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Opportunity management enablers in construction projects: a systematic literature review

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ABSTRACT

Using various activities and practices for opportunity management, namely, enablers can help maximise opportunities for project-oriented organisations in the construction industry. Opportunity management literature does not offer an extensive set of enablers with their performance track records in construction projects. Hence, the purpose of this paper is to identify enablers that have proven effective. This study is based on a systematic literature review of 65 real-life project cases. This is one of the few studies that has attempted to observe the cost and time savings from various opportunity management enablers across many construction projects. By contrast, previous studies have mainly covered a limited number of projects and applied enablers. Using content analysis, we identified more than 20 enablers applied in the reviewed cases, and among them, value engineering (VE) and Building Information Modelling (BIM) proved effective in attaining significant cost savings. Constructability analysis is another viable approach that can reduce costs and expedite the execution of construction. This paper provides realistic cost and time savings that can be expected from using different enablers. Such information is of practical significance to project managers considering applying enablers in construction projects.

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Introduction

This paper identifies different activities and practices that have been applied in real-life construction projects, enabling the exploitation of opportunities and helping achieve project objectives.

De Wit (1988) pointed out that there may need to be more than delivering the project output on time within the budget to call it a success. Stakeholders perceive project success differently (Bryde and Robinson 2005; Davis 2014). Based on an analysis of 650 projects, Baker, Murphy, and Fisher (1988, 903) concluded that a successful project meets the following criteria:

> technical performance specification and/or mission to be performed, and … a high level of satisfaction concerning the project outcome among key people in the parent organization, key people in the client organization, key people on the project team, and key users or clientele of the project effort.

APM (2006) defines project risk management as a ‘structured process that allows individual risk events and overall project risk to be understood and managed proactively, optimising project success by minimising threats and maximising opportunities’. De Wit (1988) distinguished between project management success and project success. While project success is measured against project objectives that tend to change during the project life cycle, project management success is traditionally gauged against project goals using an iron triangle. The iron triangle is ‘a central concept to project management research and practice, representing the relationship between key performance criteria’ (Pollack et al. 2018, 527). The concept of project success is multidimensional and includes the realisation of benefits and meeting the expectations of key stakeholders (Ika and Pinto 2022). Despite cost overruns, project success can be substantiated ‘in the context of wider benefits, whether quantified or narrative’ (Williams et al. 2023, 15).

Opportunity management aims to achieve project management success while satisfying key stakeholders. Opportunities are optional and can provide cost, time, and quality benefits and add value to end users (Rolstadås et al. 2019). Cost-, time-, and quality-related benefits are first-order effects that can be detected during a project execution. The increased value to end-users is a second-order effect that appears after project completion (Johansen et al. 2019). Based on the categorisation of opportunities by Rolstadås et al. (2019), attaining an optimised iron triangle and a higher project value is the ultimate goal of opportunity management. Hence, project-oriented organisations seeking to improve their operations management should consider

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establishing up-and-running opportunity management processes in projects.

Enhancing opportunities 'seeks to increase the probability and/or the impact of the opportunity in order to maximise the benefit to the project' (Hillson 2002, 239). Opportunities can be identified or enhanced by performing different activities and practices. We define such activities and practices as opportunity management enablers (enablers hereinafter).

Case studies covering opportunity management in construction projects show that the nature of opportunities is highly dependent on project scope and context (Chapman and Ward 2004; Lechler, Edington, and Gao 2012; Hietajärvi, Aaltonen, and Haapasalo 2017; Johansen, Bjerke, and Landmark 2018). Opportunity identification methods used in certain construction projects may not apply to others. Currently, opportunity management literature does not offer a comprehensive set of activities and practices that have proven effective in identifying opportunities, irrespective of the project scope and context. Cost overruns and delays frequently observed in the construction industry indicate a demand for an extensive set of opportunity management enablers with their performance track records. Hence, the purpose of this paper is to identify effective enablers used across different construction projects. To achieve this purpose, we deploy a literature review on the cost and time savings from various opportunity management enablers across multiple case studies, which is a novel approach because previous papers on this topic have mainly covered a limited number of projects and applied enablers. The research questions (RQs) that address the paper's purpose are as follows:

- RQ1: Which opportunity management enablers have been described in the recently published case studies?
  - RQ1.1: Which parties have used these enablers?
  - RQ1.2: During which project phases have the parties used enablers?
- RQ2: What are the reported quantified effects of the described enablers?

Theoretical background

Opportunity management helps recognise favourable conditions and maximise opportunities across the project scope. Chapman and Ward (2004, 626) pointed out that '[*o*]pportunities are all feasible ways of improving the expected outcome in terms of all relevant attributes without increasing associated risk in an inappropriate manner'. When using opportunity management enablers alone, their positive effects are expected to be limited by the application area of the enablers.

Opportunity management is typically a part of uncertainty management (Kolltveit, Karlsen, and Grønhaug 2004; Shabani et al. 2022). Opportunity management requires planning response strategies for opportunities. According to Hillson (2002), one can exploit, share, enhance, or ignore opportunities. Opportunity management includes the following processes: seeking new opportunities, registering opportunities, and monitoring. The light railway project case study by Johansen et al. (2019) extensively details opportunity management processes.

Various publications contain descriptions of the enablers that represent different concepts, methods, and tools. Broad concepts relevant to opportunity management are value management (Chapman and Ward 2004; Kelly, Male, and Graham 2014), benefits management (IPA 2017), project resilience and bouncing forward (Bahrami and Evans 2010; Kutsch and Hall 2016; Olsson and Klakegg 2023), and flexibility (Bahrami and Evans 2010). Mossman, Ballard, and Pasquire (2013) highlight the following enablers in design: set-based design, evidence-based design, Target Value Design (TVD), and VE. Lean construction (Aziz and Hafez 2013; Allison et al. 2018), location-based management system (Seppänen et al. 2014), and constructability analysis of design (Arditi, Elhassan, and Toklu 2002) facilitate construction execution.

Marsov, Olsson, and Lædre (2022) identified 18 practically oriented peer-reviewed articles on opportunity management in construction projects. Half of the articles were case studies describing how project management practitioners discovered opportunities. Performing risk or uncertainty workshops was the primary method of opportunity identification in most case study projects (Krane, Rolstadas, and Olsson 2011; Krane, Johansen, and Alstad 2014; Johansen et al. 2016; Johansen, Bjerke, and Landmark 2018). Rantatunneli, an infrastructure alliance project, systematically used different activities and practices in addition to uncertainty analysis workshops that helped maximise opportunities (Hietajärvi, Aaltonen, and Haapasalo 2017). Hence, opportunity management can be complemented by the use of various enablers. Bryde and Volm (2009) and Lehtiranta (2014) revealed that practitioners were unfamiliar with opportunity management. However, opportunities often exist in construction projects. The lack of studies on the practical aspects of opportunity management calls for further research in this domain.

Bower and Walker (2007, 54) stated that '[*k*]nowing how to test options for undertaking construction operations requires both the knowledge about the available options and an ability to model options and to make decisions'. Opportunity studies typically require the involvement of various project participants (Johansen et al. 2016; Johansen, Bjerke, and Landmark 2018). Managing opportunities is often perceived as an extra burden (Hillson 2002). In other words, opportunity management triggers additional transaction costs. A balanced use of human resources can help optimise transaction costs 'so that the total project cost is reduced and cost over-runs avoided'. (Haaskjold, Andersen, and Langlo 2021, 19). Knowing enablers that have proven effective can, therefore, ease opportunity management studies and reduce transaction costs.

Considering that project management in large construction projects and major programmes persistently suffers from cost overruns and thus receives bad publicity (Caffieri et al. 2018), there is a high demand for effective means of achieving cost savings. Opportunity management can help reduce costs significantly based on case studies by Johansen, Bjerke, and Landmark (2018) and Hietajärvi, Aaltonen, and Haapasalo (2017). However, a comprehensive set of enablers that have proven effective in identifying opportunities, irrespective of project scope and context, is yet to be defined.

Construction projects often suffer delays. Attempts to address this issue have been made in previous studies by identifying the main causes of delays. Arantes and Ferreira (2021) developed an innovative methodology that allows to identify delay mitigation measures considering 'the relationships between the causes of the delay and at which stages of the construction project the causes occur'. One of the aims of opportunity management is to ensure that a project is delivered on time or ahead of schedule. In addition to the typical response strategy in dealing with delays, namely mitigation, opportunity management can offer exploitation of opportunities, leading to time savings.

Materials and methods

This study is based on a systematic literature review performed using a content analysis of recently published real-life project cases. To avoid doubt, the said project cases are not cases we have studied but those studied or presented and published by other authors.

A systematic literature review is a method of collecting and integrating data from multiple studies (Pati and Lorusso 2018). Snyder (2019, 334) pointed out that '[*t*]he aim of a systematic review is to identify all empirical evidence that fits the pre-specified inclusion criteria to answer a particular research question'. Content analysis is 'a research technique for making replicable and valid inferences from texts … to the contexts of their use' (Krippendorff 2018, 18). Content analysis helps systemise data presented across the selected literature by counting codes and tabulating categories to summarise 'what is known about the data' and identify patterns in the data (Morgan 1993, 115).

Case studies can be distinguished into single- and multiple-case studies. Many single and multiple case studies have presented the effects of applying one enabler for opportunity management, such as case studies conducted by Abdelfatah, Abdel-Hamid, and Ahmed (2020) and Göttsche and Kelly (2020), respectively. The case study by Brunet and Forgues (2019) is an example of a single case study that presents results from applying multiple enablers in a single project. Following this distinction, we can categorise this literature study as a representation of the effects of multiple enablers used across multiple cases (refer to Figure 1).

		Case study	
		single	multi
Enabler	single	(Abdelfatah et al. 2020)	(Göttsche and Kelly 2020)
	multi	(Brunet and Forgues 2019)	This literature review

Figure 1. Categorisation of studies reporting the application of opportunity management enablers.

Selected project cases

We selected 65 cases in this literature review. They are listed in Table 1. The projects described in these cases were executed in more than 24 countries across the globe. The projects varied from the renovation and expansion of existing facilities to the construction of new facilities. Out of 65 cases, 54 covered the construction of public and private buildings (37 cases), and transportation infrastructure projects (17 cases). The rest 11 cases comprised the following types of construction projects: three energy infrastructure projects, two pharmaceutical construction projects, two water resource infrastructure projects, two industrial steel buildings, one maritime infrastructure project, and one environmental infrastructure project.

Thematic limitations of the study

This literature review had certain thematic limitations. It covers case studies describing the application of enablers at the project level. Case studies about the selection and funding of business cases and evaluation of project investments are outside the scope of this review. The literature review concerns enablers that can provide cost and time benefits or add value to the client or end users. Thus, creating long-term social values is outside the scope of this study.

Literature review execution plan

Williams et al. (2021) highlight that there can be multiple combinations of execution steps in systematic literature reviews depending on the study purpose. Following the prescriptions by Briner and Denyer (2012), Williams et al. (2021) outlined execution steps widely used in systematic literature reviews. We adapted those execution steps for our literature review study in the six-step plan presented hereinafter.

Step 1. Planning the literature review. The first step included the following activities: defining the motivation for research, formulating research questions, and establishing the search strategy and inclusion/exclusion criteria for cases presented in case studies.

Step 2. Predefining enablers based on literature known to the authors. The theoretical background section outlines the predefined enablers.

Step 3. Search rules development based on the set of predefined enablers. The search rules had several limitations, such as publication type and language. The publication period was from 2018 to 2022. Appendices A and B outline the search rules.

Step 4. Searching open-access databases. The search was limited to peer-reviewed journal articles in English. Appendices A and B detail the number of retrieved records from the used databases Web of Science and Scopus, respectively.

Step 5. Systematic selection of relevant cases from the retrieved records. Case studies were selected systematically, followed

Table 1. Selected cases and assigned case numbers.

Author(s) and year	Case number and project deliverable	Country
(Abdelfatah, Abdel-Hamid, and Ahmed 2020)	1. Greater Cairo Metro (Line 3—Phase 3)	Egypt
(Alleman and Tran 2021)	2. Highway expansion	USA
(Andújar-Montoya et al. 2020)	3. Public building extension	Spain
(Bensalah, Elouadi, and Mharzi 2019)	4. Tunnel	Belgium
(Bensalah, Elouadi, and Mharzi 2019)	5. Railway—Crossrail (Elizabeth Line)	UK
(Bensalah, Elouadi, and Mharzi 2019)	6. Construction and renovation of electrical substations	Morocco
(Bhattacharya and Mathur 2022)	7. Hotel	India
(Bhattacharya and Mathur 2022)	8. Office building fit out	*Not stated*
(Bhattacharya and Mathur 2022)	9. Office building	India
(Bhattacharya and Mathur 2022)	10. High-rise residential building	India
(Bourdeau et al. 2020)	11. Rehabilitation of Canada's Parliamentary Centre Block	Canada
(Brunet and Forgues 2019)	12. Multifunctional amphitheatre	Canada
(Bygballe, Endresen, and Fålun 2018)	13. Higher education building	Norway
(Chahrour et al. 2021)	14. Two transportation projects (interfaces)	*Not stated*
(Czerewko et al. 2019)	15. Wind turbines at Bonemill Quarry	UK
(Daraei et al. 2019)	16. Twin tunnels	Iraq
(Demirkesen, Sadikoglu, and Jayamanne 2022)	17. Residential Building	USA
(Ellis et al. 2021)	18. Single-storey gymnasium and swimming pool	UK
(Gharehbaghi, McManus, and Robson 2019)	19. Railway network (metro)	Australia
(Gorod et al. 2021)	20. The Olmsted Locks and Dam replacement project	USA
(Göttsche and Kelly 2020)	21. Block M—Demolition and landscaping	Ireland
(Göttsche and Kelly 2020)	22. CF unit—New build healthcare	Ireland
(Göttsche and Kelly 2020)	23. Podiatry unit—New build healthcare	Ireland
(Göttsche and Kelly 2020)	24. HDU—Demolition and fit out	Ireland
(Gransberg and Gransberg 2020)	25. Tuttle Creek Dam modification	USA
(Gransberg and Gransberg 2020)	26. Sellwood Bridge replacement	USA
(Hein et al. 2021)	27. Backbarrier saltmarsh construction	USA
(Huang et al. 2021)	28. Metro line	China
(Jang et al. 2019)	29. R&D centre	South Korea
(Jang et al. 2019)	30. Business facility complex	South Korea
(Jang et al. 2019)	31. Hospital	South Korea
(Jang et al. 2019)	32. Apartment complex	South Korea
(Jang et al. 2019)	33. Data centre	South Korea
(Khodeir and El Ghandour 2019)	34. Luxurious residential compound	Egypt
(Khodeir and El Ghandour 2019)	35. National Project for Housing choose	Egypt
(Koseoglu and Nurtan-Gunes 2018) & (Koseoglu, Sakin, and Arayici 2018)	36. Istanbul Airport (Phase 1)	Turkey
(Laryea and Watermeyer 2020)	37. Sol Plaatje University	South Africa
(Laryea and Watermeyer 2020)	38. University of Mpumalanga	South Africa
(Laurent and Leicht 2019)	39. Building renewal	*Not stated*
(Lee et al. 2020)	40. Road widening and rehabilitation	USA
(Leicht et al. 2020)	41. Project B	Germany
(Li, Wang, and Alashwal 2021)	42. High-rise residential building	China
(Liu et al. 2022)	43. Megaproject: Bridge	China
(Lyu et al. 2020)	44. Prefabricated housing project	China
(Ma et al. 2018)	45. Office building	China
(Majava, Haapasalo, and Aaltonen 2019)	46. New transportation system	Finland
(Mitropoulos and Tajima 2022)	47. Pier replacement	*Not stated*
(Zender and de Soto 2021)	48. Rehabilitation of a shopping mall	Peru
(Othman and Abdelrahim 2020)	49. Pharmaceutical plant	India
(Othman and Abdelrahim 2020)	50. Governmental building	Indonesia
(Perez and Ghosh 2018)	51. New five-story educational building	USA
(Peters et al. 2018)	52. Combined heat and power plant	*Not stated*
(Power et al. 2021)	53. Pharma facilities	Ireland
(Ramani and KSD 2021)	54. Steel building erection	India
(Rasmussen 2021)	55. Airport extension	Denmark
(Rasmussen 2021)	56. Hospital building	Denmark
(Rodrigues and Lindhard 2021)	57. Hospital buildings	Norway
(Savolainen et al. 2018)	58. Media centre renovation	*Not stated*
(Shafiq 2021)	59. Commercial and residential development project	UAE
(Shahhosseini et al. 2018)	60. Ilam Gas Refinery	Iran
(Staub-French et al. 2022)	61. Student residence (hybrid mass timber high-rise building)	Canada
(Xing et al. 2021)	62. Industrial building	China
(Yu et al. 2022)	63. Public housing redevelopment	*Not stated*
(Yu et al. 2022)	64. Primary drainage channel	*Not stated*
(Bensalah, Elouadi, and Mharzi 2019)	65. Mälarbanan railway	Sweden

by the selection of individual cases. Meeting thematic limitations and providing information about the enablers and their effects were the inclusion criteria for the cases presented in the selected case studies.

The reasons for excluding articles and cases are presented in Appendix C, using the PRISMA diagram (Page et al. 2021). We selected only single- and multiple-case studies that presented individual project cases. Multiple case studies that mainly reported the synthesised results were excluded to maintain a systematic selection approach.

Step 6. Mapping and tabulation of data regarding the enablers. The final step involved mapping the selected cases and addressing the research questions. The relevant data were mapped across the selected cases using content analysis and are presented in the tables and Figure 2 in the results and discussion section.

Results and discussion

In the following, we first present the enablers described in the mapped cases and identify which contracting parties used the enablers and during which project phases the application of enablers occurred. Second, we describe what could be extracted from case studies on the quantified effects of the use of enablers.

We distinguished the effects of enablers between first- and second-order, following the categorisation of opportunities proposed by Rolstadås et al. (2019). For instance, the synergy of the applied enablers in the case study by Brunet and Forgues (2019, 645) helped achieve project objectives 'concerning the schedule and a cost reduction of CAD$ 30 m from the initial budget'. The optimised schedule and reduced cost were first-order effects because they could be detected during the project execution. Adopting technical innovations, namely LED lighting, reduced energy consumption, which is a second-order effect that could be experienced after the project's completion.

Enablers described in the mapped case studies

Table 2 lists the enablers that were applied in the selected cases. The content analysis revealed that project management practitioners most frequently applied VE studies, BIM, and waste reduction methods to achieve positive effects (refer to Table 2). This observation indicates that the use of other enablers in real-world settings has received less attention. More empirical findings on other enablers are required to increase the awareness of their potential.

Deploying various enablers during project execution is not uncommon (refer to Table 2). However, as practice shows, using enablers always requires extra effort and resources. For instance, when clients expect to receive value-adding proposals during tenders, they should secure pre-construction fees for bidders (Alleman and Tran 2021). The Last Planner System (LPS), a workflow improvement planning system, requires the involvement of concerned construction trades when arranging weekly work-plan meetings (Perez and Ghosh 2018; Andújar-Montoya et al. 2020).

Table 2. Observed enablers applied in the selected cases, along with observed types of expected and actual positive effects, and contracting parties that used the enablers (N = number of projects).

	Effects		Contracting party that used the enablers			
Opportunity management enablers	First-order	Second-order	Client and Contractor(s)	Client	Contractor	Subcontractor
VE	$N=14$	$N=3$		$N=1$	$N=3$	$N=5$
BIM and computer-aided solutions	$N=13$		$N=1$	$N=2$	$N=6$	$N=1$
Waste reduction methods (resource efficiency initiatives, time studies, value stream mapping)	$N=7$	$N=1$		$N=1$	$N=4$	$N=2$
Workflow improvement planning systems, e.g. Last Planner System (LPS), Takt Time Planning (TPP)	$N=5$	$N=1$	$N=1$		$N=2$	$N=1$
Constructability analysis	$N=4$	$N=3$			$N=4$	
Stakeholder management	$N=2$	$N=4$		$N=4$		
Call-off procurement with incomplete design	$N=2$			$N=2$		
BIM, LPS, VE, Flexibility and Technical Innovations, Constructability analysis	$N=1$	$N=1$		$N=1$		
Computer-aided solutions, LPS + TTP, Prefabrication and just-in-time (JIT) delivery	$N=1$		$N=1$		*No available data*	
BIM, computer-aided solutions, Prefabrication and JIT delivery, Full-scale mock-up	$N=1$		$N=1$			
LPS, TVD	$N=1$		$N=1$			
VE, Technical Innovations	$N=1$	$N=1$			$N=1$	
Technical Innovations, Exploration: cross-industry and cross-disciplinary learning, Prefabrication	$N=1$		$N=1$			
Flexibility: scope changes and value creation	$N=1$	$N=1$		$N=1$		
Technical Innovations	$N=1$				*No available data*	
Pilot tunnelling section monitoring	$N=1$					
Exploration: cross-industry and cross-disciplinary learning		$N=1$	$N=1$			
Identification of borrow sites with fill material in proximity to the project location	$N=1$					
TVD	$N=1$		$N=1$			
Non-invasive testing	$N=1$				$N=1$	
Lessons learnt from previous project	$N=1$			$N=1$		
Open book policy and allowing adjustments to final account	$N=1$				$N=1$	
Scrum	$N=1$				$N=1$	
Total:	$N=62$	$N=16$	$N=8$	$N=13$	$N=23$	$N=9$

Most of the identified enablers could yield first-order positive effects associated with cost or time savings. Applying enablers can trigger both first- and second-order effects. Table 2 shows that first-order effects occured more frequently than second-order effects in the reviewed cases. This observation suggests that the primary purpose of using enablers is typically to reduce cost and time, which may consequently add value to end-users. For example, the analysis of constructability (Lee et al. 2020) and the application of LPS (Andújar-Montoya et al. 2020) can reduce the critical path(s). Shortened project duration allows early opening or occupation of newly built facilities, increasing value to end-users.

Contracting parties that applied specific enablers

Different methods can be used to achieve positive effects depending on the project characteristics and scope of work. From the description of most selected cases, 53 out of 65, it was possible to conclude which contracting parties used the enablers. This information is presented in Table 2. Notably, various contracting parties can use similar enablers. The variety of enablers applied by subcontractors was lower than that of clients and contractors, because subcontractors are typically responsible for a limited scope of work. We note that it is inevitable for subcontractors to become part of workflow planning by contractors who use LPS or Takt Time Planning (TTP).

Sometimes, clients require contractors to use specific enablers, such as VE studies (Jang et al. 2019), BIM (Shafiq 2021), constructability analysis (Lee et al. 2020), open book policy, and allowing adjustments to the final account (Ellis et al. 2021). When clients attempt to introduce the use of innovative enablers during project execution, they invest extra resources to ensure that their contractors seek opportunities in the required manner. For instance, in the case study by Bygballe, Endresen, and Fålun (2018, 1326), the client 'had an explicit ambition of implementing … TTP in the construction phase,' which was considered an innovative approach at that time. To create a shared understanding of TTP among project participants, the client hired a takt consulting firm. The client mandated that construction contractors follow the predefined takt plan—however, the inability to change the execution sequence affected progress.

Project phases where enablers were applied

Most of the selected cases (60 out of 65) provided information about the timing of the enabler application. This information is presented in Table 3, emphasising which enablers apply to a specific project phase rather than indicating the number of case study projects that utilised the enablers. Given that the project delivery models in these cases differed, we introduced general project phases as follows: conceptual design, detailed design, tender, and construction execution. The sequence of project phases may vary depending on the project delivery model. For instance, a tender can be performed after conceptual design. Construction execution can be commenced before detailed design completion.

Table 3 suggests that the variety of enablers widens during the project phases that come after the conceptual design. When a contracting party holds control over a detailed design or construction execution, it can seek opportunities by utilising a wider variety of methods and tools. Certain enablers can be used during several project phases. However, due to the lack of reported quantified positive effects, there is no evidence that the probability and impact of opportunities increase or decrease when transitioning from conceptual design to subsequent phases.

Collaborative project delivery models, such as Integrated Project Delivery (IPD) and alliance, foster the use of multiple enablers (Hietajärvi, Aaltonen, and Haapasalo 2017; Allison et al. 2018). In contrast to IPD and alliances, do traditional project delivery models allow the application of various enablers?

Figure 2 depicts the enablers applied during different project phases under various project delivery models. Figure 2 was developed based on cases that provided the following

Table 3. Application timing of enablers, sorted by general project phases (X = at least one observation of enabler utilisation during the project phase).

Opportunity management enablers	Conceptual design	Detailed design	Tender	Construction execution
VE	X	X	X	X
BIM and computer-aided solutions	X	X		X
Constructability analysis	X	X		X
Stakeholder management	X	X		X
Flexibility: scope changes and value creation	X	X		
Target value design	X	X		
Waste reduction methods	X			X
Identification of borrow sites with fill material in proximity to the project location	X			
Technical Innovations		X	X	X
Pilot tunnelling section monitoring		X		X
Full-scale mock-up		X		X
Workflow improvement planning systems		X		X
Call-off procurement with incomplete design		X		
Prefabrication		X		
Exploration: cross-industry and cross-disciplinary learning		X		
Non-invasive testing in combination with BIM		X		
Lessons learnt from previous project		X		
JIT delivery				X
Open book policy and allowing adjustments to final account				X
Scrum				X
Variety of enablers:	8	15	2	12

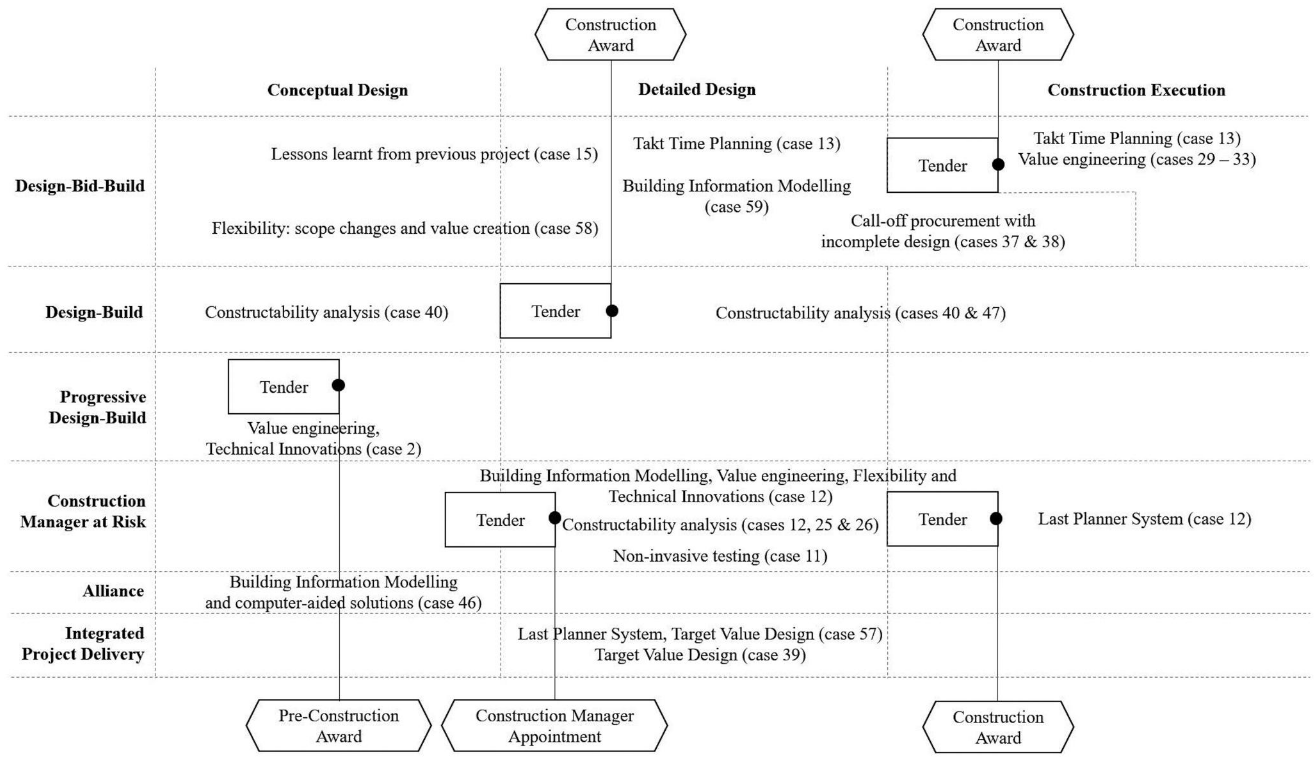

Figure 2. Project phases in which the enablers were applied, and the project delivery models.

information: the selected project delivery model, contracting parties that used enablers, and the application timing of specific enablers.

The number of selected case study projects that provided the abovementioned details numbered 21 out of 65. Figure 2 suggests that traditional project delivery models, such as Design-Bid-Build (DBB) and Design-Build (DB), do not restrict the variety of enablers. In DBB and DB projects, the beneficiary of harvested opportunities is typically the contracting party that applies associated enablers, whereas collaborative project delivery models allow multiple contracting parties to benefit from enablers whose use is initiated by one party.

Quantifying the effects of the use of enablers

The selected cases reported the outcomes of applying the enablers in different ways. We distinguished the effects of enablers between first- and second-order following the categorisation of opportunities proposed by Rolstadås et al. (2019). The following subsections present the size of the quantified effects.

Quantified first-order effects

First-order effects are typically tangible and associated with cost and time savings. For example, the detection and resolution of clashes via BIM helped avoid spending extra manhours in the range of 474–131,536 (Koseoglu, Sakin, and Arayici 2018; Li, Wang, and Alashwal 2021; Shafiq 2021). Bensalah, Elouadi, and Mharzi (2019) reported an estimated range of the return on investment (ROI) from BIM in Crossrail (Elizabeth Line) as follows: 3:1–12:1.

Tangible effects can be compared to historical data from similar projects. Owing to the lack of such historical data, the most appropriate approach to assess the effectiveness of enablers was to evaluate the quantified first-order effects relative to the project costs or baseline schedule. Furthermore, such an approach could reveal the extent to which applying enablers helps achieve project management success.

Table 4 presents the quantified effects of enablers, which were divided into three categories: Category 1—cost effects relative to the estimated project cost, Category 2—time effects relative to the project baseline schedule, and, Category 3—cost savings relative to the cost of the associated parts of the project scope (specific construction elements, building components, scope deliverables, or construction trades). Out of 65 cases, 25 provided sufficient information to measure the quantified effects of enablers against the estimated costs or baseline project schedule. Cases 1, 3 and 40 fell into more than one category of quantified effects and therefore appear multiple times in Table 4.

Category 1 effects indicate that the most frequently used enablers, namely, BIM and VE studies, can help avoid a project cost increase in the range of 10–20% and reduce the project cost by up to 10%, respectively. The expected cost savings from the constructability analysis were minor relative to the estimated project cost. However, in case 25, the Tuttle Creek Dam modification project (Gransberg and Gransberg 2020), finding an alternative technical solution facilitating constructability yielded cost savings accounting for approx. USD 75 M, which could be significant. Note that case 25 is not represented in Table 4 because of the lack of information about the project costs.

Table 4. Approximated size of quantified first-order effects relative to the project cost, project baseline schedule or costs of the associated parts of the project scope (N = number of projects).

Opportunity management enablers	Case number	Quantified first-order effects	
		Category 1 (cost effects relative to the estimated project cost)	
BIM	14, 36	Avoided cost increase:	10–20%
VE	1, 42	Expected cost savings:	1.7–10%
BIM, Workflow improvement planning systems (LPS), VE, Flexibility and Technical Innovations, Constructability analysis	12	Actual cost savings:	7.5%
Workflow improvement planning system (LPS) + BIM	3	Avoided cost increase:	4.3%
Constructability analysis	47	Expected cost savings:	1.15%
Waste reduction methods: resource efficiency initiatives	21–24	Actual cost savings:	0.33 – 0.72%
Computer-aided solution: 5D-PROMPT	41	Actual losses:	−6.04%
	$N = 12$		
		Category 2 (time effects relative to the project baseline schedule)	
BIM and computer-aided solutions: augmented reality and capturing as-built conditions via laser scanning	8	Actual time savings:	30%
Waste reduction methods: value stream mapping	54	Avoided delay:	30%
Constructability analysis	40	Actual time savings:	18%
Workflow improvement planning system (LPS) + BIM	3	Actual time savings and avoided delay:	11.7%
	$N = 4$		
		Category 3 (cost savings relative to the cost of the associated parts of the project scope)	
VE	1, 10, 16, 29–33, 34, 60	Expected cost savings:	1.2 – 58.6%
BIM	9	Expected cost savings:	4.5%
Constructability analysis	40	Expected cost savings:	3.42%
	$N = 12$		

Table 5. Quantified second-order effects of enablers.

Case number	Opportunity management enablers	Quantified second-order effects	
58	Flexibility: scope changes and value creation	End-user satisfaction	Net Promoter Score® (NPS) = 37% *Remark: NPS is a metric proposed by* Reichheld (2006*)*
63	Stakeholder management: public engagement and public consultation	End-user satisfaction	Survey results: '92% of residents were satisfied with the new estate' (Yu et al. 2022, 2293)
40	Constructability analysis	Value from early project completion	'The road widening was found to save regular lane and express lane road users 12 and 90 min per day' (Lee et al. 2020, 2) *Remark: considering that the project was commissioned ten months ahead of schedule, the positive effects accounted for approx. 60 and 450 hours for regular lane and express lane road users, respectively*

Category 2 effects indicate that value stream mapping and the synergy of BIM and capturing as-built conditions via laser scanning can substantially improve the project schedule. Notably, the necessity of capturing the as-built conditions via laser scanning is highly dependent on the project scope and therefore may not be applicable to a wide range of project types. The case study projects that reported the top two quantified time effects were small in size. These results suggest that the duration of small projects can be sensitive to the effects of specific enablers.

According to the Category 2 effects in Table 4, performing a constructability analysis of design can yield significant time savings and add value to end-users. Although constructability analysis was not among the most frequently used enablers (refer to Table 2), the substantial time savings presented in Table 4 suggest that project management practitioners should consider performing constructability analysis.

Category 3 cost savings were quantified relative to the costs of the associated parts of the project scope. At first glance, Category 3 effects of VE studies and the constructability analysis were higher than the Category 1 effects of the use of these two enablers. However, this does not necessarily mean that the expected cost savings from VE studies and the constructability analysis in Category 3 would be significant when compared to the project cost. For instance, in case 1, 'by applying VE technique … the cost decreased by 23% of the total price of typical slabs and by 1.7% of the overall contract amount' (Abdelfatah, Abdel-Hamid, and Ahmed 2020, 1561). To avoid misreporting the size of cost savings as a percentage that an enabler can yield, it is essential to specify whether the reported cost savings are compared relative to the overall project cost or to the associated parts of the project.

The use of enablers requires additional resources. The actual value of the positive effects of enablers can be determined by deducting the size of the invested resources. When considering all utilised resources, the actual size of the positive effects may diminish, eliminating an upward bias

(Davis et al. 2014) towards the effectiveness of the applied enablers. We observed only one case study that reported the costs incurred using an enabler, namely, 5D-PROMPT—a computer-aided process planning method (refer to Table 4):

> At first glance, Project B matched the budget; however, additional and unexpected extra costs for necessary tablet/computer hardware and servers … were required due to the implementation of the new methodology. These costs amounted to a total of EUR 22,825 net per 1000 m^2 per year for Project B. This resulted in an actual cost overrun of 6.04% for this Project. (Leicht et al. 2020, 17)

Within the context of an individual project, Chapman and Ward (2004) defined opportunities as ways to improve the expected outcome without a high increase in the associated risks. In other words, opportunities that pose high risks at the project level are not real opportunities, but threats. Some selected cases (Bygballe, Endresen, and Fålun 2018; Leicht et al. 2020) show that the introduction of certain workflow improvement systems and computer-aided solutions incur extra costs associated with training programmes for personnel and the procurement of hardware and software tailored to project needs. Such extra costs are typically one-time and can pose the risk of cost overrun in an individual project. Nevertheless, for project-oriented organisations that iteratively execute construction projects with commensurable scopes of work, the introduction of workflow improvement systems and computer-aided solutions has the potential to maximise opportunities and reduce the risk profile of the project portfolio over time. This observation expands the above-mentioned definition of opportunities by Chapman and Ward (2004).

Quantified second-order effects

Table 5 shows the documented quantified second-order effects of the enablers. In most cases, the reported second-order effects were qualitatively expressed. Only two types of second-order effects from applying enablers were quantified among the selected cases: (1) end-user satisfaction and (2) value from early project completion (refer to Table 5). In addition, reduced energy consumption (Brunet and Forgues 2019) and lower maintenance costs (Rasmussen 2021) can also be considered quantifiable second-order effects.

Conclusion

In this literature review, we identified opportunity management enablers that have proven to be effective in achieving cost and time savings in construction projects. The first research question aimed to determine the opportunity management enablers described in recent case studies. The results of the content analysis of the selected cases showed that project management practitioners are accustomed to VE studies, BIM, and waste reduction methods. We observed that various contracting parties apply these three enablers in pursuit of positive effects.

Less frequently used enablers that have received attention from scholars include workflow improvement planning systems, constructability analysis, and stakeholder management. Contractors use workflow improvement planning systems that require the involvement of subcontractors to optimise the schedule. The key parties that perform constructability analyses are typically the contractors. Among the selected cases, we observed that clients use stakeholder management to address the end-users' needs.

Project management practitioners apply BIM and perform VE studies, constructability analysis, and stakeholder management throughout the conceptual design, detailed design, and construction execution. Clients can request bidders to perform VE studies during the tender period to achieve contract price reduction. Various waste reduction methods can be utilised during conceptual design and construction. The application of workflow improvement planning systems can be initiated during detailed design and continued throughout construction execution.

The second research question aimed to identify the quantified effects of opportunity management enablers used in the reviewed cases. We determined that VE studies and BIM can yield significant first-order effects associated with the costs of large and medium-sized projects. One can expect a project cost reduction of up to 10% owing to the solutions proposed during VE studies. BIM utilisation can help avoid redesign efforts and escalation of project costs by 10–20%. Value stream mapping, a waste reduction method, can offer substantial schedule improvements in small projects, helping to avoid delays of up to 30% relative to the project baseline schedule. VE studies are frequently conducted in construction projects. As practice shows, the ROI from BIM can be net positive. Besides, BIM can lead to improvements in other aspects of the project execution that are difficult to measure, such as design and construction integration, information exchange, and coordination. Thus, investing extra resources in VE studies and BIM can likely be paid off, helping attain project management success. Constructability analysis is another viable approach that can help expedite construction execution and increase cost savings.

We identified the following quantifiable second-order effects in the reviewed cases: end-users' satisfaction, the value from early project completion, reduced energy consumption and maintenance costs. These second-order effects can serve as measurable parameters for assessing project success. Project management practitioners should consider pre-defining quantifiable second-order effects to improve ex-post evaluations of projects.

Occasionally, clients mandate contractors to apply innovative enablers. In such cases, clients are at risk because the effects of the enablers may not meet their expectations. Choosing a suitable set of enablers requires understanding the project context and scope, the peculiarities of the selected project delivery model, and the end-users' needs. As Bower and Walker (2007, 54) pointed out, '[*t*]he key first focus for planning any type of project should be on developing a deep understanding of the project characteristics and context and not the technique to be used'.

Practical contribution

Knowing which enablers proved effective can minimise transaction costs and facilitate opportunity management processes. The effects observed in the case studies provide project managers with realistic cost and time savings, which can be expected from using different enablers.

Certain enablers are part of a toolkit for consultants who promote their services to project owners and contractors. The application of enablers can be initiated internally by project team members. The summary of the cost and time savings from enablers presented in this paper is an empirical track record. This track record allows decision-makers to reckon with a high degree of confidence in the extent to which the measures proposed by consultants or project team members can save cost and time.

The empirical evidence presented in this study reveals that the variety of enablers for opportunity management is not restricted by the selected project delivery model. The most effective enablers identified in this literature review, namely VE studies, BIM, and constructability analysis, can be applied in collaborative projects, as well as in projects with traditional project delivery models.

Theoretical contribution

Studies by Hällgren (2012) and Marsov, Olsson, and Lædre (2022) suggest that project management research is practically oriented. Hence, summarising empirical evidence from the application of various methods and practices aimed at achieving specific effects in projects advances project management and other intersecting areas of research such as portfolio management. In this study we observed that the introduction of certain workflow improvement systems and computer-aided solutions that enable opportunity management incurs one-time extra costs. The means of seising opportunities that pose high risks in an individual project due to one-time extra costs can be adopted by a project-oriented organisation in other similar projects and become beneficial in the context of portfolio management. This observation expands the definition of opportunities by Chapman and Ward (2004), suggesting that threats that lead to performance improvements at the project level can become opportunities from a portfolio management perspective.

This is one of the few studies that has attempted to observe the effects of various opportunity management enablers across many projects, whereas previous studies have mainly covered a limited number of projects and applied enablers. This type of literature study, covering various measures used in multiple projects, can be applied to other project management domains, such as risk management and project control.

Research limitations

Wawak and Woźniak (2020, 871) defined seven common limitations in 'prior literature reviews in the field of project management'. These are the limitations relevant to this literature review: analysis of abstracts instead of full texts leading to poor representation of results; searching papers using predefined clusters of keywords that can lead to the omission of relevant studies; lack of longitudinal quantitative data.

During the selection of case studies, full texts were analysed when the information provided in the abstracts was insufficient to determine whether the articles were relevant to this study. To overcome the limitations associated with analysing articles, full texts of case studies were analysed to retrieve data to answer the research questions.

This literature review has two possible limitations, which are in line with similar studies in the field of project management (Wawak and Woźniak 2020). The first limitation concerns the number of databases searched and the predefined search rules, which were restricted to peer-reviewed journals. Finding case studies in this manner helped tailor the search and retrieve a manageable number of records. The first limitation led to the omission of articles that could potentially meet the selection criteria. In addition, most practitioners do not publish in peer-reviewed journals unless the project supports a research student, which is a standing limitation in the field of project management. The second limitation is associated with the information available from the selected cases. For example, only three cases presented second-order effects that could be quantified. Furthermore, most of the selected cases did not provide longitudinal quantitative data on the effects of the applied enablers. Instead, some of the included cases mentioned the expected and actual cost reductions and time savings.

Further research

Using enablers can incur extra costs, compromising the achievement of the project objectives. Thus, there needs to be more cases reporting quantified positive effects and losses from different enablers. Furthermore, case studies should define the selected project delivery models to recommend the best timing for applying specific enablers to various contracting parties. Based on the foregoing, we encourage scholars to report quantified effects of enablers and provide extensive project descriptions in future case studies.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Appendices

Appendix A. Search rules and the number of retrieved articles on Web of Science

#	Pre-defined enablers	Search rule and key words	Number of identified records
1	Flexibility concepts	TS=(flexibility OR flexible OR adaptability OR agility OR ambidexterity OR versatility OR pliability OR liquidity OR malleability OR mobility OR modularity OR plasticity OR resilience OR agile)	95
2	Opportunity management enablers in design	TS=('value engineering' OR 'value design' OR 'target value' OR 'target value design' OR 'set based design' OR 'set-based design' OR cbd OR 'evidence-based design' OR ebd)	21
3	Lean construction	TS=('lean' OR 'last responsible moment' OR 'last planner system' OR 'LPS')	48
4	Value/benefits management	TS=('value management' OR 'value adding' OR 'adding value' OR 'value creation' OR 'benefits creation' OR 'benefit creation' OR 'enhance value' OR 'value added' OR 'benefits management' OR 'benefit realisation' OR 'benefits realisation' OR 'enhance benefit' OR 'enhance benefits' OR 'added value' OR 'value addition')	54
5	Constructability analysis	TS=(constructability OR buildability OR contractibility OR 'location-based design' OR 'Location based design' OR 'location based design management' OR 'location-based design management' OR 'LBDM' OR 'Location Based Management System' OR 'Location-Based Management System' OR 'LBMS')	15
6	Cost savings and optimisations	TS=(('cost savings' OR 'cost saving' OR 'budget control' OR 'alternative materials' OR 'alternative design' OR 'alternative material' OR 'cheaper solution' OR 'cheaper solutions' OR 'alternative solution' OR 'alternative solutions' OR 'faster solution' OR 'faster solutions' OR 'optimisation' OR 'optimising' OR 'optimum solution' OR 'optimum solution' OR 'optimised design' OR 'optimised design' OR 'optimum alternative' OR 'optimum alternatives' OR 'lead time reduction' OR 'time reduction' OR 'schedule acceleration' OR 'decrease time to market' OR 'decreased time to market') NOT (*all the key words mentioned above*))	26
7	Resilience and bouncing forward	TS=('resilience' OR 'crisis management' OR 'project saving' OR 'crises management' OR 'saved project' OR 'saved projects' OR 'disruption management' OR 'bouncing forward' OR 'bounce forward')	22
		Total:	281
	Applied restrictions in the search rules	AND (TS=(project) AND TS=(opportunity OR opportunities OR 'positive risk' OR 'positive risks' OR benefit OR benefits OR value OR 'positive effect' OR 'positive effects') AND TS= ('case study' OR 'case studies') AND TS= ('project management' OR 'engineering management' OR 'construction management' OR 'construction')) AND TS = construction LANGUAGE: (English) Refined by: DOCUMENT TYPES: (ARTICLE) Timespan: 2018-2022.	

Appendix B. Search rules and the number of retrieved articles on Scopus

#	Pre-defined enablers	Search rule and key words	Number of identified records
1	Flexibility concepts	TITLE-ABS-KEY (flexibility OR flexible OR adaptability OR agility OR ambidexterity OR versatility OR pliability OR liquidity OR malleability OR mobility OR modularity OR plasticity OR resilience OR agile)	83
2	Opportunity management enablers in design	TITLE-ABS ('value engineering' OR 'value design' OR 'target value' OR 'target value design' OR 'set based design' OR 'set-based design' OR cbd OR 'evidence-based design' OR ebd)	23
3	Lean construction	TITLE-ABS ('lean' OR 'last responsible moment' OR 'last planner system' OR 'LPS')	40
4	Value/benefits management	TITLE-ABS-KEY ('value management' OR 'value adding' OR 'adding value' OR 'value creation' OR 'benefits creation' OR 'benefit creation' OR 'enhance value' OR 'value added' OR 'benefits management' OR 'benefit realisation' OR 'benefits realisation' OR 'enhance benefit' OR 'enhance benefits' OR 'added value' OR 'value addition')	53
5	Constructability analysis	TITLE-ABS-KEY (constructability OR buildability OR contractibility OR 'location-based design' OR 'Location based design' OR 'location based design management' OR 'location-based design management' OR 'LBDM' OR 'Location Based Management System' OR 'Location-Based Management System' OR 'LBMS')	14
6	Cost savings and optimisations	TITLE-ABS (('cost savings' OR 'cost saving' OR 'budget control' OR 'alternative materials' OR 'alternative design' OR 'alternative material' OR 'cheaper solution' OR 'cheaper solutions' OR 'alternative solution' OR 'alternative solutions' OR 'faster solution' OR 'faster solutions' OR 'optimisation' OR 'optimising' OR 'optimum solution' OR 'optimum solution' OR 'optimised design' OR 'optimised design' OR 'optimum alternative' OR 'optimum alternatives' OR 'lead time reduction' OR 'time reduction' OR 'schedule acceleration' OR 'decrease time to market' OR 'decreased time to market') AND NOT (*all the key words mentioned above*))	129
7	Resilience and bouncing forward	TITLE-ABS-KEY ('resilience' OR 'crisis management' OR 'project saving' OR 'crises management' OR 'saved project' OR 'saved projects' OR 'disruption management') AND TITLE-ABS (project) AND TITLE-ABS-KEY (opportunity OR opportunities OR 'positive risk' OR 'positive risks' OR benefit OR benefits OR value OR 'positive effect' OR 'positive effects')	16
		Total:	358
	Applied restrictions in the search rules	AND TITLE-ABS (project) AND TITLE-ABS-KEY (opportunity OR opportunities OR 'positive risk' OR 'positive risks' OR benefit OR benefits OR value OR 'positive effect' OR 'positive effects') AND TITLE-ABS-KEY ('case study' OR 'case studies') AND TITLE-ABS-KEY ('project management' OR 'engineering management' OR 'construction management' OR 'construction') AND TITLE-ABS (construction) AND (LIMIT-TO (PUBYEAR, 2022) OR LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018)) AND (LIMIT-TO (DOCTYPE, 'ar')) AND (LIMIT-TO (LANGUAGE, 'English')) AND (LIMIT-TO (SRCTYPE, 'j'))	

Appendix C. PRISMA diagram tailored for the research design