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Job Order Contracting (JOC) as an Alternative Project Delivery Method: Challenges and Opportunities

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Executive Summary

In 2021, Gordian and NIGP: The Institute for Public Procurement partnered to conduct market research on construction project delivery method challenges and opportunities. The scope of this research was to better understand construction procurement trends, solicitation activities and the differences between project delivery methods. Specifically, the research sought to answer two main questions:

1. Are solicitation, transaction and coordination efforts different when implementing Job Order Contracting compared to other delivery methods?
2. How do contractor relationships and governance of the contract differ when using Job Order Contracting compared to other delivery methods?

To answer the research questions, a survey instrument was designed based on transaction costs theory. A transaction cost is any cost (quantified in terms of human efforts and/or material and capital resources invested) involved in an economic transaction between a buyer and a supplier for the exchange of goods and services. These costs are usually distinguished into three broad categories:

- **Search and information costs,** related to activities required to determine if the good/service is available on the market and at what conditions (e.g., supply market scouting, price analysis, etc.).
- **Bargaining and decision costs,** related to activities required to come to an acceptable agreement with the other party to the transaction, drawing up an appropriate contract.
- **Policing and enforcement costs,** related to all the activities required to make sure the other party sticks to the terms of the contract, and taking appropriate action (often through the legal system) if this turns out not to be the case.

In the Summer of 2021, following a pre-test period, the survey instrument was disseminated to members of NIGP: The Institute for Public Procurement's and Gordian's databases.

Respondents had the option to provide information about Job Order Contracting (JOC) alone, other project delivery methods or both. Our ideal respondent was a procurement professional aware of construction management practices in their respective organization. Overall, we received 355 responses, out of which 95 individuals shared only descriptive information about the organization, 59 shared their agency's experience with JOC, 171 shared their experience with other project delivery methods and 30 shared information about JOC and other project delivery methods. Thus, the final usable sample consists of 260 responses from procurement professionals operating in different public organizations.

Respondents in the sample generally have wide experience (in years) with procuring construction projects. The sample consists of local government organizations, state agencies, county governments, healthcare organizations, education institutions and others. Most of the organizations in the sample are local and state governments. Additionally, 66.6% of the agencies in the sample are large organizations that spend more than 10 million dollars on construction projects annually. Agencies in the sample spend significant amounts on few construction contracts every year (i.e., around 47.9% of agencies complete

less than 25 projects), and for most of the respondents, the duration of the procurement process generally surpasses 12 weeks.

We analyzed data gathered through a survey instrument designed for the specific purpose of the project. Statistical tests (e.g., Mann-Whitney, T-tests) were applied to compare the distribution and the mean of relevant variables for JOC vs. other delivery methods. Additional qualitative data were used to further interpret the results. The Highlights section below outlines the main findings of the research project.

Highlights:

- Governments have various construction project delivery methods at their disposal, depending on the project type and scope of work.
- We collected information from 355 public organizations in the United States at various government levels to understand how JOC compares to other project delivery methods, i.e., Design-Bid-Build (DBB), Design-Build (DB), Construction Manager at Risk-(CMAR).
- Findings show that:
    - JOC contracts (using a 3rd party intermediary or not) require a lower procurement process duration and a lower number of employees involved.
    - JOC contracts simplify the individual project control activities, but they require more coordination efforts in the upfront solicitation process.
    - Overall, JOC contracts are comparable to other project delivery methods in terms of transaction costs.
    - JOC contracts (using a 3rd party intermediary or not) favor trust generation with contractors and prevent opportunistic behaviors.
    - No significant differences in terms of the magnitude of transaction costs and characteristics of supplier relationships are found between traditional delivery methods (DBB vs. DB vs. CMAR)

1. Introduction

The construction industry plays a significant role in a country's economy and investment in this sector has been linked to economic growth.[1] Depending on the project scope and objective of the contract, government agencies have various project delivery methods at their disposal, among which we can mention, for example, Job Order Contracting (JOC), Design-Bid-Build (DBB), Design-Build (DB) and Construction Manager at Risk (CMAR).

Among these different project delivery methods, JOC presents singular characteristics. Job Order Contracting (JOC) was created in 1982 by Gordian's founder, Harry H. Mellon, to tackle the demanding requirements, tight timeframes and stringent competitive bidding requirements at U.S. Army facilities in Europe. JOC is a unique, indefinite delivery, indefinite quantity (IDIQ) procurement process that helps facility and infrastructure owners complete many repairs, maintenance jobs, renovations and straightforward new construction projects through a competitively awarded contract. JOC is a project delivery method conceived to simplify construction procurement. Unlike traditional bidding where each project is identified, designed and then put out to bid, Job Order Contracting establishes competitively-bid prices up front and eliminates the need to separately bid each project. Therefore, JOC is presented as a solution to reduce the bidding effort in the procurement of construction projects and as an alternative to more time-consuming delivery methods for routine construction projects.

Although the purpose of JOC is to simplify the process of completing repair, maintenance, renovation and straightforward new construction projects, its use still represents an unexplored territory for many organizations, especially in the public sector. While extensive research has been conducted on the performance of traditional methods such as DBB, DB and CMAR, there is little research conducted on the implementation of JOC. Therefore, to understand the effort needed to procure construction projects through such a method and evaluate and how it compares to other project delivery methods, Gordian partnered with NIGP to conduct market research on the challenges and opportunities from the owner's perspective, specifically procurement professionals. The research team comprises Dr. Andrea S. Patrucco, Assistant professor of Supply Chain Management at Florida International University and Dr. Ana-Maria Dimand, Assistant professor of Public Policy and Administration at Boise State University.

[1] *See* Patrucco, A. S., Moretto, A., & Knight, L. (2021). Does relationship control hinder relationship commitment? The role of supplier performance measurement systems in construction infrastructure projects. *International journal of production economics*. DOI: https://doi.org/10.1016/j.ijpe.2020.108000

The study employs a mixed-method research design. Building on transaction costs theory and principles of supplier relationship governance[2] [3] [4] [5] [6] [7], the research team designed a survey to assess solicitation, transaction and coordination efforts in the case of JOC compared to other delivery methods, as well as the relationship and governance aspects in the case of JOC compared to other delivery methods. We analyzed the questionnaires collected from 260 different respondents and complemented these results with qualitative data collected from 32 construction procurement experts and JOC users.

This report is structured as follows. *Section 2* outlines the characteristics of project delivery methods. *Section 3* details the research problem and methodology. Next, *Section 4* presents the data analysis results, followed by qualitative data analysis in *Section 5*. Finally, the report ends with an in-depth discussion of the main results.

[2] *See* Petersen, O. H., Baekkeskov, E., Potoski, M., & Brown, T. L. (2019). Measuring and managing ex ante transaction costs in public sector contracting. *Public Administration Review*, 79(5), 641-650.

[3] *See* Liu, Y., Luo, Y., & Liu, T. (2009). Governing buyer–supplier relationships through transactional and relational mechanisms: Evidence from China. *Journal of Operations Management*, 27(4), 294-309.

[4] *See* Jääskeläinen, A. (2021). The relational outcomes of performance management in buyer-supplier relationships. *International Journal of Production Economics, DOI:* https://doi.org/10.1016/j.ijpe.2020.107933

[5] *See* Shahzad, K., Ali, T., Takala, J., Helo, P., & Zaefarian, G. (2018). The varying roles of governance mechanisms on ex-post transaction costs and relationship commitment in buyer-supplier relationships. *Industrial Marketing Management*, 71, 135-146.

[6] *See* Ketkar, S., Kock, N., Parente, R., & Verville, J. (2012). The impact of individualism on buyer–supplier relationship norms, trust and market performance: An analysis of data from Brazil and the USA. *International Business Review*, 21(5), 782-793.

[7] *See* Sheng, S., Zhou, K. Z., Li, J. J., & Guo, Z. (2018). Institutions and opportunism in buyer–supplier exchanges: the moderated mediating effects of contractual and relational governance. *Journal of the Academy of Marketing Science*, 46(6), 1014-1031.

2. Characteristics of Project Delivery Methods [8] [9]

When a government organization identifies the need for a construction project[10], they have the option to select from various project delivery methods, among which we have DBB, DB, CMAR and JOC. As outlined in the introduction, some of these methods are more traditional, while others less diffused. They have different characteristics and implications from a procurement process perspective that are outlined in the following sections.

2.1 Characteristics of traditional project delivery methods

DBB, DB and CMAR are all considered more traditional delivery methods.

Design-Bid-Build is the most used method for completing construction projects.

This delivery method consists of three distinct phases: the design, bid and build phases. Design-Bid-Build is a good option for new commercial construction. Although it's a lengthy process, it allows owners to work jointly with architects and engineers to get the best price for their project.

The **design phase** begins with an owner hiring a designer, either an architect or an engineer, to design a new facility. While designing the new building, the architect or engineer will prepare any necessary drawings and specifications that the contractor's team will need to complete the construction work. Once the design work is finished, the project is opened for bids.

During the **bid phase**, general contractors review construction documents, confer with any needed subcontractors and ask the architect or engineer clarifying questions to prepare their bid. Each bid represents a general contractor's best price for a project, and multiple bids for the same project can vary greatly. After all the general contractors have submitted their respective bids, the designer reviews each bid, asks the contractors for any additional information, and, ultimately, chooses the bid they think best fits the owner's needs.

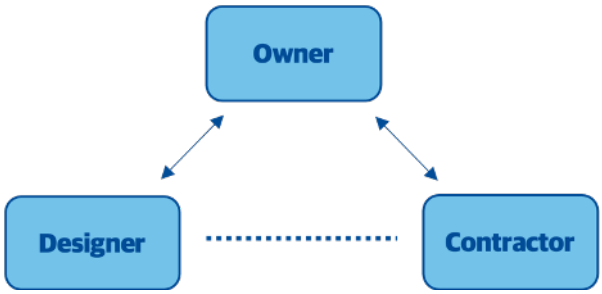
Once the winning bid has been selected, the build phase begins, and the general contractor's team can get to work constructing the new facility. A unique feature of the Design-Bid-Build method is that the designer will oversee the work of the general contractor and subcontractors. This helps

[8] *See* Owner's Guide to Project Delivery Methods. 2012. The Construction Management Association of America. Retrieved from https://www.cmaanet.org/sites/default/files/inline-files/owners-guide-to-project-delivery-methods.pdf

[9] *See* Comparing 5 project delivery methods. Retrieved from https://www.gordian.com/resources/comparing-5-project-delivery-methods/

ensure that the owner receives a quality product (see **Figure 1** for a representation of the relationships between the parties involved).

Figure 1. Design-Bid-Build (Adapted from Engie Map/ Trystate Mechanical Inc).[11]



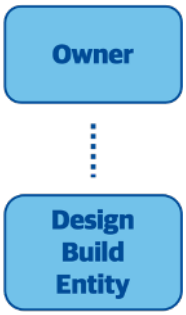
The Design-Build (DB) method was created to reduce the lengthy timeline that often accompanies Design-Bid-Build. It replaces the designer and the contractor with a single party who fills both roles called a design-builder. The design-builder, who is usually an architect, engineer or contractor, serves as the owner's single contact for the entirety of the project. And while this allows for efficient communication, it also means that the design-builder is singularly accountable for the outcome of the project. As a result, the Design-Build method is ideal for large projects that require an accelerated timeline.

The DB process begins with an owner drafting an initial project design and asking for project proposals from various design builders. Like bids in the Design-Bid-Build method, these proposals generally represent a design builder's best price for the project. The key difference between a bid and a proposal is that proposals include notes on the project design, whereas bids don't alter the project design. As a result, owners typically select the proposal that provides the best value for the project without sacrificing design elements. After the owner has chosen a specific proposal, the design builder's team can get to work securing permits and beginning construction immediately. The project can also be completed in phases, where the first phase is designed, and construction begins while the second phase is designed, again allowing for a faster start to construction.

But the benefits of DB also add some risk to the owner. Owners who choose the DB delivery method for their projects lose the advantage of having a separate party oversee the quality of construction. Instead, the design-builder has complete autonomy in the construction phase. Thus, choosing a trustworthy design-builder is integral to success in Design-Build (see **Figure 2** for a representation of the relationships between the parties involved).

[11]Advantages of Design Build for Mechanical Projects. Retrieved from https://www.engiemep.com/news/advantages-of-design-build-for-mechanical-projects/

Figure 2. Design-Build (Adapted from Engie Map/ Trystate Mechanical Inc).[12]



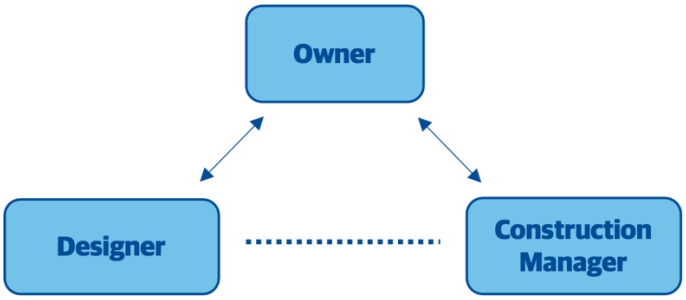
Construction Manager at Risk, also called CM at Risk or simply CMAR, is also a derivative of the Design-Bid-Build process. But instead of the designer overseeing the design process and construction quality, a construction manager (CM) is hired by the owner to oversee the entire project (Please see Figure 3 for a depiction of the relationships between the parties involved). Once hired, the CM stands in as the owner's representative and advocate in every step of the construction process, from preconstruction to design and bid, through construction. This makes CMAR ideal for project owners who want an expert's help managing their project or communicating between parties, and sometimes CMAR allows owners to remove themselves from most of the construction process altogether.

When an owner decides to use the CMAR delivery method for their project, they'll bring an initial design to a CM, who will then begin consulting with designers to draw up plans. During the design phase, the CM will work on the owner's behalf to value engineer and find cost-saving opportunities where possible. About halfway through the design phase, the CM will present the owner with their Guaranteed Maximum Price (GMP). With their GMP, the CM sets a price threshold that they promise the owner's project will not exceed. If the project comes in under this threshold, the owner will likely reward the CM through a cost-sharing agreement. But if the project exceeds the GMP, then the CM takes on the risk of making up the difference.

Once the design phase is finished, the CM will collect bids from contractors for the project and select the bid they believe best meets the owner's needs without crossing the GMP threshold. Once construction begins, the CM will work with the contractor to schedule construction phases, oversee the quality of the contractor's work, and coordinate any needed change orders (see **Figure 3** for a representation of the relationships between the parties involved).

[12]Advantages of Design Build for Mechanical Projects. Retrieved from https://www.engiemep.com/news/advantages-of-design-build-for-mechanical-projects/

Figure 3. Construction Manager at Risk (Adapted from Francom et al. 2016 and Engie Map/ Trystate Mechanical Inc).[13][14]



2.2 Characteristics of Job Order Contracting

Job Order Contracting[15] is an indefinite-delivery, indefinite-quantity (IDIQ) project delivery method. This means that multiple projects can be completed over the life of one long-term contract, as opposed to the single-project contracts used in the three previous methods. The long-term contract makes JOC an ideal choice for owners who complete a high volume of routine or less complex construction projects each year. This method is suitable for various construction projects, including repairs, renovations and maintenance work, especially when short timelines or fixed budgets are involved. JOC, however, is not typically an ideal choice for complex new construction. Rather than needing to take each project to bid, owners take bids from contractors at the beginning of the contract. Once contractors are awarded, the owner can access their services throughout the entire life of the contract.

The JOC project delivery method is predicated on a Unit Price Book with preset prices for construction tasks, that lives for the entirety of the contract. Thus, JOC is a perfect match for owners who have the need to complete many repair and renovation projects easily and quickly. Once a JOC contract is in place, the owner simply identifies each project with a brief description and notes the desired or required dates and times for performing the work. Next, the JOC contractor is notified by the owner, who requests a design (if necessary), a detailed scope of work, and a price proposal for the project. This process is commonly referred to in JOC as a Request for a Job Order (JO) Proposal. The owner, JOC contractor, and designer (if necessary) work closely during the site visit to identify site characteristics and decide on the most economically advantageous means and methods needed to perform the work. The design (if needed), along with a detailed scope of work, including the project's performance times, is then

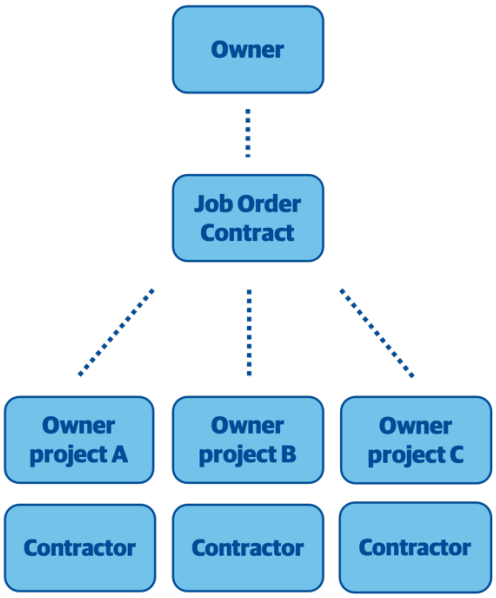
[13] See Francom, T., El Asmar, M., & Ariaratnam, S. T. (2016). Performance analysis of construction manager at risk on pipeline engineering and construction projects. *Journal of Management in Engineering*, *32*(6), 04016016.

[14] *See* Advantages of Design Build for Mechanical Projects. Retrieved from https://www.engiemep.com/news/advantages-of-design-build-for-mechanical-projects/

[15] *See* Job Order Contracting. Retrieved from https://www.gordian.com/products/job-order-contracting/

submitted by the JOC contractor to the owner for consideration. Once these submittals are agreed on, the JOC contractor submits a detailed, lump-sum fixed-price proposal based on the defined scope of work (see **Figure 4** for a representation of the relationships between the parties involved).

Figure 4. Job Order Contracting (adapted from Gordian).[16]



The method is suitable for projects that require phasing to accommodate operations and/or budget constraints and is particularly well-matched for projects with critical performance times. Additionally, having access to a local JOC contractor can give owners the capability of almost immediate mobilization for emergency projects. After the contract is awarded, the winning contractor can perform work for the owner at any point needed throughout the duration of the contract.

Some organizations choose to have a 3rd party, like Gordian, help implement and support their JOC program. A JOC consultant can develop a custom, local Unit Price Book, provide JOC-specific language for the contract, perform contractor outreach, review project proposals and deliver program management with purpose-built software and quality control measures to ensure contract compliance. This end-to-end program support supplements the experience and knowledge of procurement teams, especially during peak construction season.

[16] *See* Gordian. Best Practices for a successful Job Order Contracting (JOC) Program. Available at https://www.gordian.com/landing-pages/job-order-contracting-best-practices/

2.3 Comparison between projects delivery methods and limitations of existing knowledge

Table 1 compares the various project delivery methods on suitability, actors involved, contractors' documents, contract type, the role of the owner, risk for the owner, and issues. The academic field has paid extensive attention[17] [18] [19] [20] to project delivery methods such as DBB, DB, CMAR. However, we still know little about JOC [21], particularly concerning the benefits of its application in terms of transaction costs during the solicitation process and the characteristics of the relationship between the parties involved in the contracts.

[17] *See* Hale, D. R., Shrestha, P. P., Gibson Jr, G. E., & Migliaccio, G. C. (2009). Empirical comparison of design/build and design/bid/build project delivery methods. *Journal of construction engineering and management*, *135*(7), 579-587.

[18] *See* Ling, F. Y. Y., Chan, S. L., Chong, E., & Ee, L. P. (2004). Predicting performance of design-build and design-bid-build projects. *Journal of construction engineering and management*, *130*(1), 75-83.

[19] *See* Minchin Jr, R. E., Li, X., Issa, R. R., & Vargas, G. G. (2013). Comparison of cost and time performance of design-build and design-bid-build delivery systems in Florida. *Journal of Construction Engineering and Management*, *139*(10), 04013007.

[20] *See* Sullivan, J., Asmar, M. E., Chalhoub, J., & Obeid, H. (2017). Two decades of performance comparisons for design-build, construction manager at risk, and design-bid-build: Quantitative analysis of the state of knowledge on project cost, schedule, and quality. *Journal of construction engineering and management*, *143*(6), 04017009.

[21] See Ohrn, G. (2009). The influence of job-order-contracting as a construction project delivery method on owner satisfaction. Indiana State University.

Table 1. Project delivery methods - comparative characteristics.

	Suitability	Main actors	Contractors' documents	Contract type	Role of the owner	Risk for the owner	Issues
Design-Bid-Build	New construction	Owner Contractor Designer	Bid (unique for each contractor)	One contract-one project	Pick a designer to design project specifications Evaluate bids Supervise the work executed by the contractor	Medium (owner oversees the project)	Lengthy process
Design-Build	Large projects with a tight timeline	Owner Contractor with design capabilities	Bid + Proposal	One contract-one project	Evaluate proposals	High (supplier oversees the project)	Requires trust between partners
Construction Manager at Risk	Very technical projects	Owner Contractor Designer Construction manager (CM)	Bid	One contract-one project	Pick a designer to design project specifications	Very low (CM oversees the project and covers costs over the guaranteed maximum price)	Selection of competent CM
Job Order Contracting	Routine, less complex construction projects	Owner Contractor(s) Designer(s)	Contract Bid + Proposal for each project	One contract-multiple projects	Evaluate contract bids (upfront) Review/ approve project proposals	Low	Not suitable for complex, capital projects

3. Research Problem and Data Collection

As explained in the previous section, an owner needs to address several areas of concern when choosing the most suitable project delivery method for their projects. It is necessary to choose an overall project delivery and contracting strategy that effectively and efficiently delivers the project, considering factors such as budget, complexity and supplier relationship risks.

While the implications of using project delivery methods such as DBB, DB and CMAR have been studied in both literature and practice[22] [23], less is known for what concerns the adoption of JOC, particularly in two key procurement areas:

1. The magnitude of the transaction costs related to the construction project contract (i.e., searching, negotiating and monitoring).
2. The impact on contractor relationship aspects, such as communication and information exchange, trust and opportunistic behavior.

In order to provide new evidence in these two areas, between May and September 2021, the research team employed a mixed-method approach that involved the design and development of an ad-hoc survey instrument, and the analysis of semi-structured interview data collected following conversations with senior procurement experts to discuss the validity of the results found through the questionnaire.

Table 2 provides an overview of the main questionnaire items. Ultimately, our sample includes 260 responses from professionals operating in different public organizations; as 30 of them filled the questionnaire twice (one time for JOC and a second time for another project delivery method of their choice), we ended up with 290 usable responses.

Table 3 describes the characteristics of the sample.

For a more comprehensive understanding of the questionnaire design and structure and data collection procedure, please look at Section A in *Appendix*.

[22] *See* Hale, D. R., Shrestha, P. P., Gibson Jr, G. E., & Migliaccio, G. C. (2009). Empirical comparison of design/build and design/bid/build project delivery methods. *Journal of construction engineering and management*, *135*(7), 579-587.

[23] See Levy, S. M. (2009). Construction process planning and management: An owner's guide to successful projects. Butterworth-Heinemann.

Table 2. Main items included in the questionnaire.

Transaction cost items (TC)	
TC1.	It is difficult and/or time-consuming to scan the market for potential contractors.
TC2.	It is difficult and/or time-consuming to incentivize and/or train potential bidders.
TC3.	It is difficult and/or time-consuming to evaluate formal bids.
TC4.	It is difficult and/or time-consuming to conduct reference checks of potential contractors.
TC5.	It is difficult and/or time-consuming to negotiate prices and payment terms with the awarded contractors.
TC6.	It is difficult and/or time-consuming to negotiate and agree on the scope of work that the awarded contractors will perform.
TC7.	JOC contracts are renegotiated and re-signed several times to include sophisticated areas and clauses.
TC8.	For the projects executed under the contract, it is difficult and/or time-consuming to come to an agreement with the contractor about the detailed specifications (scope, time, cost).
TC9.	It is difficult and/or time-consuming to develop performance metrics.
TC10	It is difficult and/or time-consuming to gather information about project progress.
TC11.	It is difficult and/or time-consuming to control the project execution of awarded contractors.
TC12.	We incur substantial expenditures in coordinating with the contractors on contractual aspects.
TC13.	It is difficult to execute contract options or termination.
TC14.	It is difficult to implement performance incentives with contractors.
TC15.	It is time-consuming to resolve disputes with contractors.

Table 2 (cont.). Main items included in the questionnaire.

Relational items (REL)	
REL1.	We have a systematic approach to sharing performance measurement information with the contractors.
REL2.	We agree with the awarded contractors to keep each other informed about any events or changes that might affect the projects.
REL3.	We agree with the awarded contractors that any information, which might help the other party, will be provided to them.
REL4.	We agree with the awarded contractors that the exchange of information in this relationship takes place frequently and informally, not only according to a pre-specified agreement.
REL5.	We agree with awarded contractors that problems or conflicts are expected by both parties to be solved through joint consultations and discussions.
REL6.	We believe the awarded contractors strive to perform the highest quality work possible.
REL7.	When making important decisions regarding project execution, we believe the awarded contractors are concerned about our welfare or interests.
REL8.	We believe the awarded contractors' future decisions and actions will not adversely affect the contract with us.
REL9.	We believe the awarded contractors never try to alter the facts in order to get concessions from us.
REL10.	We believe the awarded contractors conduct business in a manner that is in accordance with the terms of the contract.
REL11.	We occasionally discover that awarded contractors lie about project-related aspects in order to protect their interests.
REL12.	We sometimes discover that awarded contractors try to breach informal agreements between our companies to maximize their own benefit.
REL13.	We sometimes realize that awarded contractors try to take advantage of "holes" in the contract to further their own interests.
REL14.	We sometimes realize that awarded contractors fail to deliver promises, as described in the contract, for their own interests.

Table 3. Sample characteristics.

		Freq	%			Freq	%
Job profile	Manager/Director (Purchasing)	173	48.7%	**Experience (years)**	1-5 years	123	34.6%
	Manager/Director (Other)	32	9.0%		6-10 years	79	22.3%
	Buyer/other types of purchasing role	107	30.1%		11-15 years	49	13.8%
	Other	43	12.1%		> 15 years	104	29.3%
Type of organization	Local governments	152	42.8%	**Number of employees working in procurement**	< 3	60	16.9%
	State agency/governments	48	13.5%		3-5	84	23.7%
	County governments	47	13.2%		6-10	70	19.7%
	Education institutions	2	0.6%		11-20	51	14.4%
	Healthcare providers	72	20.3%		> 20	90	25.4%
	Others	34	9.6%				
Spend in construction procurement (USD)	< 1 million	22	6.2%	**Yearly # of construction projects**	< 25	170	47.9%
	1-5 million	47	13.2%		25-50	85	23.9%
	5-10 million	50	14.1%		51-75	31	8.7%
	10-50 million	99	27.9%		76-100	24	6.8%
	> 50 million	137	38.6%		> 100	45	12.7%
Length of construction project procurement	< 2 weeks	5	1.4%	**Groups**	1 - JOC with 3rd party	33	11.4%
	2-4 weeks	21	5.9%		2 - JOC with no 3rd party	56	19.3%
	5-8 weeks	60	16.9%		3 - Design-Bid-build	136	46.9%
	9-12 weeks	80	22.5%		4 - Other (DB, CMAR, IPD)	65	22.4%
	> 12 weeks*	189	53.2%				

*A preliminary version of this research report was presented at the 2021 NIGP Annual Virtual Forum, and session attendees were polled on the length of their typical construction procurement process. 36 attendees responded to the poll, and their responses indicated that for 70% of them (25 respondents) the construction procurement process can last between 3 and 9 months. 3 respondents declared their procurement process timeframe is longer than 9 months, while 8 indicated < 3 months as the average duration.

To better complement the evidence collected through the survey instrument and further interpret the results, we used additional **qualitative data** directly supplied by Gordian.

Gordian regularly conducts interviews with procurement professionals and JOC users from public agencies of all sizes and types to gather insights on construction procurement challenges. These interviews, which typically last between 30 minutes to an hour, aim to understand how Gordian can enhance and improve JOC solutions to provide more efficiencies in the procurement process. The main information collected includes:

- Overview of interviewees' roles and responsibilities.
- Characteristics of their procurement process for repair, maintenance and alteration construction work.
- Their biggest challenges in the construction procurement process.
- How they determine which project delivery method to use.
- If they currently use JOC to procure construction projects and
    - If not, for what reasons.
    - If yes, when and why they decide to use JOC, and the benefits they've realized when using JOC.

4. Data Analysis Results

The data analysis process was structured at two levels. First, general descriptions and comparisons are provided to outline the differences between JOC and all the other types of project delivery methods. Then, a more detailed analysis across the four contract groups (in line with the classification included in **Table 3**) is provided.

4.1 Time and effort for procurement of construction projects

As the first step in our analysis, we compared differences in the number of people involved and length of the procurement needed for JOC and other project delivery methods. The Mann-Whitney and Kruskal-Wallis tests were used to compare the distributions across different groups.

4.1.1 JOC vs. other project delivery methods

Table 4 provides an overview of the distribution of responses indicating the number of employees involved in and the duration of procurement process for JOC and other delivery methods.

Table 4.

		JOC		Other project delivery methods	
		Freq	%	Freq	%
Number of employees involved in the construction procurement process	1-2	26	29.2%	34	16.9%
	3-4	26	29.2%	69	34.3%
	5-7	19	21.3%	49	24.4%
	8-10	10	11.2%	27	13.4%
	> 10	8	9.0%	22	10.9%
Length of the construction procurement process	< 2 weeks	11	12.4%	5	2.5%
	2-4 weeks	24	27.0%	16	8.0%
	5-8 weeks	27	30.3%	32	15.9%
	9-12 weeks	19	21.3%	46	22.9%
	> 12 weeks	8	9.0%	102	50.7%

For both the number of employees and the length of the construction procurement process, the Mann-Whitney test led to the rejection of equality of distribution between JOC and other delivery methods. Particularly, although at different levels of significance, in both cases the test reveals that JOC seems to require involvement of less people and a lower length of the procurement process compared with other project delivery methods. Additional details about statistical results are included in Section B1 in *Appendix*.

4.1.2 Contract group comparisons

To provide more details to the previous results, we tested the equality of distribution across the four main types of construction procurement contracts included in the sample: JOC contracts with the use of a 3rd party as an intermediary (*Group 1*); JOC contracts without the use of a 3rd party as an intermediary (*Group 2*); DBB contracts (*Group 3*); other delivery method contracts (*Group 4*).

Table 5 provides an overview of the distribution of responses indicating the number of employees involved in and the duration of procurement process for the four groups.

Table 5.

		Group 1		Group 2		Group 3		Group 4	
		Freq	%	Freq	%	Freq	%	Freq	%
Number of employees involved in the construction procurement process	1-2	8	24.2%	19	33.9%	22	16.2%	12	18.5%
	3-4	9	27.3%	18	32.1%	49	36.0%	20	30.8%
	5-7	5	15.2%	15	26.8%	36	26.5%	15	23.1%
	8-10	5	15.2%	3	5.4%	15	11.0%	10	15.4%
	> 10	6	18.2%	1	1.8%	14	10.3%	8	12.3%
Length of the construction procurement process	< 2 weeks	2	6.1%	8	14.3%	2	1.5%	3	4.6%
	2-4 weeks	6	18.2%	18	32.1%	13	9.6%	3	4.6%
	5-8 weeks	13	39.4%	16	28.6%	18	13.2%	14	21.5%
	9-12 weeks	8	24.2%	10	17.9%	35	25.7%	12	18.5%
	> 12 weeks	4	12.1%	4	7.1%	68	50.0%	33	50.8%

The results of the Kruskall-Wallis tests (reported, in detail, in Section B2 in *Appendix*) shows that differences exist between groups.

Focusing on the number of employees, the only difference seen in the results is between Group 1 (JOC with the use of a 3rd party intermediary) and Group 2 (JOC with no use of a 3rd party intermediary), with Group 2 seeming to require less human involvement compared to Group 1 ($p < 0.05$). This result is not surprising – with the use of a 3rd party, the owner would require resources also to appropriately interact with the JOC provider, thus increasing the need for human involvement. The distribution of the number of people needed for the procurement process using JOC without a 3rd party is similar to traditional delivery methods.

As per the length of the process, while there are no differences between Group 1 and Group 2, both these groups have a distribution that is significantly different from Group 3 and 4; particularly, we can

notice that JOC contracts (no matter whether there is involvement or a 3rd party or not) seem to be skewed toward lower categories of procurement process duration compared to other delivery methods. This means that the procurement of JOC contracts is likely to be faster compared to other contract typologies. There are no differences between DBB contracts and contracts that involve other traditional delivery methods.

4.2 Transaction costs of construction project contracts

We proceeded to analyze the data related to the transaction cost items included in the questionnaire.

Figure 5 and **Figure 6** report, respectively, the distribution of the responses for JOC and other project delivery methods.

Figure 5. Transaction costs of JOC contracts.

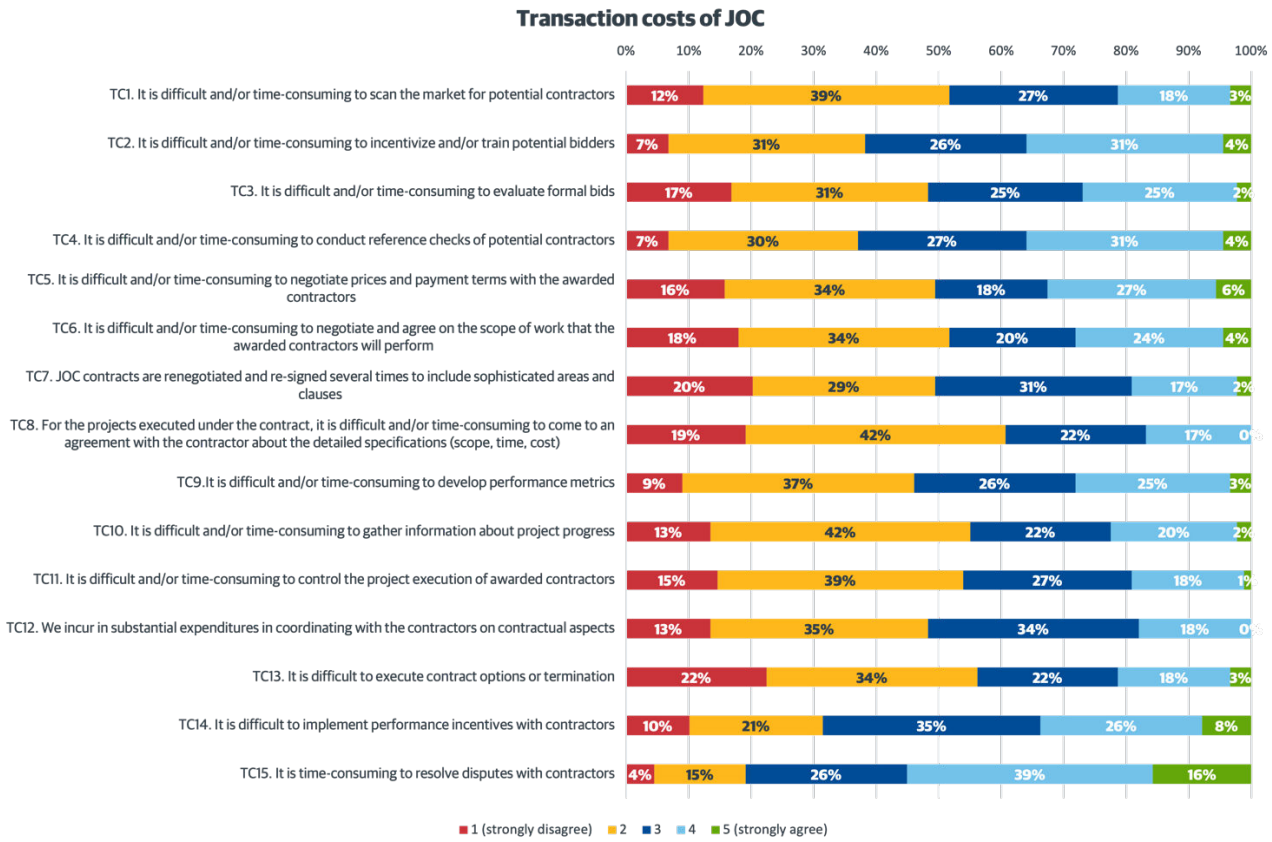
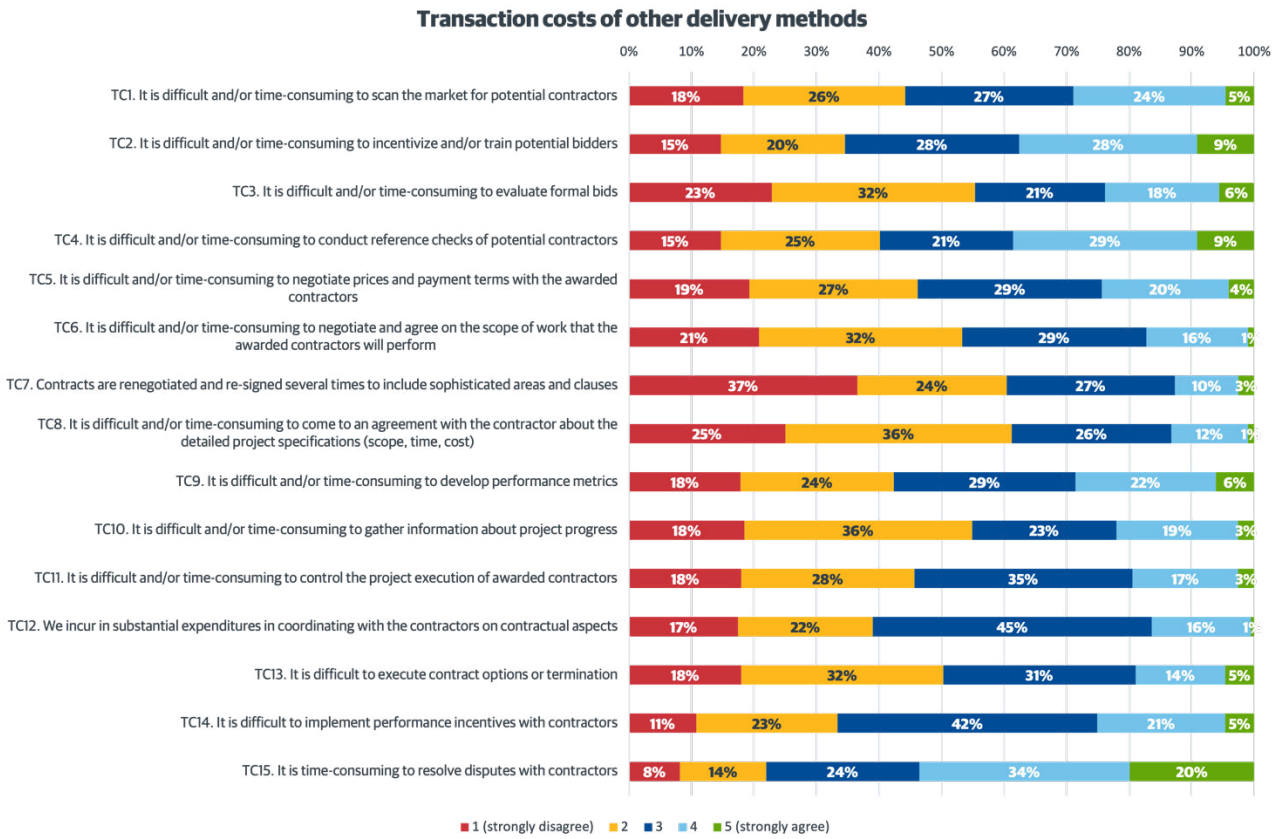


Figure 6. Transaction costs of other project delivery method contracts.



To understand if differences between the two sub-samples exist for what concerns the transaction costs, we ran a series of T-test to evaluate the statistical significance of mean differences. Section B3 in *Appendix* reports the details of the statistical results.

Results show that the mean can be considered statistically different only for two items:

- TC7 - "Contracts are renegotiated and re-signed several times to include sophisticated areas and clauses" which is higher (thus, more difficult) for JOC contracts.
- TC11 - "It is difficult and/or time-consuming to control the project execution of awarded contractors" which is higher (thus, more difficult) for contracts with other project delivery methods.

4.3 Characteristics of supplier relationships within construction project contracts

Next, we used the same approach to analyze the data for what concerns the supplier relationship items included in the questionnaire.

Figure 7 and **Figure 8** report, respectively, the distribution of the responses for JOC contracts and other project delivery method contracts.

Figure 7. Characteristics of supplier relationships in JOC contracts.

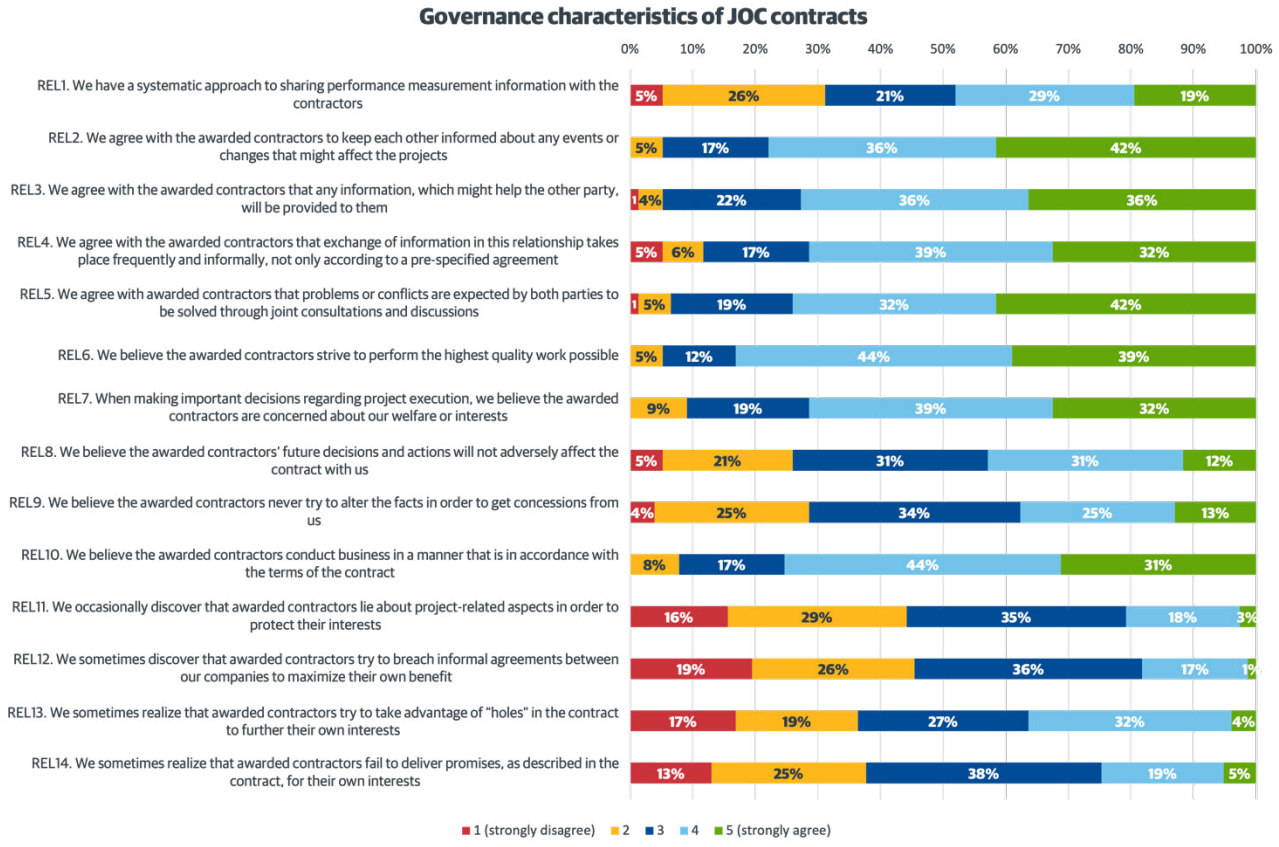
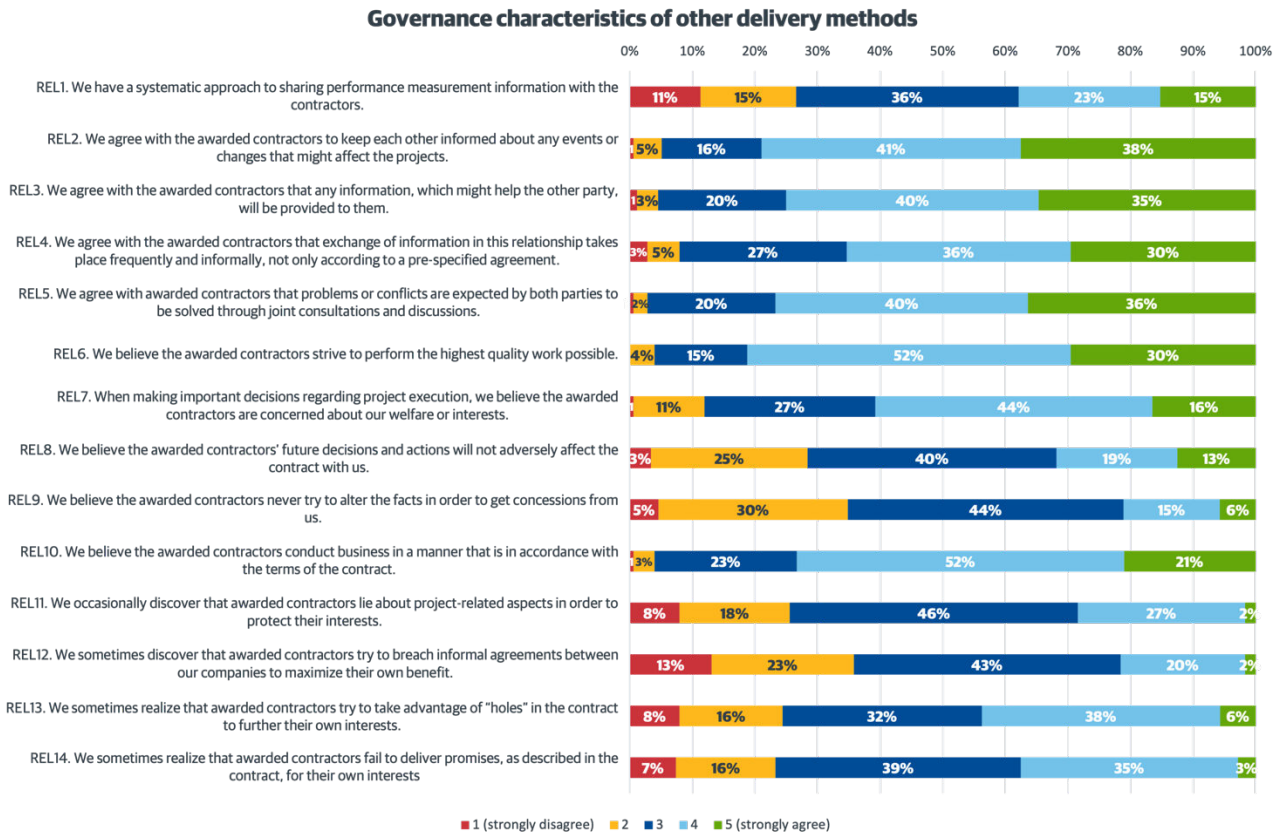


Figure 8. Characteristics of supplier relationships in contracts using other project delivery method contracts.



T-tests were performed once again to evaluate the statistical significance of mean differences. Section B4 in *Appendix* reports the details of the statistical results.

In this case, more differences are found, as we see statistical differences of mean between the two sub-samples for five items:

- REL7 - "When making important decisions regarding project execution, we believe the awarded contractors are concerned about our welfare or interests" which is higher (thus more favorable) for JOC contracts.
- REL9 - "We believe the awarded contractors never try to alter the facts in order to get concessions from us" which is higher (thus more favorable) for JOC contracts.
- REL11 - "We occasionally discover that awarded contractors lie about project-related aspects in order to protect their interests" which is lower (thus more favorable) for JOC contracts.
- REL13 - "We sometimes realize that awarded contractors try to take advantage of "holes" in the contract to further their own interests" which is lower (thus more favorable) for JOC contracts.
- REL14 - "We sometimes realize that awarded contractors fail to deliver promises, as described in the contract, for their own interests" which is lower (thus more favorable) for JOC contracts.

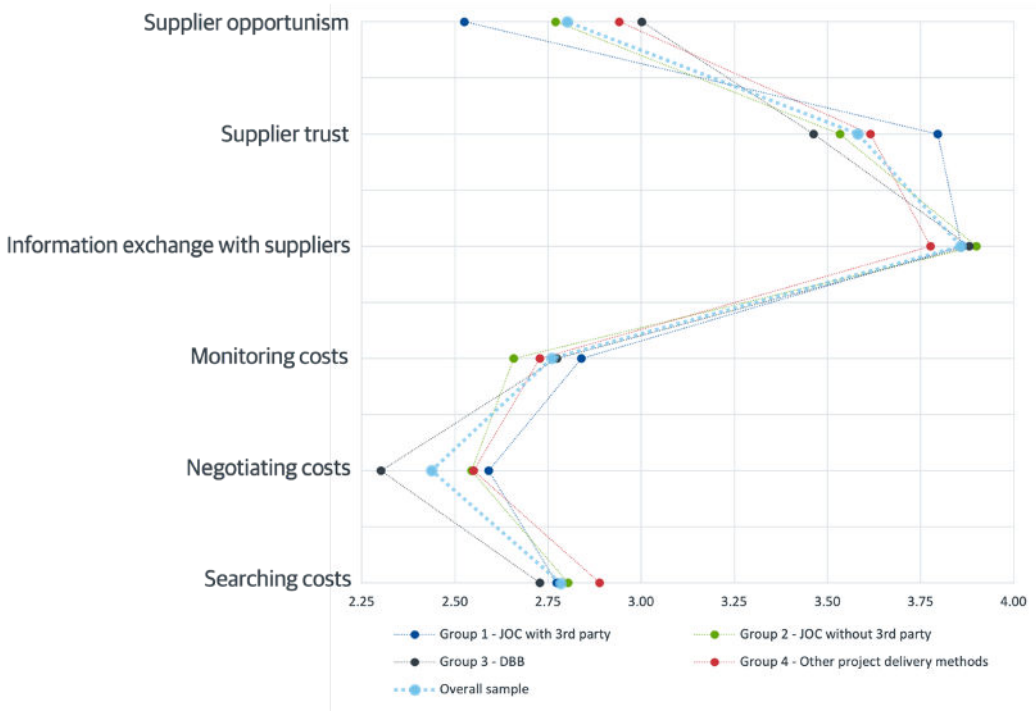
4.4 Group profiling

As a last step of the data analysis, to better characterize the four groups of delivery method contracts included in the sample, we profiled each of them in terms of transaction costs and contractor relationship characteristics.

To make the analysis more efficient, we ran a factor analysis with the objective to cluster the 15 questions measuring transaction costs and the 14 for measuring supplier relationship characteristics in factors characterized by statistical homogeneity. The analysis produced six robust factors characterized by good validity and reliability (see Section B5 in *Appendix*).

Following the results of the factor analysis, the profiling of each group was made according to the six identified factors. **Figure 9** represents the profile of each group against the overall sample mean values.

Figure 9. Group profile.



To understand if differences are present between groups across the different factors, we performed an Analysis of Variance (ANOVA). The detailed results of ANOVA tests, together with the average values for each group are reported in Section B5 in *Appendix*.

The statistical analysis differences of mean between the groups exist in terms of "supplier trust" and "supplier opportunism," factors whose values are more favorable in the case of JOC – particularly when a 3rd party intermediary is involved. Consistent with the results of the aggregate analysis reported in sections 4.2 and 4.3, our sample shows no significant differences are found for transaction costs factors that seem comparable across different project delivery method contracts. The level of "information exchange with suppliers" is also comparable across groups.

5. Qualitative Data Analysis

The qualitative data collected provide better nuances to the results found through survey data analysis.

Table 6 summarizes the main themes that emerged from the interviews with the 32 procurement and construction professionals, coded into:

- Problems with the construction procurement process.
- Problems with internal resources in terms of capabilities and skills of the employees.
- Reasons for not using JOC.
- Reasons for using JOC.

Table 6. Themes and factors discussed during the interview with practitioners.

Theme	Factor	Times mentioned
Problems with the construction procurement process	Too many bureaucratic procedures and/or approval steps	9
	Finding the right supplier/receive enough offers at competitive prices	7
	Lack of time to execute activities appropriately	6
	Late involvement of procurement	1
	Lack of planning	1
	Lack of process standardization	1
Problems with internal resources capabilities and skills when executing construction procurement	Lack of knowledge on financial and cost aspects	3
	Lack of supply market knowledge, especially on bigger projects	3
	Lack of expertise in bid evaluation	2
Reasons for not using JOC	Project prices perceived too expensive	2
	Insufficient knowledge	2
	Resistance to switch from traditional contracts	1
Reasons for using JOC	Possibility to have support from a 3rd party (Gordian)	3
	Reduction of the project time	3
	Ease of use once set-up	3

The difficulty receiving enough offers (and so, obtaining competitive prices), the lengthy duration and the bureaucratic procedures were mentioned as the most relevant issues when executing construction procurement. Interestingly, when executing the procurement process, the problem with internal resources mostly referred to lack of knowledge and expertise in specific areas – rather than lack of employees per se.

Among the reasons for using JOC, interviewees equally mentioned the possibility to use a 3rd party provider during the solicitation process (something that is not possible with traditional delivery methods), the reduction of project duration, and the ease of use once a Job Order Contract is in place. The perception of expensive prices, lack of knowledge and awareness about JOC and habitual use of traditional contracts were instead discussed as barriers to JOC.

6. Discussion

Given the limited understanding, in both theory and practice, of the characteristics of JOC compared to more traditional delivery methods, the main objective of this research project was to provide preliminary evidence of how JOC performs in terms of organizational efforts to procure the construction project contract, the magnitude of the transaction costs affiliated with the construction project contract, and the characteristics of the relationship established with the contractor.

For the purpose of this research, we define performance as the degree of achievement of the following goals: 1) organizational efforts, 2) transaction costs, 3) relationship with the contractor. The analysis of the survey data collected allows us to provide preliminary evidence in each of the previous areas.

6.1 Organizational efforts: JOC vs. other project delivery methods

On an organizational level, we find that JOC contracts require fewer employees and employ a shorter time for the procurement process compared to other delivery methods. Group analysis supports the argument that this is the case regardless of a 3rd party's involvement. Additionally, the results show no significant differences between traditional delivery methods (DBB vs. DB vs. CMAR) in terms of the number of individuals required in the procurement process or its duration.

The performance of a project is highly dependent on the procurement system. Procurement in a construction project generally involves many individuals, and the timeline spans over a significant period of time [24]. Therefore, having a delivery method that can enhance project performance in terms of the number of individuals involved in the process and the time needed to complete the procurement process is essential.

6.2 What are the main benefits of JOC?

Governments generally seek to purchase goods and services from the market to reduce costs. However, these decision processes involve a series of transaction costs associated with searching, negotiating, and monitoring activities. In addition, transaction costs are largely higher for complex contracts, such as those for construction procurement. [25] Therefore, we account for the transaction costs associated with various project delivery methods when defining performance in this context.

Therefore, in this study, we focused on assessing the performance of JOC and other delivery methods in terms of transaction costs.

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[24] *See* Rashid, R. A., Taib, I. M., Ahmad, W. B. W., Nasid, M. A., Ali, W. N. W., & Zainordin, Z. M. (2006). Effect of procurement systems on the performance of construction projects. *Padang, Indonesia*.

[25] *See* Petersen, O. H., Baekkeskov, E., Potoski, M., & Brown, T. L. (2019). Measuring and managing ex ante transaction costs in public sector contracting. *Public Administration Review*, 79(5), 641-650.

Specific results at the single-item level show that, for JOC contracts, it is more difficult to negotiate and define contract clauses compared to contracts using other project delivery methods. This result makes sense if we think about the fact that JOC represents an IDIQ contract that requires a particular level of attention when defined, since it usually refers to a multi-year time horizon and potentially millions of dollars of spending. This does not seem to affect the process duration – which is comparable, if not better, compared to procurement of traditional contracting – but it certainly requires more expertise and knowledge from procurement people that not all public organizations possess. This much was made clear by the interviewees. Nonetheless, our results also reveal that projects that fall under JOC contracts are easier to monitor and control. Therefore, organizations that encounter difficulties in monitoring contract implementation may find JOC a useful tool to counteract issues arising from contract management.

Overall, this study concludes that, for what concerns the magnitude of the transaction costs related to the construction project contract (i.e., searching, negotiating, and monitoring costs), **JOC is comparable to more traditional project delivery methods**. Considering the low diffusion of JOC in public organizations, this result is indeed surprising. The procurement process for JOC contracts – especially for those cases where no 3rd party is involved – cannot count on the same economies of scale and scope as traditional delivery methods. Nevertheless, the fact that transaction costs are comparable already at these different maturity stages means that **potential future benefits are very high**.

The other benefits area analyzed relates to the characteristics of the owner-contractor relationship. To be successful, construction projects need a collaborative environment where the owners and the contractors work together toward mutual interests. Mistrust, lack of commitment and opportunistic behaviors are the most severe issues in construction procurement, especially in the public sector.[26] Public organizations constantly look for strategies focused on relationship governance aimed to build trust, increase collaboration between parties and limit opportunism[27]. Our results show that JOC (with or without the use of a 3rd party), compared to other project delivery methods, can guarantee buyers more effective governance of the relationships with contractors. This increases the relationship quality in terms of better communication, enhanced trust and prevention of opportunistic behavior, ultimately providing a better project outcome. This aspect of JOC is particularly relevant, especially for a type of procurement (construction) for which professionals highlight multiple times the difficulty of obtaining quality offers and competitive prices – thus exposing public organizations to opportunistic behavior on the part of contractors.

[26] See Eriksson, P. E., & Lind, H. (2015). Moral hazard and construction procurement: A conceptual framework. Working paper.

[27] *See* Galvin, P., Tywoniak, S., & Sutherland, J. (2021). Collaboration and opportunism in megaproject alliance contracts: The interplay between governance, trust and culture. *International Journal of Project Management*, 39(4), 394-405.

6.3 Why should public procurement professionals use JOC?

In conclusion, despite its relatively low diffusion, our study concludes that JOC performs equally to or better than other delivery methods. Considering that JOC has been conceived to support the delivery of specific types of projects (while other methods, such as DBB or DB, are designed to be potentially suitable for heterogeneous classes of projects), we conclude that public organizations should carefully consider this option for the types of projects that fall under the JOC umbrella.

There are three main reasons public organizations should look more into JOC:

1. ***The public sector is known for complicated and bureaucratic procurement procedures (especially for complex requests), that are often delayed because of lack of appropriate resources:*** Procurement of JOC contracts is shown to require less time and less human resources.
2. ***The public sector is resistant to adopt innovative and alternative ways to procure items that have been procured using more traditional procedures:*** Procurement of JOC contracts requires the acquisition of new knowledge, but the transaction costs connected to the procurement process are comparable to those of more traditional, consolidated delivery methods.
3. ***The public sector lacks competencies for managing strategic relationships with contractors:*** JOC contracts, because of their structure, naturally favor a more collaborative environment, increasing trust and preventing contractor opportunism that might generate from adversarial relationship situations.

Clearly, this is not easy to be achieved. Especially considering the information collected through the interviews, JOC adoption is more likely to happen in organizations where there is 1) a commitment to invest in alternative project delivery methods; 2) a procurement organization characterized by advanced competences and skills.

There are also different ways to facilitate the adoption JOC. Besides using a 3rd party intermediary like Gordian, public organizations can also start to approach JOC by piggy-backing on existing contracts in place in other public organizations or a cooperative purchasing network. However, this requires their involvement in collaborative procurement initiatives that, as highlighted by the interview data, are not so diffused as well, especially in local governments.

6.4 Future areas of development

Considering how much JOC represents an under-researched area in both the public management and the construction management literature, this research, although exploratory, opens avenues for future developments in various areas. First, this study aimed at understanding how JOC contracts compare with other project delivery methods in terms of organizational effort, transaction costs, and relationships between parties. The data used to answer the research questions put forth by the research team were collected using a survey instrument and semi-structured interviews. Future studies could include in-depth assessments of construction projects implemented using the different project delivery methods. Second, this research focused on construction procurement in general, without a specific focus on project outcomes. It would be interesting for future studies to identify contracts that could be awarded

using any of the project delivery methods in this study and compare performance. Third, while having clear benefits, JOC is still under-studied and underutilized. Future research could address the question as to why that is the case and what factors may determine a higher level of implementation. In doing this, also considering the contractor perspective will be key. For example, among the barriers mentioned to JOC adoption we had the issue of perceived higher project prices. The reasons why this happens, though, were not fully clarified. The inclusion of the contractor perspective will help fill in these knowledge gaps.

APPENDIX

Section A: Questionnaire characteristics

A1. Survey instrument design

The initial draft of the survey was designed considering existing construction and supply chain management literature around the two areas highlighted below. A pre-test of the survey was conducted with JOC experts (inside and outside Gordian). This allowed the research team to revise and refine the survey multiple times until a full consensus on the survey version was reached.

The team designed a survey that could be answered by any professional knowledgeable about how their organization procures construction projects and the activities involved in the procurement of construction projects. Thus, to participate in the study, respondents did not necessarily need to be familiar with JOC or have used it in the past. If the respondent lacked experience with JOC, the questionnaire included questions about another project delivery method of the respondent's choice. The questionnaire also allowed a respondent working for an organization that uses multiple project delivery methods to answer the questionnaire twice (once for JOC, and again in reference to another project delivery method of the respondent's choice).

The final version of the survey was divided into the following sections:

- Section A: General information about the organization (7 questions)
- Section B: Transaction costs connected to the use of the project delivery method (JOC or other; 17 questions)
- Section C1: Characteristics of the supplier relationships when using the project delivery method (JOC or other; 14 questions)

Figure A1.1 summarizes the characteristics and flow of the questionnaire.

A2. Sample characteristics

Responses were collected between July and August 2021. As our ideal respondent was a professional aware of the construction management practices of their organization, and our survey was sent out to potential respondents using both NIGP and Gordian's list of contacts.

We estimate that the survey was sent out to approximately 5,000 potential respondents.

576 people opened and initiated the survey, but only 355 fully or partially completed the questionnaire. After data cleaning, we observed that 95 responses were missing data on critical items; these responses were included for descriptive purposes, but they were eliminated from the detailed data analysis. Ultimately, our sample includes 260 responses, that translate into 290 usable responses, as 30 respondents filled the questionnaire twice (one time for JOC and a second time for another project delivery method of their choice).

Figure A1.1. Questionnaire flow

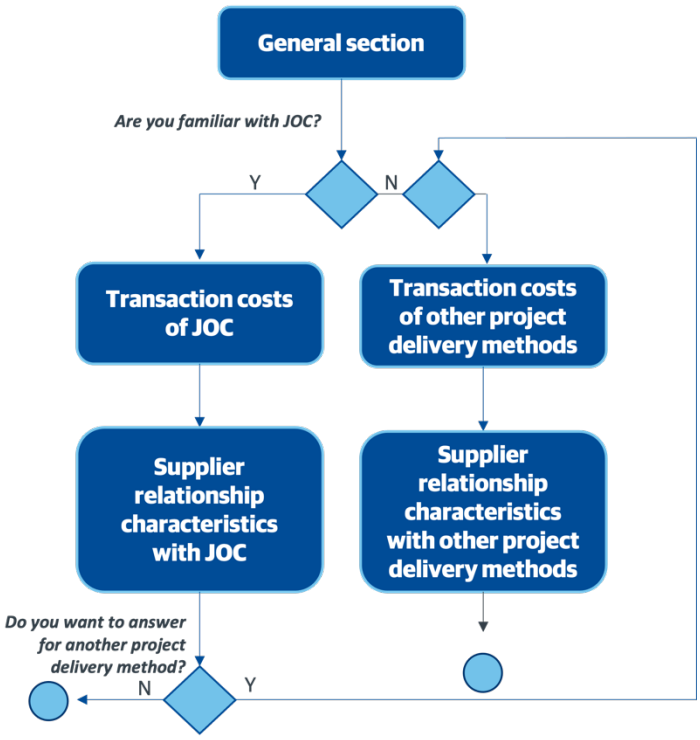


Table A2.1 provides a detailed breakdown of the received responses.

Table A2.1. Breakdown of response

Responses for JOC only	59	
	Complete (100%)	47
	Partial (missing less than 25% of the TC and REL items)	12
Responses for other delivery methods only	171	
	Complete	151
	Partial	20
Responses for both JOC and other delivery methods	30	
Incomplete responses (missing more than 25% of the TC and REL items)	95	
Total responses 355	**Total usable responses 260**	

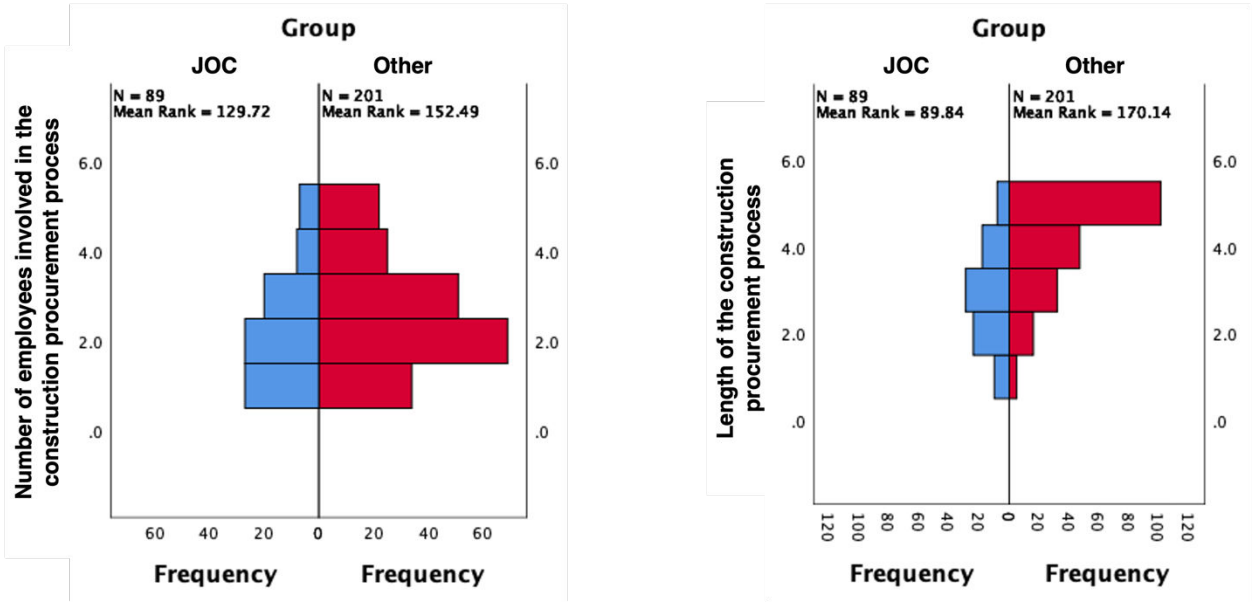
Section B: Data analysis

B1. Time and efforts for procurement of construction projects: JOC vs. other project delivery methods

In order to test the difference in distribution of number of employees and length of the construction procurement process between JOC and other delivery methods, we performed a Mann-Withney test.

Figure B1.1 represents the distribution comparison on the two variables under analysis.

Figure B1.1.



The Mann-Whitney test aims to verify if the null hypothesis of equality of distribution across sub-samples should be rejected.

For both variables, the test rejects the null hypothesis of equality of distribution, particularly:

- For the "number of employees involved in the construction procurement process", the test rejects the null hypothesis with $p = 0.028$ ($p < 0.05$).
- For the "length of the construction procurement process", the test rejects the null hypothesis with $p = 0.000$ ($p < 0.001$).

In both cases, the rejection of the null hypothesis shows that the use of JOC contract has a distribution for what concerns the number of employees involved and length of the procurement process which is different compared with other project delivery methods (at 95% and 99% levels of significance, respectively). Specifically, in the case of JOC, the sample population appears more skewed toward lower

values – which makes us conclude that, in the case of JOC, the construction procurement process is likely to require involvement of less people and have a shorter duration.

B2. Time and efforts for procurement of construction projects: contract group comparisons

In order to test the difference in distribution of number of employees and length of the construction procurement process between different contracts, we performed a Kruskall-Wallis test.

The following figures represent the distribution of responses for number of employees and length of the construction procurement process through bar charts (**Figure B2.1**) and boxplots (**Figure B2.2**) for the four groups (where 1 = JOC with 3rd party; 2 = JOC with no 3rd party; 3 = DBB; 4 = Other delivery methods)

Figure B2.1. Distribution of responses for number of employees and length of the construction procurement process: contract groups comparison

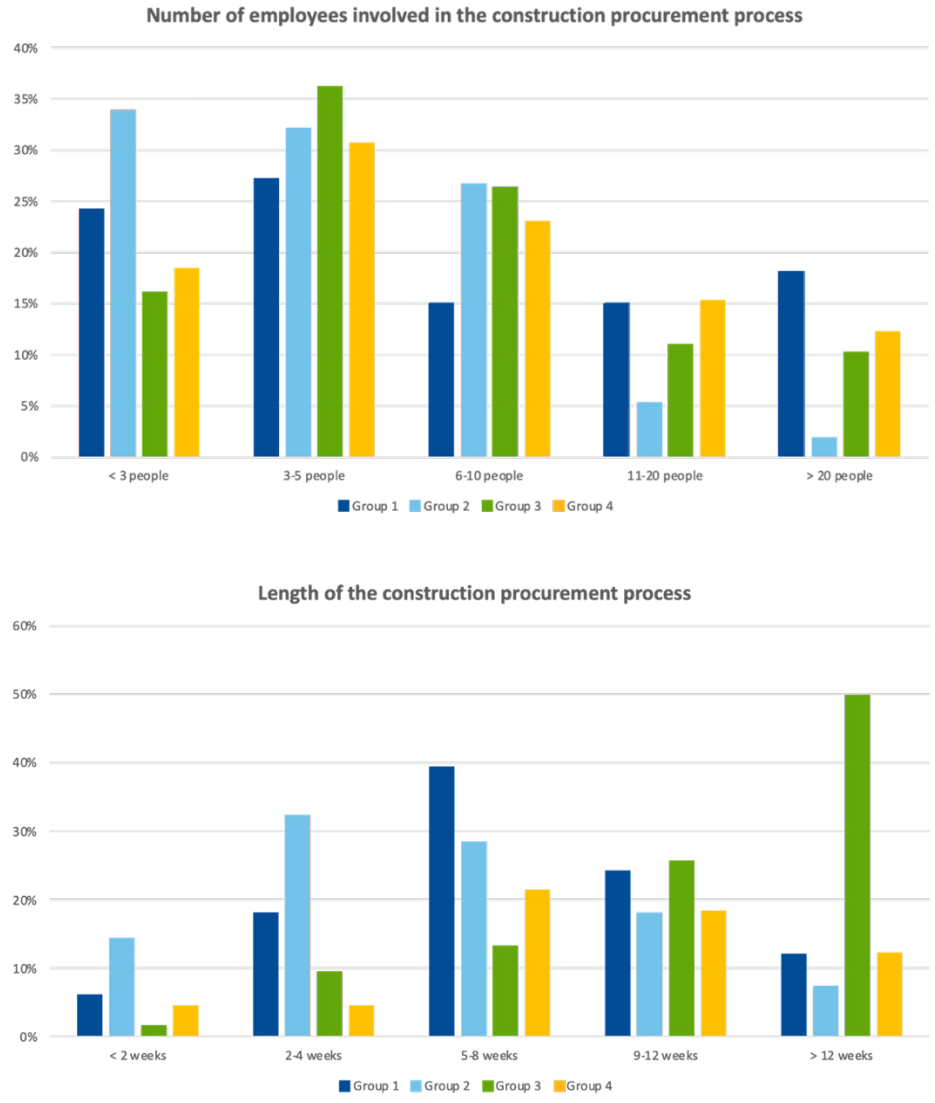


Figure B2.2. Boxplots for number of employees and length of the construction procurement process: contract groups comparison

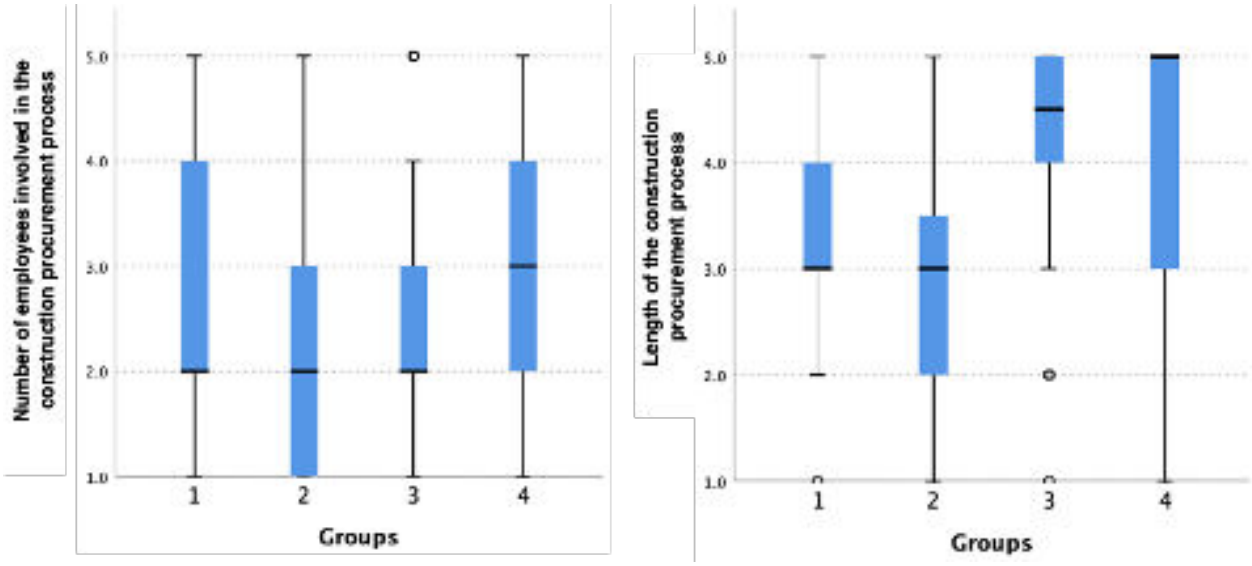


Table B2.1. Kruskall-Wallis test and group comparisons for the number of employees and length of the construction procurement process (***Note***: Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same; the significance level is $p < 0.05$)

Kruskall-Wallis test for "Number of employees involved in the procurement process"				
Group comparison	Test Statistic	Std. Error	Std. Test Statistic	p-value
Group 2 - Group 1	38.46	17.817	2.159	0.031*
Group 3 - Group 1	2.935	15.755	0.186	0.852^{NS}
Group 1 - Group 4	-1.691	17.354	-0.097	0.922^{NS}
Group 2 - Group 3	-35.53	12.891	-2.756	0.006^{NS}
Group 2 - Group 4	-40.15	14.802	-2.712	0.007^{NS}
Group 3 - Group 4	-4.626	12.242	-0.378	0.706^{NS}
N = 290, Test statistic = 9.65, d.f. = 3, p = 0.022* - Reject the null hypothesis of equality of distribution				

Kruskall-Wallis test for "Length of the procurement process"		
Group comparison	Test Statistic	Std. Error
Group 2 - Group 1	24.956	17.686
Group 1 - Group 3	-65.69	15.639
Group 1 - Group 4	-62.31	17.226
Group 2 - Group 3	-90.65	12.796
Group 2 - Group 4	-87.27	14.694
Group 4 - Group 3	3.385	12.152
N = 290, Test statistic = 63.31, d.f. = 3, p = 0.000*** - Reject the null hypothesis of equality of distribution		

For both tests, the null hypothesis is rejected (at 95% significance for "number of employees involved in the procurement process" and 99% significance for "length of the procurement process"), as differences are present

- between Group 1 and Group 2 for "Number of employees involved in the procurement process."
- between Group 1 and Group 3, Group 1 and Group 4, Group 2 and Group 3, Group 2 and Group 4 for "Length of the procurement process."

B3. Transaction costs of construction project contracts

To evaluate mean differences between JOC and other project delivery method contracts for what concerns transaction costs questionnaire items, we ran a series of T-tests. **Table B3.1** provides an overview of the test results.

As seen, the average value is significantly different only for two items – TC7 and TC11 – both at 95% significance ($p < 0.05$).

		Mean	Std. Deviation	p-value
TC1	JOC	2.61	1.06	0.443^{NS}
	Other delivery methods	2.72	1.14	
TC2	JOC	2.96	1.06	0.945^{NS}
	Other delivery methods	2.97	1.20	
TC3	JOC	2.64	1.12	0.405^{NS}
	Other delivery methods	2.52	1.19	
TC4	JOC	2.97	1.04	0.757^{NS}
	Other delivery methods	2.92	1.24	
TC5	JOC	2.73	1.19	0.499^{NS}
	Other delivery methods	2.63	1.11	
TC6	JOC	2.63	1.16	0.151^{NS}
	Other delivery methods	2.43	1.04	
TC7	JOC	2.52	1.10	0.017*
	Other delivery methods	2.18	1.10	
TC8	JOC	2.37	0.99	0.469^{NS}
	Other delivery methods	2.28	1.00	
TC9	JOC	2.76	1.03	0.901^{NS}
	Other delivery methods	2.75	1.17	
TC10	JOC	2.56	1.09	0.716^{NS}
	Other delivery methods	2.51	1.06	
TC11	JOC	2.52	1.03	0.047*
	Other delivery methods	2.79	1.05	
TC12	JOC	2.56	0.94	0.712^{NS}
	Other delivery methods	2.61	0.97	
TC13	JOC	2.46	1.16	0.446^{NS}
	Other delivery methods	2.57	1.09	
TC14	JOC	3.00	1.14	0.291^{NS}
	Other delivery methods	2.86	1.05	
TC15	JOC	3.47	1.07	0.842^{NS}
	Other delivery methods	3.44	1.19	

Table B3.1. T-tests for mean differences between JOC and other project delivery methods on transaction costs items

B4. Characteristics of supplier relationships within construction project contracts

To evaluate mean differences between JOC and other project delivery method contracts for what concerns supplier relationship questionnaire items, we ran a series of T-tests. **Table B4.1** provides an overview of the test results.

As seen, the average value is significantly different only for five items – REL7, REL9, REL11, REL13 and REL14 – all at 95% significance ($p < 0.05$).

		Mean	Std. Deviation	p-value
REL1	JOC	3.31	1.21	0.389^{NS}
	Other delivery methods	3.17	1.19	
REL2	JOC	4.14	0.88	0.679^{NS}
	Other delivery methods	4.09	0.86	
REL3	JOC	4.03	0.93	0.953^{NS}
	Other delivery methods	4.03	0.88	
REL4	JOC	3.87	1.10	0.828^{NS}
	Other delivery methods	3.84	0.99	
REL5	JOC	4.08	0.97	0.893^{NS}
	Other delivery methods	4.09	0.83	
REL6	JOC	4.17	0.83	0.341^{NS}
	Other delivery methods	4.07	0.77	
REL7	JOC	3.95	0.94	0.018*
	Other delivery methods	3.65	0.90	
REL8	JOC	3.23	1.07	0.484^{NS}
	Other delivery methods	3.13	1.04	
REL9	JOC	3.18	1.07	0.029*
	Other delivery methods	2.90	0.94	
REL10	JOC	3.99	0.90	0.387^{NS}
	Other delivery methods	3.89	0.80	
REL11	JOC	2.64	1.04	0.014*
	Other delivery methods	2.96	0.91	
REL12	JOC	2.55	1.03	0.138^{NS}
	Other delivery methods	2.75	0.97	
REL13	JOC	2.87	1.16	0.046*
	Other delivery methods	3.15	1.04	
REL14	JOC	2.79	1.07	0.035*
	Other delivery methods	3.08	0.96	
REL1	JOC	3.31	1.21	0.389^{NS}
	Other delivery methods	3.17	1.19	

Table B4.1

B5. Group profiling

Table B5.1 reports the results of the factor analysis on the 29 questionnaire items related to transaction costs and supplier relationships.

Table B5.1.

	Transaction costs factors			Supplier relationship characteristics		
	Searching costs	Negotiating costs	Monitoring costs	Information exchange with suppliers	Supplier trust	Supplier opportunism
Items included in the factor	TC1	TC5	TC9	REL1	REL6	REL11
	TC2	TC6	TC10	REL2	REL7	REL12
	TC3	TC7	TC11	REL3	REL8	REL13
	TC4	TC8	TC12	REL4	REL9	REL14
			TC13	REL5	REL10	
			TC14			
			TC15			
Composite reliability	0.79	0.84	0.86	0.91	0.84	0.90
Average Variance Extracted	0.5	0.57	0.47	0.58	0.52	0.69

For all the factors, the Composite Reliability Index is > 0.7 (suggested threshold), and the Average Variance Extracted > 0.5 except in one case (Monitoring costs). However, as the Variance Inflation Factors for all the items vary between 2 and 5, we can conclude that all the factors are characterized by good reliability and validity.

We finally performed ANOVA to evaluate mean differences across groups for each of the previous factors.

Table B5.2 reports the values for each group, together with the results of the ANOVA tests for the analysis of mean differences across groups.

Table B5.2.

	Group 1 – JOC with 3rd party	Group 2 – JOC without 3rd party	Group 3 - DBB	Group 4 – Other delivery methods	Overall sample	p-value
Searching costs	2.77	2.80	2.73	2.89	2.78	0.702^{NS}
Negotiating costs	2.59	2.54	2.30	2.55	2.44	0.112^{NS}
Monitoring costs	2.84	2.66	2.77	2.73	2.76	0.437^{NS}
Information exchange with suppliers	3.86	3.90	3.88	3.78	3.86	0.812^{NS}
Supplier trust	3.80	3.53	3.46	3.62	3.58	0.026*
Supplier opportunism	2.53	2.77	3.00	2.94	2.80	0.046*

Only two factors are significantly different across groups – supplier trust and supplier opportunism - both at 95% significance ($p < 0.05$).