HSL network among Spain and France	1995
At the European Union Summit in Essen, the HSL project is included within the Director Scheme of the Trans-European High-Speed Network, being one of the 14 priority projects	1995
The first tenders and contracts were awarded by the Ministry of Public Works	1995-96
The Council of Ministers, attributed to the GIF the construction and administration of the HSL	1997
GIF started its activity through the formalization of several design and consultancy contracts	1997
The HSL project was declared priority by the Council of Ministers	1998
The Director of GIF approved an Internal Circular that regulated in detail the internal procedures for contracting the Public Entity	1999
Start of the construction phase: the shovel goes in the ground and the first steel was bent	1999
UIC (1,435 mm) track gauge implementation	2001
Addendum agreement signed by the parties involved, the Ministry of Development, Government of Catalunya, Madrid and Barcelona city council, GIF/ Adif and Renfe-Operator	2002
The Law 39/2003 established a complete reorganization of the rail sector, Adif was created	2003
Cost overrun reported by the Plenary of the Court of Auditors	2003
Start of construction works in problematic Tunnels de ‘Guadarrama’ (28,7 km)	2004
Adif adopted measures ensuring that the basic project design has enough details for implementation – approved guidelines for decision-making following phased-review model	2005
Delivery of rail foundation, bridges and tunnels	2007
Delivery of rail infrastructure, and problems with contracts suspensions and the ERTMS	2008
Start of operations partially, including a segment line	2009
The setup of the Monitoring Committee	2009
Adif implemented behavioral guides that regulated in detail the processes	2010
The first expansion phase, involving the separation of the departure and arrival areas in Atocha	2010
Sants- La Sagrera section was subject of contentious appeals, revolving the temple of the Sagrada Familia	2012
Problematic start of Atocha-Chamartin tunnel in Madrid	2013
Final report by the Plenary of the Court of Auditors	2016

Appendix A2. Summary of data collection

Data collection method	Data collected
Semi-structured interviews	first interval (1996-2010) 5 interviews with the HSL PM, Adif Quality Controller, Head of Infrastructure Projects, Engineer at Organization B, project proponent and other relevant actors. Average duration was slightly over one hour. second interval (2015-2010) 12 interviews with the program managers and other relevant actors (project managers, construction manager at Adif, Organization 'A' Contractor PM, Organization B Supplier, Organization C Contractor PM). Average duration was slightly over one hour.
(Participant) Observations	first interval (1996-2010) ➤ participant observations, ➤ group interviews, ➤ Extensive informal communication second interval (2015-2010) The insider spent 2–3 days per week at the organization's offices and conducted observations: ➤ 7 management meetings; ➤ Extensive informal communication; ➤ Field notes for each of the days spent on site;
Document analysis	In total more than 20 documents: ➤ Internal program documents (internal financial and audit reports, overview presentations, internal organization and escalation matrices, lessons learned, and program tools, e.g., risk logs). ➤ Organization-wide guidelines and frameworks for project and program risk management.
High-level interview design first interval (1996-2010) 1. Describe the role that governmental mechanisms play in your project. What are the specific events with regard to your project's life implications in decision-making? Describe specific events and processes influencing the formal decision. 2. What do you think about project changes? Who, if anyone, disagrees with you on this? 3. What are the main factors and processes influencing technical decisions and methods? What did the decision lead to? 4. What are the main factors and processes influencing schedule overrun? 5. Describe an example of possibly changing an inefficient decision involving the design of the project. Who have been the most	Low-level interview design second interval (2015-2018) <u>Interview warm-up</u> 1. What is your job role and where are you located? 2. Which project(s) have you been involved with? 3. Can you elaborate on the history of this project? 4. You mentioned project 'A' – why was this project started? <u>Exploratory</u> 5. What difficulties did you face in this project? 6. You mentioned the influence of project 'A' in your project. What is the connection of that project to your project? 7. You mentioned this particular issue in the project; what drivers brought to this issue? 8. Who would disagree with you about this, if anyone? Please elaborate. <u>Refine</u> 9. My research looks at decision-making action and uncertainty management in a large project context, unfolding under schedule pressure in a multi-project environment. What does schedule pressure mean to you? 10. How are resources allocated in your project? 11. Describe an example of changing resource demands — who are the most influential actors involved in the process? 12. You mentioned that decision 'X' increased the schedule pressure in your project; please describe the process influencing decision 'X' your project.

influential actors involved in the process?	13. From my observations, I found that decision ‘Y’ causes ‘Z’. But what do you think causes ‘Y’ to happen?
6. Describe the process of estimation, prior to the decision-making level? Are there incentives promoting ‘estimate accuracy’ or reference class forecasting?	<u>Wrap-up</u> 14. Do you think that the long project execution timescale explains the reasons for the problem you mentioned? 15. Some interviewees told me that ‘X’ causes ‘Y.’ Do you agree? If not, please describe the process. 16. I learned that ‘Y’ happens in a similar context. Do you think this happen frequently in your project/portfolio?

Appendix A3. Overview of empirical evidence, illustrative data supporting interpretation

Identified theme	Illustrative interview data	Sources of evidence / respondents' project affiliation and year
Institutional setting influencing the choice path trajectory		
Pre-project effects	<i>“When the project design was handed to Adif for further development and delivery, and we stepped in: “the train” was running in full speed and there was no way it could be stopped.”</i>	Transcript of the notes collected by one of the researchers during a Research related-meeting (approx. 45 min.) April 2006
	<i>“The Politicians, they want the work for tomorrow and they rush to tell the people that the line will be ready in two years. A politician once told that the line will be opened for service on 2003, but as you know it only did on 2009</i>	Transcript of the notes collected by one of the researchers during a Research related-meeting (approx. 60 min.) June 2008
	<i>Political compromises are a complete disaster! The catenary (the overhead line) project, was awarded in 2006, installation of the wires was contracted but the, platform was not there!”</i>	
	<i>“Politicians in Spain decide what needs to be worked and how long it will take. This is crazy as they do not understand what needs to be done... there is no time to carry out a feasibility study properly, thus evaluating infrastructure needs: there is no time to lose because the elections are in four years.”</i>	Transcript of the telephone interview (approx. 60 min.)/ Interview with former HSL PM, December 1997
Institutional influence	<i>“We were very task-oriented and not behavior-focused. We need a giant step to better organize. There were process guides, which described how to run things, but the way we lived life, the project had little to do with that”</i>	Transcript of the telephone interview (approx. 60 min.)/ Interview with construction manager, April 2016
	<i>“I was responsible to select suppliers to initiate project modifications or construct the new components needed. If you know, GIF has a strong hierarchy, huge work packages are delivered to me, and I’m accountable for work approval and pricing our contractors/suppliers whom I actually do not contract and at times do not supervise”</i>	Transcript of the face-to-face interview (approx. 60 min.)/ (Interview with facultative director, March 1998)

	<i>“We were awarded the catenary contract, in the first segment Madrid- Lleida on 2006. This was a complete ridiculous situation. It happens to know I can’t work, because the platform is not done, this as the installation of the overhead wires is made following other special works, e.g. platform. We lost money, equipment and other machines were blocked in the field. Due to our long cooperation, we did not take legal matters in consideration! “</i>	Transcript of the telephone interview (approx. 60 min.) External online documents – audits and official reports/ Interview with Project Manager at Organization ‘C’ (contractor), April 2018
Post-project future effects	<i>“It is the higher pressure we have - the schedule; due to political influence – they want to start the project; for them (politicians and proponents involved) it is important to start the project but not necessarily to get them done, at least this is the Spanish case.”</i> <i>“There are also changes, when the designed solution is not properly done; When this happened the contacted organization/ the provider tries to make money in such occasion. In that respect, they are opportunistic if they can. I believe it is a problem, because when you have the problem, and you change the solution approach from the one agreed– we have to ‘negotiate’ on the changes and foremost to agree on the pricing. Because we are overscheduled, we usually end-up agreeing”</i>	Transcript of the notes collected by one of the researchers during a Research related-meeting (approx. 60 min.) with GIF management, April 1998 Transcript of the notes collected by one of the researchers during a Research related-meeting (approx. 90 min.) with GIF management, July 1998
Multiple mechanisms/ effects enabling fixed choices		
Coordination effects	<i>“There were process guides, which described how to run things, but the way we lived life, the project had little to do with that... I think earlier the decision making in our projects were really discrete, and there was really less interaction needed among us, but I think right now, it helps a lot if you have a flexible contract in these dynamics. We need to shuffle things around, to change things, move them on. However, we depend very much in the support from the new Minister of Infrastructure”</i> <i>“[T]ake the ERTMS system for example, it has been established for years, and there was a clear understanding of work to be performed. In my view, it has improved the production and maintenance costs while simplifying approval processes in the project by reducing the certification costs. Moreover, ERTMS system remain the same from project to project which enables easier installation and manufacturing.”</i> <i>“When things go wrong that’s when the quality and team effort was tested, we either worked together and solved a problem or break apart and blamed each other. Several cases in our project demanded parties to work together, I hold all the risk of cooperation at all time and we needed a better solution to this”</i>	Transcript of the notes collected by one of the researchers during a Research related-meeting (approx. 60 min.) April 2008 Transcript of the telephone interview (approx. 90 min.)/ Interview with the Head of Infrastructure Projects at ADIF, June 2008 Transcript of the notes collected by one of the researchers during a Research related-meeting (approx. 60 min.) April 2006

Complementary effects	<i>"We were in project in pursue of joint objectives with our partners, we adhered to the usage of complementary management systems set by owner even though we were much advanced in certain terms – in technology adoption for instance"</i>	Transcript of the face-to-face interview (approx. 90 min.)/ Interview with the Engineer at Organization B, June 2008
	<i>"...during many changes we relied on BIM modelling to coordinate our work, we were able to process further in smoother manner; although there were also few cases where BIM for example complicated matters! "</i>	Transcript of the face-to-face interview (approx. 60 min.)/ Interview with Project Manager at Adif, April 2016
Learning effects	<i>"Nowadays, it is a different system solution, it has a big influence to know the latest technologies influencing the bridge length for example. In that sense, it is important to have strong contacts with the contractor for a smooth delivery in infrastructure and for the purpose of learning. We need to learn more about the capabilities and the behavior of our contractors. Usually this means more expenses for Adif at the beginning, but we learn for future projects..."</i>	Transcript of the telephone interview (approx. 90 min.)/ Interview with the Head of Infrastructure Projects at ADIF, June 2008)
	<i>My job is to run the development and construction program, to put in place arrangements for developing and implementing projects that would enable continues performance improvement. A very clear objective is to make Adif a modern owner by improving our working routines while learning from projects in international market, including our projects."</i>	
	<i>"I work together and closely with the design team, and I prioritize and reprioritize work along their requests. They are flexible to some extent; however, they got a program pattern and they need to deliver accordingly. We could improve the learning process and have mutual benefits."</i>	Transcript of the notes collected by one of the researchers during a Research related-meeting (approx. 60 min.) June 2017
Adaptive expectation effects	<i>"It was challenging to deliver our work chunk in project, I had to relate and analyze the work recurrently and intensively not only to our task at hand, but at the same time to more macro levels of analysis. "</i>	Transcript of the telephone interview (approx. 60 min.) / Interview with ADIF PM, October 2016
	<i>"We have schedule pressure, unfortunately in the design part, we don't have the opportunity to do proper design-sometimes we do in short time. We know as engineers that we will end up in troubles, however we follow procedures and regulations when changes are to happen..."</i>	Transcript of the telephone interview (approx. 60 min.)/ Interview with Civil Engineer at Adif, March 2017

Creating the action space

Guarding/shielding effects	<i>"We have a factor called the social rentability, that is worth it!... for instance, if you introduce reasons that specific part of the project is not performing and is having problems due to communication for example – this argument is considered prior to financial</i>	Transcript of the notes collected by one of the researchers during a research related-meeting with ADIF management, April 2017
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rentability... So, the rentability of the line could sometimes never be managed at large... ones the decision for a change in project is taken, then we have the time (actually) to do the feasibility, cost benefit analysis, and accessibility... our engineers use macro-prices provided from the Ministry – so now the estimation of the change order is quite accurate as we have 20 years of experience... we work in a scale 1:1000 and avoid details.”

“It seems like a well-known behavior, contractors tend to be very crafty, they disclose information and tell about problems only when they really have to, and it is good for their business.”

‘The problem is that such complex projects have grand magnitude and involve years if not decades. It is difficult to plan them, and you never have a perfect project, you need a lot of time and money to do a good project; and we usually engage in projects in a hurry. So, the better the design is, less business for the contractor – unfortunately the opposite holds. When changes happen, the contracted organization tries to make money in such occasion – they are opportunistic, indeed if they can’

The temporary
fix effects

“Lots of unforeseen issues are to happen. We had pressure, and we had to fulfill the work processes in prompt. The problem was that the line is segmented, and each segment then is subdivided. When we do the platform, then come other actors – we are engaged in civil work and not in telecommunication, nor in electrification, or signaling, each influences the work differently.”

“Trying to do the things faster, means exactly the opposite. I don’t know..., I guess, it is just that due to political pressure, the management initiates the work packages to soon.”

I lack support and human resources to support my work and the colleagues. We were three Engineers and it was difficult to cover the project – it actually was ridiculous. It was impossible to take care of the work. I had to cope with 5 contracts at once, and we needed like 5 or 6 people to take care of the workload in the field. The only support was from the CyA contracts, the vigilantes for example, they were my eyes in the field. They approved the work as well, yet many problems aroused and change orders increased due to this problem...

It depends of the work, when there are complex works, there are vigilantes. Their scope of work is to control, the work done. They do not have a civil engineering qualification necessarily, but they have done that specific work for some time now. They have to fill in a

Transcript of the telephone
interview (approx. 60 min.)/
Interview with CM at Adif, March
2018

Transcript of the face-to-face
interview (approx. 75 min.)/
Interview with Quantity Surveyor
at Adif, July 2017

Transcript of the face-to-face
interview (approx. 90 min.)/
Interview with a project team
member at ADIF, March 2017

Transcript of the face-to-face
interview (approx. 60 min.)
Field notes collected during
organization visit/ Interview with
the Quality controller at ADIF,
April 2017

form, volumes and double check the worked. They are part of the team contracted through CyA contract type”

“In my view, I’ve seen cases when construction companies, they go and speak with the local administration responsible in that region, and ask changes based on the regulative territory. So, when changes happen, it is because of the construction organization maneuver.”

Transcript of the telephone
interview (approx. 45 min.)/
Interview with the Engineer at
Organization C, June 2017