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Construction Project Delivery System Selection Framework: Professional Service Firms' Perspective

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Abstract: There is a variety of PDSs (project delivery systems) in today's construction industry. This leads to confusion when it comes to selecting the most suitable PDS for a specific project. The wrong selection decision might lead eventually to reduced profit margins or perhaps financial losses to PSFs (professional service firms). This research proposes a conceptual framework that helps PSFs in the selection of one or more suitable PDSs for their construction operations. The framework uses SWOT (strengths, weaknesses, opportunities and threats) analysis as a tool for assessing each PDS considered in this research. The PDSs included in the framework are design-bid-build, design-build, construction management agency, public-private partnerships and integrated project delivery. The main aim of this research framework is to enhance decision-making efficiency in PDS selection for PSF operations.

Key words: Project delivery system, selection, SWOT analysis, construction, professional services firms, framework.

1. Introduction

In construction projects, several stakeholders are involved with the unified aim of successfully creating a structure. The relationship between these stakeholders can be defined by a PDS (project delivery system). It is a system that includes both contractual and compensation arrangements that allow the owner to acquire a complete facility that meets their needs [1]. Furthermore, it defines the owner's role in the project execution, and reveals the roles, duties, and risk allocation of the project stakeholders as well as the means by which the owner pays for the services [2]. A number of PSFs (professional service firms), such as architecture, engineering and consultancy firms, deal with PDSs on a daily basis, as they represent a significant proportion of PDS stakeholders. The PDS is considered as an important factor in the success of the implementation of a building project [3]. The selection of the correct system may assist in preventing problems and act as a main contributor to achieving specific project goals, such as fast-track scheduling, low price, risk allocation, and level of owner involvement [3]. A PDS has a significant impact on the schedule, cost, quality, and contract management of a project [2]. The selection of a suitable PDS is necessary for the success of a construction project [4, 5]. Not selecting the appropriate PDS will cause poor project performance [6]. Eventually, this will lead to extra costs to the PSF.

No specific PDS can be suitable for all projects [7, 8]. Based on the project criteria, a PDS can be better suited for a particular project than another [9]. Thus, the selection of a suitable PDS for a project is a complex decision-making process and is critical for project success [1]. A large quantity of ambiguous information exists when attempting to select a suitable PDS, and this renders the selection process a difficult task [10]. Each PDS has certain weaknesses that limit their wide use [9]. Decision makers need to know what are the available PDSs? How do these systems work? How are they different? What are their strengths and weaknesses [8]? Additionally, it is also significant to identify the

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opportunities and threats of each available PDS. The owner should not necessarily seek the lowest initial cost but rather the best value for money [9].

The development and use of different PDSs is prompted by the widespread dissatisfaction of owners with the results of their construction projects [5]. Traditional PDSs such as DBB (design-bid-build) that mainly focus on mutual contracts and the lowest bid do not support collaboration, as project stakeholders attempt to maximize their operations and risks [11]. Moreover, researchers perceive traditional PDSs as inefficient and controversial [12]. Thus, there is a significant need for alternative PDSs in the construction industry [12]. However, the existence of various types of PDSs has created the issue of selecting a suitable PDS [6]. As the number of different PDSs increases, the selection process becomes more complex, specifically with the increase in the technical complexity of projects and the owner's need for better value for money projects [4].

This paper establishes a conceptual framework to assist PSFs in the selection of a suitable PDS for their operations. SWOT (Strengths, weaknesses, opportunities, threats) analysis is used in the framework as a tool to allow PSFs to select the suitable PDSs based on their assessment of the available factors in the framework. This paper begins with an introduction to the research topic. Following the introduction, a literature review section presents PDSs considered in this research as well as previous work related to PDS selection and SWOT analysis in the construction industry. This will be followed by a section clarifying the gap in knowledge and the research methodology. Next, the conceptual framework is explained. Finally, the paper will touch on several conclusions under the conclusion section.

2. Literature Review

2.1 Project Delivery Systems

The PDSs considered in this research are:

- DBB;
- DB (design-build);
- CMA (construction management agency);
- PPP (public-private partnership);
- IPD (integrated project delivery).

2.1.1 DBB

In the design and construction industry, DBB is a well-known PDS model [7, 9, 13]. It is used for the majority of public projects and many private projects [9]. Its contract clearly defines the roles and responsibilities for all involved parties [7]. There are three main players in this PDS: owner, designer and contractor [9]. These represent the key stakeholders. The overall project process is managed by the building owner, who along with the designer controls the scope with technical support and design coordination [7]. During the design phase, no direct contact is made between the designer and general contractor [7]. Rather, the owner appoints an experienced design firm to prepare the project's design documents, and after completion, the bid package is advertised in a competitive bidding process [7, 13]. Finally, the awarded general contractor is responsible for constructing the project within the specified timeframe and price [7]. The DBB model process requires all design work to be completed before the bidding process and construction stage's beginning, which renders this PDS time-consuming and resources extensive [7]. At the same time, DBB encourages construction quality because the designer and contractor are separate entities and both are in a position to discover errors made by the other party, resulting in a system of check and balances [9].

2.1.2 DB

The design and construction in this PDS is made by a single entity that the owner contracts with [3, 9, 13], which can eliminate the adversarial relationship that usually forms in DBB [13]. Furthermore, it allows the reduction of total project time as well as information integration during the design stage [13]. Thus, it allows fast tracking of project realization. A number of studies on DB PDSs reported faster project delivery and reduced costs [14]. DB lacks the system of check and balances that exist in DBB, which can render quality assurance in an issue of concern [13]. As the designer is not directly contracted with the owner, the owner has limited influence on the final design quality [7]. Overall, the owner has little involvement in a project with a DB PDS arrangement and thus a well-defined scope of work is essential, so no misunderstandings occur [15]. An owner with little background information can start the project because of the combination of design and construction at the design stage [7].

2.1.3 CMA

Generally, in a construction management of PDS arrangement, the owner capabilities are temporarily expanded by utilizing the construction, design, and management expertise of a firm to productively complete the owner's program or project [16]. The construction manager is engaged early in the design stage as a member of the design team to make important cost, schedule, constructability, and serviceability contributions to the design [17]. Construction management is found in two forms: CMA and CMAR (construction management at risk) [16]. With CMA, the construction manager proceeds as an agent for the owner, providing advice and managing the project from concept to completion [16]. Here, the owner inherits all risks related to every trade contract made in the project [17]. With CMAR, the construction manager provides expert support to the owner before the construction, including constructability, budget and schedule advice, and acts similarly to a contractor during construction [16]. In this form, the construction manager acts as a general contractor by signing a number of trade contracts with contractors and suppliers [17]. Thus, unlike CMA, the risks are transferred from the owner to the construction manager. A CMAR becomes a construction manager/general contractor hybrid instead of the traditional general contractor [18]. CMAR is not permitted in more than half of the states in the United States of America [19]. Some of these states enforce restrictions or extra approval requirements for the use of CMAR as a PDS [19]. Therefore, only CMA will be considered in this study.

2.1.4 PPP

Public-private partnership can be defined as a collaboration between a private party and a government entity through a long-term contract with the aim of providing an asset or service to the public, where the public party is responsible for a significant risk and management role, and profits is aligned to performance [20]. For a project to be feasible as a PPP, it has to provide value for money for the private party [21]. Many forms of PPP exist in the construction industry. Some of these forms include:

- design-build-finance-operate-maintain;
- design-build-finance-operate;
- design-construct-manage-finance, operation and maintenance;
- build-operate-transfer;
- build-own-operate-transfer [20].

PPP PDSs in this research refer to any method that is based on the innovative collaboration between available government resources and private sector resources to accomplish a construction project that serves the public.

2.1.5 IPD

In recent years, IPD has appeared as a method that has the potential to reform project delivery [12]. It differs from other project delivery methods by focusing on the general improvement and the integration of processes, tools, and people in a single system [12]. This integration exploits the participants' abilities and insights to decrease waste and optimizes efficiency through the different stages of design, fabrication, and construction [22]. A primary advantage of IPD is the capability of all parties to take part in the project as early as the design stage [23]. Collaboration of all parties represents a significant component of IPD [12, 22]. The IPD construction method starts from the concept stage through to the handover and operation stage with the aim of achieving a building under the integration of the design team, owner, and contractor [24]. Furthermore, its target is to enhance project outcomes through a shared risk and reward system, early party involvement, and multi-party contracts [23]. Implementation of the IPD method should result in the elimination of the two major types of construction waste, namely construction activities waiting for people and people waiting for materials [15]. Moreover, fewer work changes, quicker processing time and quicker delivery time are seen with IPD [25].

2.2 Previous Research on PDS Selection

A number of studies have discussed the selection of a PDS through the quantitative approach [1, 9, 10, 13, 26, 27]. But limited studies have discussed the selection of PDSs through the qualitative approach. With respect to the quantitative approach, many authors use the analytical hierarchy process in their research to propose models or frameworks to assist in PDS selection [1, 9, 13, 26]. To improve the precision of PDS selection in a quantitative approach, a research study managed to combine artificial neural network and data envelopment analysis in their PDS selection model [10]. Moreover, a number of researchers used performance metrics comparison as part of their quantitative analysis to select a suitable PDS [14, 28]. With regards to the qualitative approach in PDS selection, a study that looked into contracting strategy selection for highway projects includes the following three components: PDS, procurement procedure and payment provision, using a project delivery selection matrix to provide formal guidance on PDS selection [29]. In another study, two qualitative approaches: the analytical delivery decision approach and the weighted matrix delivery decision approach, were introduced to provide transit agencies with suitable PDS selection criteria [19].

2.3 SWOT Analysis and Previous Research in the Construction Industry

SWOT analysis is a significant tool used in the process of strategic management by organizations. Strategic management can be defined as the art or science that permits an organization to realize its aims by creating, applying, and assessing cross-functional decisions [30]. SWOT analysis has been developed as a significant tool that works to reduce the amount of information to develop decision-making and thus address complex strategic situations [31]. Organizations adopting strategic management concepts realize many benefits such as sales enhancement, profitability, productivity, understanding of external threats, knowledge of competitors' strategies, lower resistance to change, and awareness of performance-reward relationships [30]. Here, the organization identifies its external opportunities and threats as well as its internal strengths and weaknesses [30]. For an organization's external opportunities and threats, the EFE (external factor evaluation) matrix is used (Table 1). Moreover, for the organization's internal strengths and weaknesses, the IFE (internal factor evaluation) matrix is used (Table 2) [30]. To develop an EFE matrix, five steps need to be taken:

(1) list identified key external factors;

(2) assign a weight for each factor: the range should be from 0.0 (not significant) to 1.0 (very significant);

(3) assign a rating for each factor: the range should be from 1 (response is poor) to 4 (response is average);

Table 1 EFE matrix.

Key external factor	Weight	Rating	Weighted score
Factor 1			
Factor 2			

Table 2 IFE matrix.

Key internal factor	Weight	Rating	Weighted score
Factor 1			
Factor 2			

(4) determine the weighted score by multiplying the factor's weight by its rating;

(5) sum the weighted scores to determine the total weighted score.

The IFE matrix can be developed in a similar manner to the EFE matrix. The steps required are as follow:

(1) list identified key internal factors;

(2) assign a weight for each factor: the range should be from 0.0 (not significant) to 1.0 (very significant);

(3) assign a rating for each factor: the range should be from 1 (major weakness) to 4 (major strength);

(4) determine the weighted score by multiplying the factor's weight by its rating;

(5) sum the weighted scores to determine the total weighted score.

Many studies have used SWOT analysis to investigate different aspects of the construction industry. For example, a study on Vietnamese architectural, engineering, and construction firms used SWOT analysis to investigate how these firms operate in the domestic market, respond to opportunities and threats in the market, as well as recommend how similar foreign firms operating in Vietnam could respond [32]. In China, SWOT analysis was used with the aim of identifying the SWOT of Chinese construction professional services in the international context [33]. Besides, a study used SWOT analysis to identify the SWOT of foreign-invested construction enterprises working in the Chinese construction market [34]. SWOT analysis was used as the main tool to conduct a study on identifying the critical strategies for improving the construction waste management situation in Shenzhen, China [35].

3. Gap in Knowledge

SWOT analysis has been used as a tool by researchers in many construction applications. However, to the author's knowledge, the use of SWOT analysis in the selection of a construction PDS has not been studied. The majority of approaches used has been quantitative and was seldom qualitative. Moreover, SWOT analysis requires human judgment, which is subjective [31], and the source of data in previous PDS selection research studies depends on expert opinions, which does not lend a dynamic nature to these studies. This research provides PSFs with a conceptual framework that can produce different outputs depending on the requirements, strategies and capabilities of the PSF. Furthermore, past studies on PDS selection did not collectively include the five different PDS selected in this study. Thus, this research aims to close the existing gap in knowledge by proposing a conceptual framework that integrates the use of SWOT analysis in the selection of suitable PDSs for PSF operations.

4. Methodology

This research follows a qualitative approach in the creation of a conceptual framework for the selection of a suitable construction PDS for PSF operations. Traditionally, researchers used quantitative methods for project delivery studies [36]. Conversely, qualitative methods have lately gained more consideration as an applicable approach for project delivery research, particularly for sustainable building projects [36]. This research started with a literature review search of several academic databases and search engines, including Elsevier, ProQuest, Springer, and Google Scholar. The literature review revealed the lack of a qualitative PDS selection framework that considers DBB, DB, CMA, PPP and IPD collectively for PSF operations. Therefore, this research aims to bridge this knowledge gap by creating a qualitative conceptual framework that enables PSFs to select suitable PDSs for their businesses, taking into consideration their requirements, capabilities and strategies. SWOT analysis is used as a tool in the framework to assist PSFs in the selection process. The framework is designed to be practical and simple to use by PSFs, where assessment is primarily made based on a number of internal and external factors related to PDSs.

5. Conceptual Framework

The creation of a construction PDS selection framework can assist PSFs in choosing the most suitable PDS with the best outcomes for the firm. The framework aims to achieve successful project results. Simultaneously, the framework is designed for the ease of use of the PSF stakeholders. It consists of three stages:

(1) identification, where the PSF requirements, capabilities, strategies and other considerations are identified;

(2) evaluation, where a weighted score calculation is made for the selection process;

(3) review, where the selection outcomes of PDS are reviewed (Fig. 1).

5.1 Stage One (Identification)

In the first stage of the framework, a number of considerations related to PSF and the construction work environment are identified. The five main considerations in stage one are:

(1) PSF requirements;

(2) PSF strategies;

(3) PSF capabilities;

(4) local government regulations;

(5) market aspects.

PSF requirements include the aims that the firm is willing to achieve from the selected PDS. For example, the firm might want all of its construction projects to be subjected to fast-track scheduling. The second consideration that should be taken into account in the PDS selection process is PSF strategy. For example, a PSF might have a long-term strategy of conducting a large number of partnerships with the private and public sector as part of their growth strategy, and thus PDSs such as PPP and IPD should be emphasized. The capabilities and available resources of the firm, whether financial or manpower, must also be considered in the selection process. A PSF with a limited amount of resources cannot be involved as a major stakeholder in a PPP construction project. Government regulations are related to all guidelines and policies required by the local area government. It varies from one country to another and

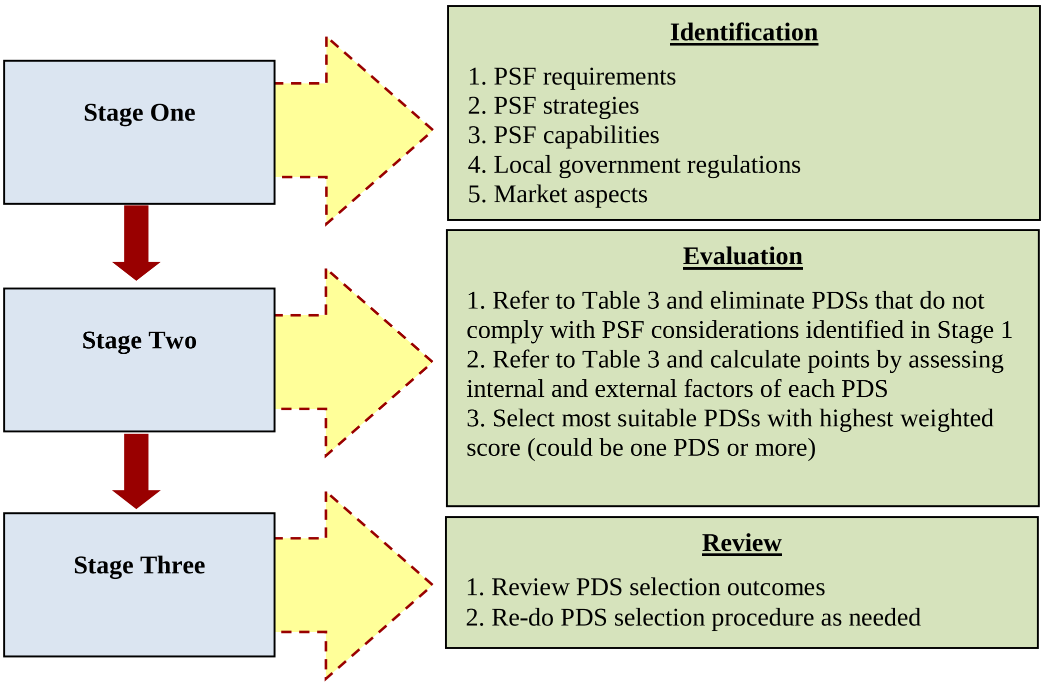

Fig. 1 Construction PDS selection framework for PSFs.

Table 3 PDS SWOT matrix.

PDS	Internal factors (related to PDS)		External factors (related to construction industry)	
	Strength	Weakness	Opportunities	Threats
DBB	1. High level of owner involvement in design process [13, 37]; 2. Well-defined scope of work [37]; 3. Maximizes the project budget [38]; 4. Offers marketplace competition and therefore higher chances for lower bids [19]; 5. Full design is made before project is awarded [19]; 6. Established procedures for change order exist, thus flexible [19].	1. Likely adversarial relationship [12]; 2. Time-consuming and lengthy [9, 25]; 3. Resources extensive [7]; 4. Possibility for a contractor to claim design errors to recover costs [7, 18]; 5. Absence of contractor involvement during design [18, 29]; 6. Requires significant owner experience and resources [29]; 7. Does not provide contractor with incentives for enhanced performance [39].	1. Most familiar project delivery method in the construction industry [7, 13, 18]; 2. Used for typical projects [29] as well as complex projects [9, 13]; 3. Well-established legal framework [39]; 4. Well-defined insurance coverage [39].	1. Obsolescence of technology and programs used in large and lengthy projects [18]; 2. Due to the absence of contractor input in the design stage, sustainable design accreditation could be at risk of being unsuccessful [19], similarly in any other innovative opportunity that depends on a third party.
DB	1. Owner contract with single entity for design and construct [7, 9, 13, 40]; 2. Fast track schedule [7, 13, 14]; 3. Owner only required to complete preliminary design [7, 9]; 4. Contractor and designer work together enabling cost cuts [18]; 5. Reduces change orders [38]; 6. Risk transferred from owner to designer and builder [29]; 7. Lower level of conflict between designer and contractor [19].	1. Lack of checks and thus issues with quality [7, 13]; 2. Scope must be very clear, otherwise the end result will not meet the exact client goals [13, 18, 19]; 3. Limited involvement of owner in design process [7, 13]; 4. Issues can arise when there is a need for multiple agency approvals on design [18].	1. Suitable for standard projects [13], as well as fast-track and unique projects [29]; 2. The owner can use sustainable features in design and construction as performance criteria [19], as well as any other innovative opportunity that depends on a third party.	1. Regulation restrictions may exist [41].
CMA	1. Fast track schedule [9, 13, 17]; 2. High level of owner involvement in design process [9, 13]; 3. Enhanced quality and build ability of design documents [7, 39]; 4. Used when owner is unable to manage the construction process [15]; 5. Assist owner in making procurement decisions [38]; 6. Provides designer with construction expertise [39].	1. Extra cost for appointing a construction manager [9, 39]; 2. Owner needs to manage two contracts [9]; 3. Slower than DB project delivery [9]; 4. No risk to agency from extra construction costs [39].	1. Used in complex projects [13, 17]; 2. A good construction manager can manage fluctuating market conditions [17].	1. Some state licensing laws for contractors or architecture/engineering firms do not regulate CMA services [39].

(Table 3 continued)

PDS	Internal factors (related to PDS)		External factors (related to construction industry)	
	Strength	Weakness	Opportunities	Threats
PPP	1. Use of private financing for infrastructure projects [21, 42]; 2. Public and private share risks [18]; 3. Offers competence in long-term operations and maintenance [18] as well as increased design quality [29]; 4. A single contract for all services and products [29]; 5. Provide lifecycle estimation [29].	1. Possible legal dispute between private operators and government [42]; 2. A high level of professionalism is required to implement a PPP project [18]; 3. Difficult to estimate costs of operation and maintenance at design stage [29].	1. Employ private sector efficiencies and innovations in project [18, 43]; 2. Promote economic development [18]; 3. Allows the selection of feasible projects for investment [29]; 4. Allows for enhanced budgetary management [29]; 5. Suitable for large, mega, complex projects [29].	1. No evidence that private sector can deliver public service more effectively than private sector [43]; 2. Service demand risk and new market trends [43]; 3. Financial stability and interest rates [43]; 4. Legislative challenges at different government levels [29].
IPD	1. Multi-party agreement [15, 23, 25]; 2. Early involvement of all parties [22, 23, 25]; 3. Shared risk and rewards [23, 25]; 4. High performance and efficiency [15, 22, 38]; 5. Appropriate technology use [22]; 6. Enhanced communication [15, 22]; 7. Improved quality [38].	1. Issues with alliance facilitator or director selection [24]; 2. Issues with traditional contracts [24]; 3. Agreement on final project contract can be difficult and time-consuming due to the many parties involved [18].	1. Best for large, unique projects with requirement for substantial coordination [23].	1. Insurance policies may not cover all project liabilities [24]; 2. Non-adversarial team relationships is rare in the construction industry [18]; 3. Market lacking the right technology to support IPD as intended [23]; 4. Business risk and change [23]; 5. Lack of awareness and appropriate legal structure [23].

it must be considered as part of the PDS selection process. For example, some governments might not permit or accept certain PDSs. Similar to government regulations, market aspects differ from one country to another. It includes economical conditions and the availability of contractors, subcontractors and engineering firms that are capable of working as part of the different PDSs. All of these considerations must be identified by the PSF in stage one to render the selection process more concise and successful.

5.2 Stage Two (Evaluation)

This stage of the framework represents an important step in the PDS selection process. Here, SWOT analysis is used as a tool to assist the PSF stakeholders in the PDS selection. The first step in this stage is to eliminate the PDSs listed in Table 3 that do not comply with PSF considerations previously identified in Stage one. The second step will be to use the PDS internal and external SWOT factors listed in Table 3 to form the PSF individual EFE and IFE matrices. For each PDS considered for analysis, Table 4 and 5 should be completed.

Tables 4 and 5 should be completed by the PSF stakeholders involved in the construction projects. The involvement of these stakeholders will be in the form of factor assessment by discussing and agreeing upon the weights and ratings of each factor to ending up with a weighted score. Each PDS must have its own assessment tables. After assessing all internal and external factors for each PDS, the total weighted score is calculated by summing the weighted score for each factor. The third step will be to compare the total weighted scores of each PDS and decide on which PDS to select for the PSF operations. The higher the total weighted score, the more suitable the PDS. It is self-preference for the PSF to select one or more PDSs.

Table 4 EFE matrix.

	PDS external factor	Weight	Rating	Weighted score
PDS selected	Factor 1			
	Factor 2			

Table 5 IFE matrix.

	PDS internal factor	Weight	Rating	Weighted score
PDS selected	Factor 1			
	Factor 2			

5.3 Stage Three (Review)

The PDS selected from stage two is then reviewed and proposed for PSF operations in stage three. It is strongly suggested that the PDS selection outcomes be reviewed and any feedback recorded. Updates to the PDS SWOT matrix can be made if deemed required by PSF stakeholders. Such amendments and updates can help to enhance the research framework. Furthermore, the procedure of PDS selection can be re-done if any changes occur to the considerations identified in stage one of the framework.

6. Conclusions

The selection of a PDS could contribute toward the success or failure of a construction project. This research reviewed the available literature on PDS selection methods and found a gap in knowledge related to PDS selection through qualitative approach from the perspective of PSF. This gap was closed by the proposal of a conceptual framework that assists PSF stakeholders in the PDS selection for their construction projects. The framework uses SWOT analysis as a tool to enable easy and concise use of the framework by all PSF stakeholders. The PDSs considered in this research framework include DBB, DB, CMA, PPP and IPD. Future research related to this study might work on improving the framework in different ways, including the types of PDSs considered.

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