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Article

Integrated design and procurement strategy to achieve efficient performance in design and build government project

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Abstract: Design and procurement integration strategies in construction projects play an important role and have an impact on the overall project cycle. Integrated design and procurement will increase productivity and reduce waste. This research aims to provide a guide to good design and procurement integration strategies in Design and Build (DB) projects in government projects. This research uses qualitative and quantitative methods in the form of a schematic literature review followed by a Focus Group Discussion (FGD) with the Delphi method to formulate integrated design and procurement that improve project performance. In-depth interviews were conducted with 90 respondents to explore the implementation of the design and procurement strategy on the project used as a case study. The results of this research are recommendations for an integrated design and procurement strategy which can be used as a Standard Operating Procedure (SOP) in DB projects on government projects so that it can provide added value from the start of the project being designed through tenders. This research can be utilized by project stakeholders, academics and anyone who will develop project performance through the integrated design and procurement in the long term.

Keywords: design; design and build; management design; management procurement; project performance; procurement; reduce waste

1. Introduction

In the project cycle process, the role of design and procurement is very important (Ajayi, 2016), especially in Design and Build (DB) projects where the tender process uses basic design with a minimum design maturity of 20% (Asmar et al., 2013). This 20% design maturity must be anticipated with design that is integrated with procurement (Liu et al., 2021; Ndekugrp and Turner, 1994; Nyström, 2005). Procurement, which is involved in design from the start, must collaborate with various stakeholders such as suppliers and subcontractors to ensure that the materials to be used in the project have been integrated into the design from the start (Bigwanto et al., 2024; Al Fath et al., 2024; Sari et al., 2021; Sari et al., 2022; Sari et al., 2023). Substitution and scarcity of materials will create waste and cause losses in projects (Alwi et al., 2002; Elizar et al., 2017; Lauren, 2005; Treloar et al., 2003). Contractors must think about materials whose procurement time and price are unpredictable, especially imported materials whose procurement requires a lot of time and changes in price.

The design and procurement integration strategy are to combine collaboration due to lump sum contracts (Adamtey, 2019; Akintoye, 1994; Chan et al., 2019; Lesniak

et al., 2012; Ndekugrp and Turner, 1994). Creativity and innovation from contractors are very necessary to provide solutions to projects desired by the owner (Asmar et al., 2013; Katar, 2019; Xia et al., 2015). Owners often need input for collaborative and efficient designs that the owner had not previously thought of (Ajayi, 2016). So, a design and procurement integration strategy are needed from the start of the project being tendered (Asmar et al., 2013). Contractors must select suppliers and subcontractors based on best value, not just low price because this collaboration will be long term (Kadefors et al., 2007; Lesniak et al., 2012). A track record owned by a supplier or subcontractor is very necessary for partnering from the start of the tender (Chai et al., 2013; Verma and Pullman, 1998). Openness and trust are needed to be involved together from the design phase. Long-term contracts and price certainty must be capital in implementing design and procurement integration (Ganesan, 1994; Nyström, 2005). Al Fath (2024) stated that in readiness to carry out sustainable procurement in government projects, procurement collaboration with various stakeholders is needed. Sustainable procurement is influenced by various factors to achieve lean construction so that project performance will be achieved. Government projects without integration of design and procurement from the start will experience losses and generate high waste (Bigwanto et al., 2024). If waste is not handled, project performance will not reach the set targets. Solutions are needed to achieve project performance through the integration of design and procurement in Government DB projects.

Previous research has mostly discussed sustainable procurement, factors that influence procurement (Hui et al., 2011; Ndekugrp and Turner, 1994; Ruparathna and Hewage, 2015; Suresh and Nathan, 2020), supplier selection techniques and techniques for assessing procurement effective (Chai et al., 2013; De Boer et al., 2001; Sarkis, 2002; Verma and Pullman, 1998). This research will complement and provide a new view on how sustainable procurement starts with an integration strategy through design and involvement of suppliers and subcontractors from the time the tender is held. Each stakeholder must have the principles of trust and openness to achieve the integration target so that lump sum DB contracts can be anticipated well from the start (Sari et al., 2023).

1.1. Design and build (DB)

Design and Build (DB) is a project delivery that combines design and project implementation in one entity, usually controlled by a general contractor (Adamtey, 2019; Chan et al., 2002; Katar, 2019; Lam et al., 2004; Xia et al., 2015). In carrying out its functions, the General Contractor (GC) can partner with fellow GC companies, design companies to form new entities to participate in tenders. In terms of efforts to integrate design and procurement of DB projects, DB partners in participating in tenders with suppliers and sub-contractors. Sari et al. (2023) states that partnering carried out from the start of the project before it has started will create value for the stakeholders involved with effective communication based on the concept of TARIF (Trust, Authority, Responsiveness, Independent and Fairness) (Sari et al., 2023).

Figure 1 describe the partnership process for the DB delivery project, starting from the design phase, suppliers and sub contractors have collaborated, followed by

collaboration in the construction phase to realize the project goals.

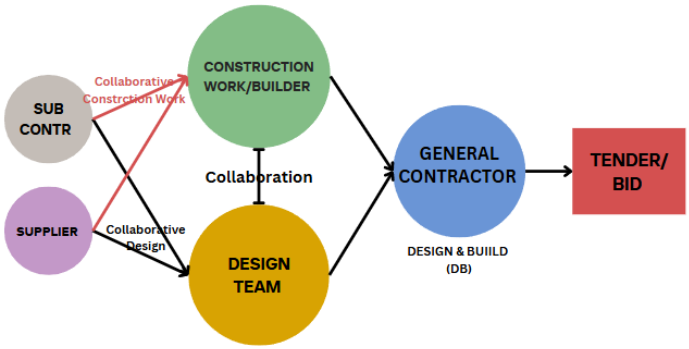

Figure 1. Design and build partnering concept.
(Source: Authors own creation based on Sari et al. (2023); Xia et al. (2015)).

1.2. Design management

The design team's ability to understand the sequence/method that will be used in completing the project is a major factor in design management (Ajayi, 2016). This raises awareness and use of standard and detailed specifications (Adamtey, 2019; Laurent et al., 2019; Tousignant et al., 1999; Zimina et al., 2012). So that clear and comprehensive information about the design is very necessary. A good design planner must identify various elements that are then integrated in the design (Falessi et al., 2006; Yin, 2003). This will make it easier for suppliers/subcontractors to participate (Chai et al., 2013; De Boer et al., 2001; Verma and Pullman, 1998). In the design management concept, you must identify the stakeholders who will be invited to partner in the tender so that what the supplier/subcontractor has can be identified first and integrated into the design. The concept of specifying available, suitable and compatible material will provide the best solution in procuring goods and materials (Ajayi, 2016). Commitment to low waste in a project requires a feasibility study on waste at the beginning to estimate using certain techniques (Ajayi and Oyedele, 2018; Alwi et al., 2002; Lauren, 2005; Treloar et al., 2003). If necessary, the design team must receive training so that they have the competence and experience to reduce waste in the project through design management. In design management, an environmental impact assessment must also be carried out to ensure that the resulting design does not damage the environment (Wibowo et al., 2018). Alternatives and considerations for different designs are options based on the frequent occurrence of waste due to environmental impacts. All design plans related to low waste must be stated consistently in design documents with a format and language that is consistent and easy to understand (Ajayi, 2016), then coordinated and integrated in the process according to the construction project cycle. Waste management is closely related to design management, it must be planned long term during the design process.

Figure 2 illustrates that design management involves 3 (three) factors, namely a competent and experienced design team, clear document design quality, and collaborative design.

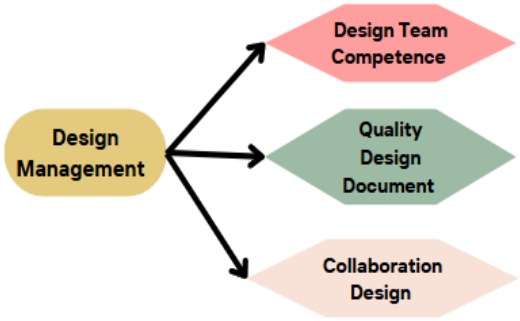

Figure 2. Design management framework.
(Source: Author's own Creation based on Ajayi (2016); Zimina et al. (2012)).

1.3. Procurement

Procurement involvement from suppliers and contractors from the start is an effort to minimize the occurrence of waste from the start which must be stated in the work contract (Hui et al., 2011; Ndekugrp and Turner, 1994; Ruparathna and Hewage, 2015). All waste problems that want to be reduced through procurement must be resolved before procurement activities are carried out. Contractors and suppliers/subcontractors must discuss methods of minimizing waste with the advantages of each stakeholder (Ajayi, 2016; Alwi et al., 2002; Lauren, 2005). So that optimization of material procurement can be achieved to prevent over/under orders and minimize excess waste (Alwi et al., 2002). This means that there is effectiveness when the material arrives at the project, and it is ensured that the material ordered is good quality material because it has been prepared from the start according to the specifications and carefully prepared. If this happens it will prevent variation orders in the project which often cause conflicts in the project (Alwi et al., 2002).

To realize procurement that minimizes waste, it is necessary to improve technical knowledge about waste for suppliers/contractors so that they have awareness of how to create an environment that is safe and protected from the impact of waste (Lauren, 2005). Carefulness in planning the work sequence and work methods must be planned before procurement work begins, so that all stakeholders have the same commitment to collaboration before the project begins, namely during the tender (Asmar et al., 2013). Suppliers and subcontractors must also collaborate in fulfilling procurement management which seeks to minimize waste in the project (Asmar et al., 2013; Lauren, 2005).

Figure 3 explained that the procurement framework requires 5 (five) factors, namely selection criteria, stakeholder experience and competencies, effective order materials, minimizing waste in contract attributes and commitment of contractors, suppliers.

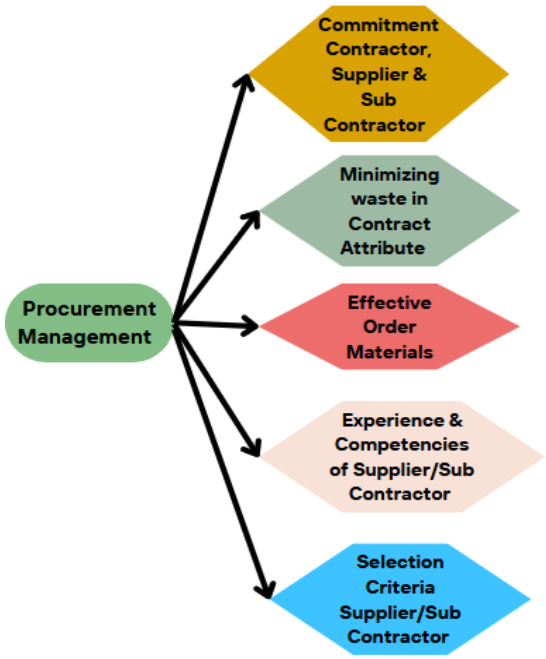

Figure 3. Procurement management framework.
(Source: Authors own creation based on Ajayi (2016); Al Fath et al. (2024)).

1.4. Integration design and procurement

The integration of design and procurement can be described through the framework below:

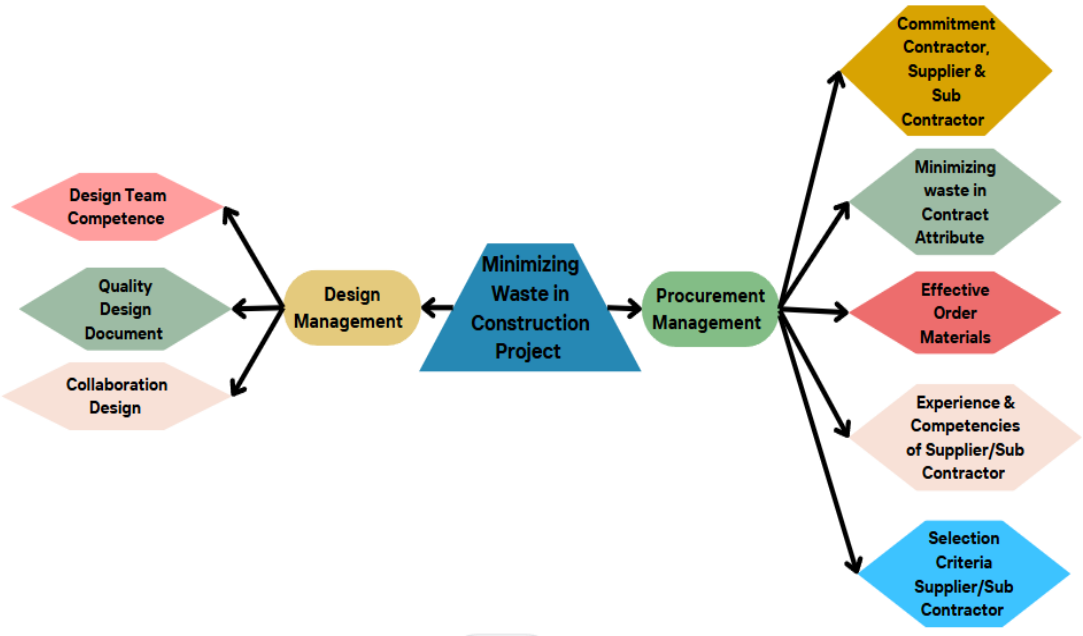

Figure 4. Integration design and procurement.
(Source: Authors creation based on Ajayi (2016); Al Fath et al. (2024); Mudzvokorwa et al. (2020); Zimina et al. (2012)).

Figure 4 illustrates that minimizing waste in a project involves integrating design and procurement. There are 3 factors that influence design and 5 factors that influence

procurement to produce minimized waste in the project. Design management involves 3 factors, there are:

1) A design team that is competent and has experience, if necessary, carries out training before carrying out the design to provide an understanding of how to minimize waste in construction projects.
2) Quality Design Document includes documents that are clear and transparent and use consistent language and notation to emphasize the importance of minimizing waste.
3) Collaboration Design is the identification of materials from all suppliers/subcontractors to carry out integration when conducting tenders. Creativity and innovation developed together in collaborative design will produce designs that have high quality and effectiveness.

Meanwhile, procurement management consists of 5 (five) factors, there are:

1) Selection criteria for suppliers/subcontractors who have a good track record on previous projects and have a long-term partnering concept and provide the best value for procurement on projects.
2) Experience and competencies of suppliers/sub contractors to understand waste in material procurement and orders, if necessary, training is carried out to provide understanding and experience to suppliers/sub contractors.
3) Effective material orders include planning and implementing material orders paying attention to optimization and suitability of material specifications in the project.
4) Minimizing waste Contract Attribute where the contract includes waste control attributes that must be carried out by contractors, suppliers and sub contractors to become a standard operating procedure in procurement management.
5) Commitment of contractors, suppliers and sub contractors to work together with high trust and commitment to implement procurement management based on minimizing waste in construction projects.

1.5. Project performance

Performance is described as “the level of achievement of a particular effort or enterprise” (Chan and Chan, 2004; Lam et al., 2004), this relates to the specified goals or objectives that form the parameters of the project (Chan and Chan, 2004; Yeung et al., 2013). Performance can be defined as exceeding stakeholder needs and expectations of a project. Where it is always linked to the iron triangle (cost, quality and time) (Atkinson, 1999) from a certain perspective it is linked to safety and the environment (Bigwanto et al., 2024; Wibowo et al., 2018). This means that projects that have high performance must ensure that environmental impacts do not occur as damage and work accidents occur. Environmental perception is also expanded to include political environment, physical environment, industrial relations environment, social environment and economic environment (Ashcraft and Bridgett, 2011). Projects that have good performance can be interpreted as being able to manage project risks by collaborating on risk management with stakeholders.

Figure 5 shows project performance that is built and measured using 5 (five) measures, namely the iron triangle (cost, quality, time), environment, safety, risk

management and team members who are successful and can use project experience in the future.

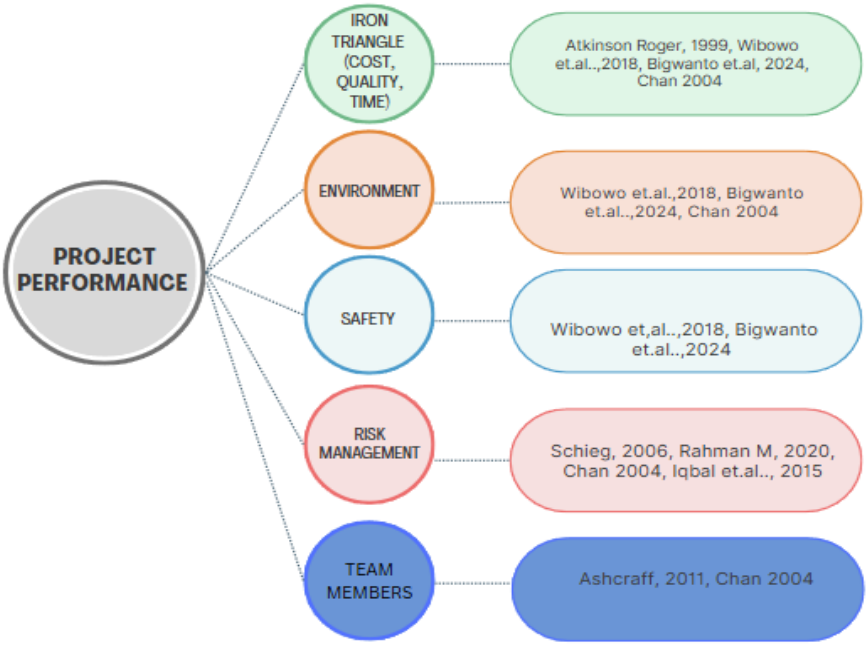

Figure 5. Project performance concept.

Source: Authors own creation based on Ashcraft and Bridgett (2011); Atkinson (1999); Bigwanto et al. (2024); Lam et al. (2004); Wibowo et al. (2018)).

1.6. Delphi method

The Delphi method is a survey technique used to gain consensus from a panel of experts in the field through several rounds of questions. This method begins with the selection of competent experts. The Delphi method is usually carried out with a minimum of 2 rounds of questionnaires distributed to experts. After each round is completed, all experts will collect and review the data, then a conclusion will be drawn from the results of the first round carried out. After the first round is completed, the next round is carried out until consensus is reached. Zahoor et al. (2017) concluded that successful Delphi studies are essentially governed by the experts involved in the research and are strongly influenced by the level of expert consensus. In the literature, there is no agreement on the minimum number of experts who should participate in a Delphi study (Alomari et al., 2018; Gunduz and Elsherbeny, 2020). Ameyaw et al. (2016) reviewed 88 research papers and showed that the majority of previous researchers used 8–20 experts in their Delphi studies. Another study by Hallowel and Gambatese (2010) recommends only 8–12 experts. Gunduz and Elsherbeny (2020) used 17 experts in their research. The quality of the output mainly depends on the experts involved in the Delphi study, and the success of the entire process is greatly influenced by unbiased assessment (Xia and Chan, 2012). Linstone and Turoff (1974) state that the usual Delphi process involves four main stages;

1) Problem definition: The problem statement is identified,
2) Participant selection: Experts are sought and contacted due to the nature of the problem statement.
3) Questionnaire preparation: Questionnaire is created and sent to experts,

4) Receive feedback: Analyze data.

2. Material and methods

This research uses qualitative and quantitative methods in the form of a schematic literature review followed by a Focus Group Discussion (FGD) with the Delphi method to formulate integrated design and procurement that improve project performance. In-depth interviews were conducted with 90 respondents to explore the implementation of the design and procurement strategy on the project used as a case study. The next stage is preparing Key Performance Indicators (KPIs) and carrying out KPI simulations on project case studies. The detailed picture is presented as follows:

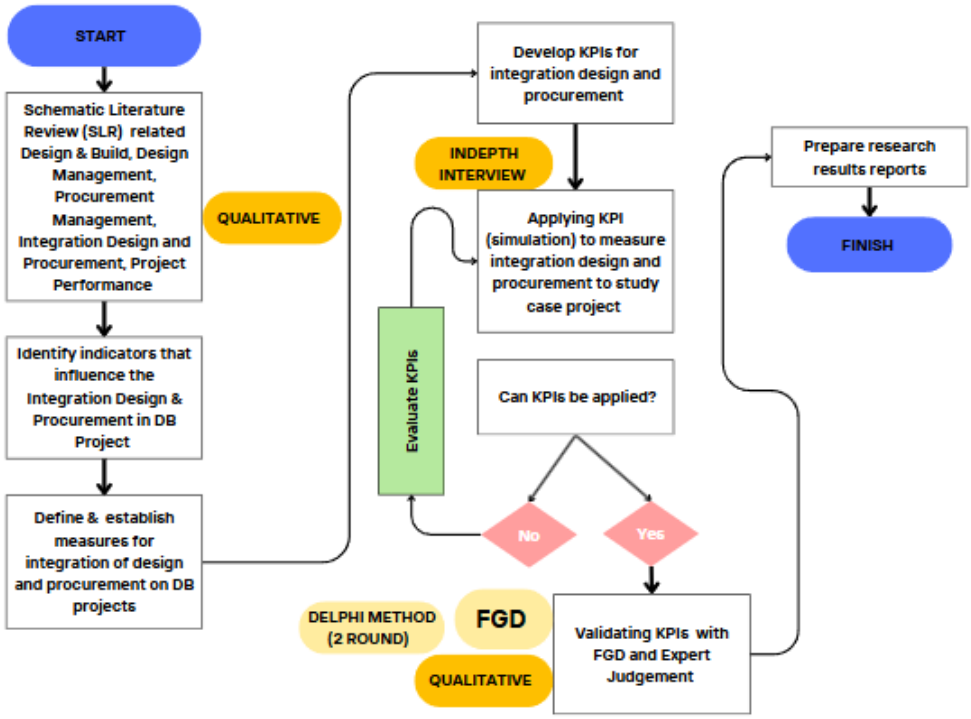

Figure 5. Step by step of the research.

Figure 5 depicts step by step the research carried out which can be explained as follows:

- Step 1: conduct a Schematic Literature Review on Design and Build, Design Management, Procurement management, integration Design and procurement is linked to project performance.
- Step 2: identify indicators that influence success in integrating design and procurement in DB projects.
- Step 3: determine the measures for integrating design and procurement to achieve project performance
- Step 4; establish Key Performance Indicators (KPI) to measure the success of design and procurement integration.
- Step 5: conduct a case study on the project to measure the success of the integration of design and procurement on the DB project.
- Step 6: validate the results of design and procurement integration measurements

in the DB project, then prepare a research report.

The stages in this research are conducting a Focus Group Discussion (FGD), Carrying out the FGD involved experts who had previously filled out a consent form to be involved in the research. Decision making is carried out using the Delphi method for 2 rounds which aims to validate the results of design and procurement integration measurements carried out in the DB project case study (Chan et al., 2001; Humphrey-Murto et al., 2020; Thangaratinam and Redman, 2005; Xia and Chan, 2012) The criteria for selecting the experts involved in this FGD have the following components:

1) The number of experts used in the FGD was 10 people, where the experts came from homogeneous competencies, namely from contractors, design consultants and academics (Hallowell and Gambatese, 2010; Humphrey-Murto et al., 2020);
2) A minimum of 2 (two) rounds is carried out to develop a consensus (Chan et al., 2001; Hallowell and Gambatese, 2010; Humphrey-Murto et al., 2020; Thangaratinam and Redman, 2005).
3) Experts who will take part in the FGD are selected according to categories according to their field. contractors and consultants must have experience in large-scale design and build projects on government projects for at least 10 years in a managerial position. Meanwhile, for academics, the minimum qualification is Ph.D in construction management.

The following is a list of experts involved in the FGD as follows:

Table 1. List of experts.

Expert No	Criteria	Description
1	Contractor	Chief Executive Officer
2		Operational Director
3		Head of Project Manager
4	Senior Consultant for Designer	Senior Consultant for designer
5		Senior Consultant Supervision
6		Senior Designer
7	Academic	P.H.D in Construction Management
8		P.H.D in Construction Management
9		Prof. In Construction Management
10		Prof. In Construction Management

Table 1 above describes the experts involved in the FGD to validate indicator for integration design and procurement. Next, KPIs of integration Design and Procurement measurements were carried out on case studies of 6 (six) DB building project locations with data as in **Table 2** as follows.

From **Table 2**, KPIs for design and procurement integration will be measured with predetermined measurements, then each project will have a profiling of the results of design and procurement integration.

Table 2. List of project for case study.

No	Title	Value (IDR Billion)	Location
1	DB "A"	200	Central Jakarta
2	DB "B"	159	West Jakarta
3	DB "C"	265	Bukit Tinggi, West Sumatera
4	DB "D"	293	East Jakarta
5	DB "E"	145	East Jakarta
6	DB "F"	265	East Kalimantan

3. Results

The stages of preparing KPIs begin with a Schematic Literature Review (SLR), then selection is carried out through FGD experts to determine the KPIs used in strategic integration design and procurement. Below are the KPIs that have been validated by experts through FGD as follows:

Table 3. List of KPIs for integration design and procurement.

No	Phase	Indicators	Description	References
1	Design	Design Team competence	Experience and competence of the design team regarding waste reduction in the project.	(Ajayi, 2016)
		Quality Design Document	Clear design documents use clear and consistent notation and language to reduce waste in the project	(Ajayi, 2016)
		Collaboration Design	Collaborative design occurs from the start with suppliers/sub-contractors to map out their respective advantages before the tender is submitted.	(Asmar et al., 2013; Katar, 2019; Sari et al., 2023; Sari et al., 2023)
2	Procurement	Selection Criteria Supplier/Subcontractor	Suppliers who have a track record on previous projects based on evaluation results.	(Chai et al., 2013; Chan et al., 2001; De Boer et al., 2001; Sarkis, 2022; Suresh and Nathan, 2020; Verma and Pullman, 1998)
		Experience and Competence of Supplier/Sub Contractor	Skills and competences of supplier/sub-contractor	(Rehman and Ishak, 2021; Shahhosseini and Sebt, 2011)
		Effective Order Materials	• Reviewing material selection/product evaluation • Method of awarding purchase contract) • Time predictability	(Ahbab, 2012; Caplice and Sheffi, 1995; Chen et al., 2016b; Li et al., 2013a; Lui et al., 2004; Mahmoud-Jouini et al., 2004; Schrijvers et al., 2020; Sriram et al., 2022)
		Minimize waste in contract attribute	Predict the occurrence of waste and prepare a plan to make improvements if waste occurs	(Ajayi and Oyedele, 2018; Lauren, 2005; Leicht and Harty, 2017)
		Commitment Contractor, supplier and Sub Contractor	There is a collaborative commitment from design and procurement to conducting tenders with contractors	(Guan, 2018; Rached and Hamzeh, 2014; Sari et al., 2023; Shane et al., 2015)

Table 3 above describes the indicators of integration of design and procurement in the DB project, then using a scale of 0–4 an assessment will be carried out on each indicator as shown in **Table 4**. Weighting of the implementation of integration is also carried out, where design has a weight of 40% and procurement has a weight of 60% so the total weight is 100%.

Table 4. Integration design and procurement measurement scale (Pinto Nunez et al., 2018; Thohirin et al., 2024).

Level	Description
Level 0	Stakeholders in the project do not coordinate and communicate to achieve general project goals so that each has a different view of the project success indicators.
Level 1	Project stakeholders coordinate to share vision and mission in achieving project goals, but do not yet have a common vision in achieving project objectives. Project indicators have not been achieved.
Level 2	Project stakeholders coordinate to share vision and mission in achieving project goals, have the same views in achieving project objectives and all project goals are expressed together as a commitment in implementing the project
Level 3	Project stakeholders coordinate to share vision and mission in achieving project goals, have the same views in achieving project objectives and all project goals are expressed together as a commitment in implementing the project. Project objectives are committed to achieving targets.
Level 4	Project stakeholders coordinate to share vision and mission in achieving project goals, have the same views in achieving project objectives and all project goals are expressed together as a commitment in implementing the project. The committed project objectives exceed the achieved targets.

Table 4 above describes levels 0–4 for measuring the depth of KPI for each indicator that will be used to measure integration design and procurement.

In-depth interviews were conducted with 90 respondents to explore the implementation of the design and procurement strategy on the project used as a case study. The survey was carried out by distributing questionnaires and in-depth interviews recorded by the researcher. The results of the questionnaire are then tabulated and coded to be concluded in the research report. Below is the profile of the research respondents as follows:

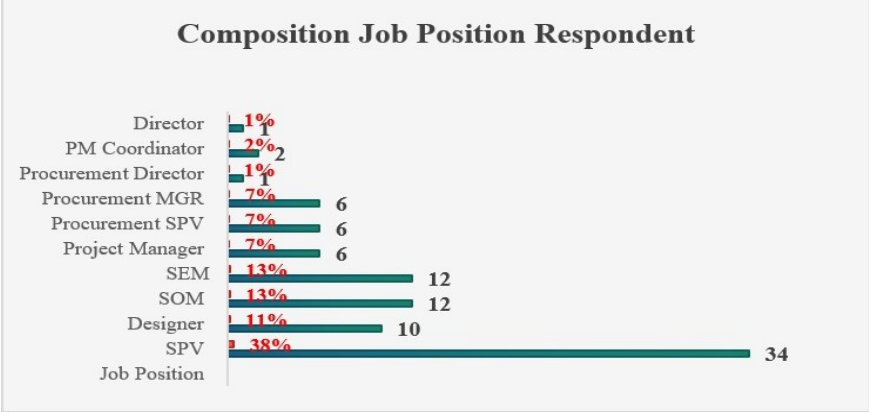

Figure 6. Profile composition job position of respondent.

Figure 6 above illustrate that the highest respondent become from Supervisor in project division is 38% from total respondent. Detail for each composition is Designer 11%, Site Operation Manager (SOM) 13%, Site Engineering Manager (SEM) 13%, Project Manager 7%, Procurement SPV 7%, Procurement Manager 7%, Procurement Director 1%, PM Coordinator 2% and Director 1%.

Figure 7 illustrate that composition age of respondent is 20–25 years 11%, 26–35 years 60%, 25–50 years is 26% and above 50 years 3%.

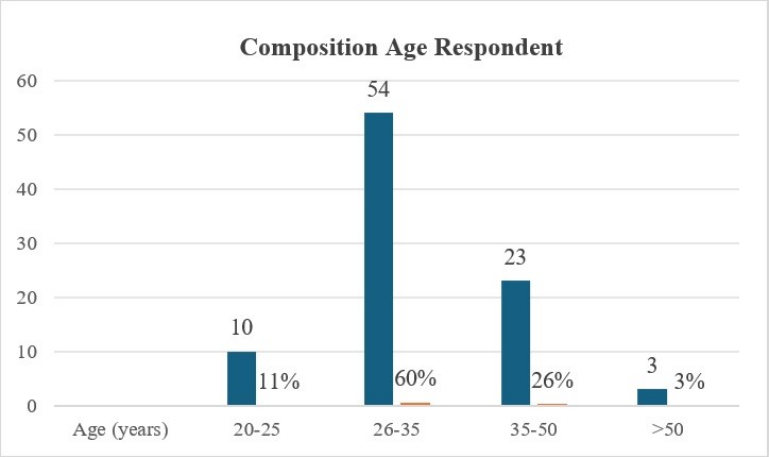

Figure 7. Profile composition age of respondent.

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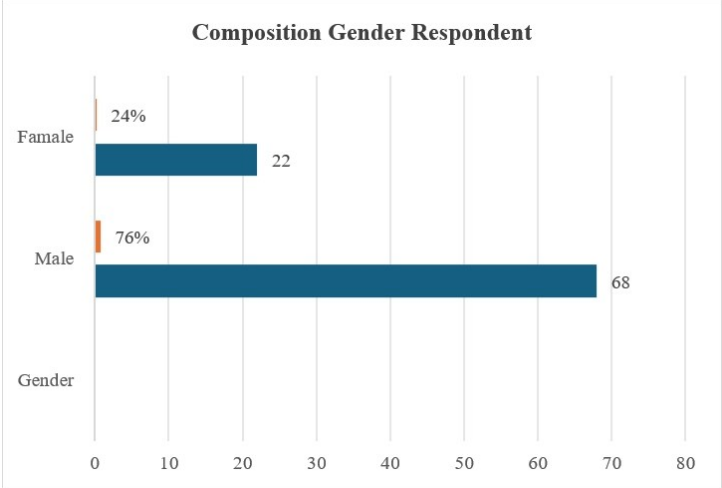

Figure 8. Profile composition gender of respondent.

Figure 8 above depicts the gender composition of respondents, consisting of 76% male and 24% female.

4. Discussion

Key Performance Indicators (KPIs) measurements were carried out on case studies from 6 building project locations with the Design and Build (DB) delivery system, assessed through in-depth interviews with a total of 90 project members from 6 project locations with the following project achievements:

Table 5. KPI assessment results on the case study project.

Phase	DB "A"	DB "B"	DB "C"	DB "D"	DB "E"	DB "F"
Design	2900	2800	3500	3600	3600	3700
Procurement	2940	2920	3460	3420	3720	3780

In **Table 5** above are the assessment results of the KPI 6 case study projects in

design and procurement. The next stage is to give weighting and give an average of each achievement in each KPI achieved by each project. Below is the weighting of each KPI achievement in integration design and procurement as in **Table 6** as follows:

Table 6. Final summary of KPIs.

Phase	**DB "A"**		**DB "B"**		**DB "C"**		**DB "D"**		**DB "E"**		**DB "F"**	
Design	2900	1160	2800	1120	3500	1400	3600	1440	3600	1440	3700	1480
Procurement	2940	1764	2920	1752	3460	2076	3420	2052	3720	2232	3780	2268
Sumarry KPI		2924		2872		3476		3492		3672		3748

From **Table 6** above is the final recap of the KPIs after being weighted according to design (40%) and procurement (60%). Furthermore, if we look at the general depiction of KPI achievements, it can be seen from **Figure 9** as follows:

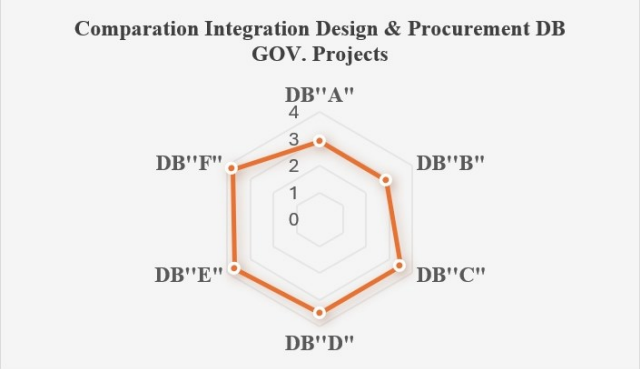

Figure 9. Comparation of KPI.

Figure 9 above illustrates that DB "A" and DB "B" are still far from the required KPI target, namely score 4. Meanwhile, DB "D", DB "E" and DB "F" are close to the required KPI based on lean construction. The closer the project approaches the required KPIs, the more it shows that the project has good performance in accordance with integration design and procurement, in the implementation of project construction that successfully implements design and procurement integration will also achieve good project performance because from the start there has been deep collaboration in tenders. Understanding of each stakeholder in the project also increased from the start along with the high level of commitment from each stakeholder.

Good design and Procurement integration if it reaches a minimum score of 3 according to the depth of integration achieved in the managed position (Pinto Nunez et al., 2018), this means that standards and strategies throughout the organization are applied to many projects. The design integration process occurs early before tendering begins to establish common goals and is managed using performance metrics. The achievement of organizational performance is visible and has productivity in accordance with the objectives set. There is comprehensive documentation of meetings and coordination regarding the partnering carried out.

Figure 10 illustrates the position of design and procurement integration results based on levels 0–4. where the results of the integration of design and procurement are considered good if they meet the minimum score of 3 at the managed level.

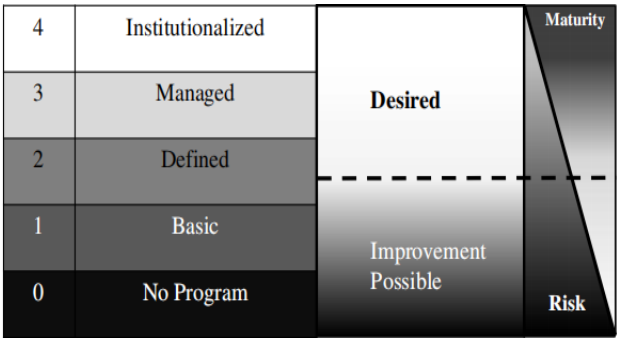

Figure 10. Results of integration (Pinto Nunez et al., 2018)

The role of each party in design and procurement integration involving many stakeholders in the project who have specific duties and responsibilities. Below is a description of the role of each stakeholder in design and procurement integration as follows:

Table 7. Stakeholder role design and procurement integration.

No	Integration	Contractor DB	Supplier/Subcontractor	Designer	Project Division	Procurement Division	Financial Division
1	Design	Provide invitations to suppliers/subcontractors to take part in tender selection by detailing the basic design from the owner.	Detail the basic design according to the materials supplier/subcontractor have.	Collaborating on design details from suppliers/subcontractors.	Approve the basic design which has become detailed engineering to be submitted to the tender.		
2	Procurement	Select suppliers/subcontractors who meet the requirements, then submit contracts to fulfil procurement.	Fulfil procurement according to project needs based on the S curve.	Oversee the design to ensure there are no changes to the design specifications.	Carry out project control with good procurement strategies and techniques.	Carry out procurement control to support project implementation.	Monitoring financial performance of project performance achievements and procurement realization.

Table 7 describes the role of each stakeholder in design and procurement integration. each has a role in carrying out its functions to achieve good integration so as to produce project performance.

The practices carried out on the DB "C", DB "C", DB "E" and DB "F" projects show a good division of roles in design and procurement integration. The integration process is carried out with contributions from each stakeholder to carry out functions in accordance with the established Standard Operating Procedure (SOP). so that performance on the DB "C", DB "C", DB "E" and DB "F" projects reaches the desired target.

5. Conclusion

From the results of the research above, the following can be concluded:

1) Government Design and Build (DB) projects require integration of design and procurement from the start of the project before a tender is held. This is necessary because projects with fixed lump sum prices, which are typical of DB Government projects, will experience risks when winning the tender if DB Contractor cannot predict from the start the design and procurement that will be

carried out at the construction implementation stage.

2) Integration of design and procurement will reduce the risk of material shortages, conflicts, and poor communication between designers, contractors, suppliers, and subcontractors. If this integration can be done well before the tender, it will make it easier to achieve project performance at the next stage.
3) Indicators developed to measure design and procurement integration will make it easier to monitor the performance of each phase.
4) The contribution of each stakeholder in integrating design and procurement is needed to become a standard operating procedure (SOP) so that project performance is achieved.
5) Recommendations for future research can be deepened for large-scale road projects that have an impact on infrastructure development in Indonesia. The preparation of indicators can be increased or decreased according to project characteristics.

The limitation of this research is that the indicators were developed for Design and Build projects in buildings. If you want to develop them for other projects such as Design Bid Build (DBB), then there must be adjustments to the indicators because DBB does not include design integration.

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