From Design to Operations: A Process Management Life-Cycle Performance Measurement System for Public-Private Partnerships

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Abstract

Public-Private Partnerships (PPPs) have become a critical vehicle for delivering infrastructure worldwide. Yet, the use of such a procurement strategy has received considerable criticism, as they have been prone to experiencing time/cost overruns and during their operation poorly managed. A key issue contributing to the poor performance of PPPs is the paucity of an effective and comprehensive performance measurement system. There has been a tendency for the performance of PPPs to be measured based on their *ex-post* criteria of time, cost and quality. Such criteria do not accommodate the complexities and lifecycle of an asset. In addressing this problem, the methodology of sequential triangulation is used to develop and examine the effectiveness of a 'Process Management Life-Cycle Performance Measurement System'. The research provides public authorities and private-sector entities embarking on PPPs with a robust mechanism to effectively measure, control and manage their projects' life-cycle performances, ensuring the assets are 'future proofed'.

Keywords: PPPs, Infrastructure asset, Performance measurement, Future proofing, Australia

Introduction

Public-Private Partnerships (PPPs) have become a critical vehicle for delivering infrastructure worldwide. In Australia, PPPs have been used to deliver both economic (e.g., roads, bridges and tunnels) and social infrastructure (e.g., hospital, stadium and school) (Duffield and Clifton, 2008). The Victorian State Government have used PPPs to procure 15 public schools, and in Western Australia (WA) to deliver a hospital, stadium and a prison to be functional before 2018 (Victoria Department of Treasury and Finance, 2015; WA Department of Treasury, 2015). In the United Kingdom (UK), there have been a total of 24 infrastructure projects delivered via PPPs since 2012, which include public housings, schools, roads, social care centres and hospitals (HM Treasury, 2013). PPPs have been and continue to form an integral part of many Governments' strategies for infrastructure procurement. Yet, they have been plagued with controversy, particularly in Australia and the UK, as they have been prone to experiencing schedule (i.e., pre-construction) and construction cost overruns and not delivering expected value during their operations and maintenance phases (Love *et al.*, 2017).

A number of factors have contributed to the poor performance of PPPs (Hodge and Greeve, 2004). However, the absence of an evaluation mechanism to manage their performance has contributed to their inability to deliver satisfactory outcomes to stakeholders and the community (Regan *et al*., 2015). Accordingly, this has led Liu *et al*. (2015a) to suggest that the lack of an effective performance measurement system (PMS) in such projects may act as a trigger to produce sub-optimal service quality for an asset. The Australian PPP industry and markets are acknowledged as being mature (Hodge, 2004). Despite this maturity, most of the procured PPPs have not undergone any form of comprehensive performance evaluation in terms of what has been delivered (Hodge and Greve, 2007; Regan *et al.*, 2011). For instance, ineffective and incomplete measurement has been identified as a determinant of unsatisfactory

81 performance of in several PPPs, such as: (1) *Latrobe Regional Hospital* and *Deer Park*
82 *Women Prison* (Australia); (2) *Ashfield Prison* and *Knowsley Park School* (UK); and (3)
83 *Golden Ears Bridge* in Canada (House of Commons, 2003; Roth, 2004; Garvin *et al.*, 2011;
84 Harris *et al.*, 2014; Whitfield, 2017).
85
86 There is a widespread consensus that performance measurement is fundamental for business
87 success (Bititci *et al.*, 2012). In fact, measuring project performance is a core activity of PPP
88 contract management (European Investment Bank – EIB, 2011a). Performance measurement
89 is a process of quantifying and reporting the effectiveness and efficiency of the action
90 performed towards influencing organisational objectives (Neely *et al.*, 2005; Berg and
91 Marques, 2011). Nonetheless, PPP performance measurement has received limited attention in
92 the normative literature, especially within the context of social infrastructure assets (Liu *et al.*,
93 2016). Rather than examining the advantages and disadvantages of PPPs, Yong (2010)
94 suggested that there is a need for empirical research about how to structure and ensure a
95 higher performance to achieve the predetermined policy goals and objectives. Against this
96 contextual backdrop, this paper aims to empirically develop a robust PMS that can be used
97 throughout a lifecycle of a social infrastructure PPP so that they can be 'future proofed'. The
98 paper commences with a review of the performance measurement and PPP literature and then
99 using the findings obtained for adopting sequential triangulation approach develops a 'Process
100 Management Life Cycle Performance Measurement System'.
101
102 **Performance Measurement**
103 The origins of performance measurement can be traced back to the 13th century; during the
104 period when double entry bookkeeping played a dominant role (Johnson, 1972). In the 1950s,
105 early globalization contributed to development of performance measurement and productivity

106 management with an emphasis being placed on financial-based measures (Keegan *et al.*,
107 1989). This cost-based measurement, which was within the framework of management
108 accounting, was widely used across the manufacturing, production and engineering industries
109 during the 1970s and 1980s (Johnson, 1981).
110
111 A distinct shift in economic thinking emerged from the 1960s to the 1980s led to a shift away
112 from supply to demand led factors such as quality, time, flexibility and customer satisfaction
113 (Slack, 1983). This resulted in performance measurement becoming a multi-dimensional
114 construct laying the building blocks for Kaplan and Norton's (1992) *Balanced Scorecard* and
115 Neely *et al.*'s (2001) *Performance Prism*. Thereafter, a number of studies have been
116 undertaken that have contributed to development of PMS or empirical examination of their
117 impacts on public or private-sector organisations (Greatbanks and Tapp, 2007; Pavlov and
118 Bourne, 2011; Baker and Bourne, 2014; Nudurupati *et al.*, 2015). As a result of such research,
119 the theoretical construct of performance measurement has matured into a robust system that
120 aims to: (1) identify an organisations' success, customer satisfaction, and where problems
121 exist and improvements can be made; (2) understanding an organisations' processes and
122 determine what they do and do not know; (3) ensure the effective decision-making; and (4)
123 indicate whether the expected outcomes have been met (Gunasekaran and Kobu, 2007;
124 Franco-Santos *et al.*, 2012).
125
126 **Future Challenges of Performance Measurement Research**
127 Despite its rise to prominence, performance measurement is being confronted with an array of
128 new challenges, which have substantially impacted the effectiveness and efficiency of the
129 PMS used by organisations (Pavlov and Bowman, 2015). This view is supported by Melnyk
130 *et al.* (2014), who suggested that the increasingly dynamic business environment has resulted

131 in a need for new performance measures and/or metrics. A review of extant performance
132 measurement confirms this view with additional challenges resulting from: (1) prediction of
133 future performance; (2) complicated and dynamic business environment (e.g., culture or
134 networks); (3) open innovation; (4) knowledge work; and (5) sustainability (Bititci *et al.*,
135 2012; Harkness and Bourne, 2015). Limited empirical research, however, has been
136 undertaken to identify how to solve the aforementioned issues within a PMS.
137
138 PPPs possess a sophisticated development process and a stakeholder network, which are
139 typically bound together by a long-term contractual arrangement and therefore have number
140 of drawbacks, such as: (1) the propensity for contracts to be renegotiated; (2) the difficulty in
141 writing such complex contracts; the more complete they are the higher the transaction costs;
142 (3) incorporating mechanisms for inflation and changes in economic conditions that are
143 beyond the control of the parties; and (4) difficulties in monitoring and rewarding service
144 ensure assets are delivered effectively and efficiently to meet key stakeholders' expectations
145 and predetermined strategic goals; this result in a dynamic business environment (Yong,
146 2010).
147
148 **PPPs and Performance Measurement**
149 A variety of definitions of PPPs can be found in the normative literature. The EIB (2004)
150 defines PPPs as "the relationships formed between private sector and public bodies often with
151 the aim of introducing private sector resources and/or expertise in order to provide and deliver
152 public sector assets and services" (p.2). Similarly, The Public Private Infrastructure Advisory
153 Facility (PPIAF) defines a PPP as involving "the private sector in aspects of the provision of
154 infrastructure assets or of new or existing infrastructure services that have traditionally been
155 provided by government". In addition, a life-cycle of a PPP can be categorised by three

156 phases, (1): *Initiation and Planning* (e.g., selection and definition, PPP option assessment,
157 organization and pre-tendering work); (2) *Procurement* (e.g., bidding, contract and financial
158 close); and (3) *Partnership* (e.g., design and construction, operation, facility maintenance and
159 handover) (EIB, 2011a).
160
161 PPPs can take a variety of forms such as Design-Build-Operate-Maintain (DBOM), Design-
162 Build-Finance-Maintain (DBFM), Design-Build-Finance-Operate-Maintain (DBFOM) (NSW
163 Treasury, 2011). They can also be categorised on the basis of their payment mechanism;
164 availability-and demand-based models. The availability-based PPP is a regime whereby the
165 government retains demand risk with the main form of revenue for a *Special Purpose Vehicle*
166 (SPV) being a regular service payment derived from an asset based on a standard of
167 performance that is being delivered. Contrastingly, for demand-based PPPs, demand risk is
168 transferred to private entities, which operate built assets for the purpose of generating profits.
169 Here revenues of the assets are yielded by charging third parties (i.e., end-users) rather than
170 receiving service payments from the public sector. The procurement of social infrastructure
171 such as hospitals, especially in Australia, has been typically delivered using an availability-
172 based regime under the auspices of DBOM/DBFM/DBFOM contracts.
173
174 Six common themes emerge from an analysis of the PPP literature (Kwak *et al*., 2009; Liu *et*
175 *al*., 2015a): (1) roles/responsibilities of government; (2) concessionaire selection; (3) risk
176 identification and allocation; (4) cost/time efficiency; (5) project finance; and (6) critical
177 success factors (CSFs). There has, however, been a paucity of research that has attempted to
178 identify how to comprehensively measure the performance of PPPs even though it is pivotal
179 for ensuring Value for Money (V*f*M) for public clients throughout their life-cycle (Liu *et al.*,
180 2014). Research on the use of PMS in PPPs has been limited as not many has not yet

completed their operational phase and thus key performance indicators (KPIs) have not been developed.

PMS have not been forthcoming as there has been a tendency to only focus on time, cost and quality (TCQ) in construction (Raiseback *et al.*, 2010; Love *et al*., 2015). Nevertheless, with increasing demand for assets to add value during operations and maintenance and meet the needs to respond to 'climate change', their development has become a necessity. Table 1 presents a summary of key studies that have examined PPP performance measurement.

Table 1. Key research on PPP performance measurement

Authors	**Measures**
Grimsey and Lewis (2002)	Cost
Haskins *et al*. (2002)	Cost
National Audit Office (2003)	Time and cost
Amos (2004)	Cost, quality and technical efficiency
Fitzgerald (2004)	Cost
Sachs *et al.* (2005)	Cost
Blanc-Brude *et al.* (2006)	Cost
Anastasopoulos *et al.* (2010)	Cost
Raisbeck *et al.* (2010)	Time and cost
Anastasopoulos *et al.* (2011)	Cost

Such studies have attempted to evaluate whether PPPs are capable of benefiting the input (cost) or output (time) of infrastructure projects. However, limited attention is being paid to PPP performance measurement from a "process" perspective, which is concerning with the project's life-cycle deliverables (e.g., initiation and planning, construction, operation and maintenance) (Yuan *et al.*, 2009; Liu *et al.*, 2015a). Nevertheless, a delivery process synergized with public and private sectors enables PPPs to be unique and have an extremely dynamic business environment (Akintoye *et al.*, 2003; Yong, 2010). According to Love *et al.* (2015), a measurement approach that neglects to consider a "process perspective" will be unable to comprehensively capture the inherent complexities of PPPs.

Research Approach

Performance measurement can marry the ontology and epistemology of interpretivism, as practitioners' experience and insights can be considered when developing a new PMS (Neely *et al.*, 1997). To develop and test a PMS for PPPs, sequential triangulation (inductive-deductive) was adopted (Love *et al*., 2002), which involved initially undertaking a qualitative study using exploratory interviews followed by questionnaire quantitatively analysed applying *Confirmatory Factor Analysis* (CFA).

Qualitative Study: Exploratory Interviews

Research relying on interpretivism can either be quantitative or qualitative (Love *et al.*, 2002). Thus, exploratory interviews with key stakeholders of PPPs were initially conducted to understand current practice in performance measurement of PPPs. Interviewees' expert judgements were solicited to develop a 'Process Management Life Cycle PMS'. Meeting this objective through the use of interviews requires a sample size of 15 to 35 participants purposefully selected, who have specialized knowledge in the topic (Kumar, 1989).

A total of 25 in-depth interviews with senior practitioners who had been involved with the delivery of PPPs were undertaken over an eight-month period (Table 2). The interviews lasted from 60 to 90 minutes and were digitally recorded. Manuscripts were transcribed verbatim and then presented to each interviewee to verify their accuracy, correct errors or inaccuracies and provide clarification to comments that were made.

Table 2. Information of samples of interviews

Interviewees	**Number**	**Organisations**
Public clients	3	State Governments
Project managers	3	Construction
Architects/design managers	4	Architectural
Financial advisors	4	Capital Investment
Contract advisor	1	Contract Consulting
Legal advisors	3	Law Firms
Procurement advisors	3	Procurement
Operations managers	2	Asset Operations
Asset managers	2	Asset/Facility Maintenance

The interview questions focused on: (1) current PPP performance measurement; (2) the shortcomings of performance measurement of PPPs; and (3) direction for amelioration. At the beginning of each interview, an interviewee was asked to select a completed or on-going social PPP project with which they had been or were currently involved. The textural narratives compiled were analysed by using *NVivo 10* software package, which combines efficient management of non-numerical and unstructured data with powerful processes of indexing and theorising. The development and reassessment of themes as the analysis progressed accords with calls to avoid confining data to predetermined sets of categories (Silverman, 2006). Kvale (1996) suggests that *ad hoc* methods for generating meaning enable the researchers to access "a variety of common-sense approaches to interview text using an interplay of techniques such as noting patterns, seeing plausibility, making comparisons etc. (p.204)."

Quantitative Study: Questionnaire Survey and CFA

A questionnaire survey was adapted to examine the feasibility of the conceptual PMS derived from the interviews. The conceptual framework is integrated with measurement perspectives as well as their relevant KPIs. Using the questionnaire survey the following hypotheses were tested:

- $F^1 - H_0$: The measurement perspectives are *not significant* for measuring social PPPs.

  $F^1 - H_1$: The measurement perspectives are significant for measuring social PPPs.
- $F^2 - H_0$: The KPIs are *not significant* for measuring social PPPs.

  $F^2 - H_1$: The KPIs are significant for measuring social PPPs.

The questionnaire comprised of the following sections: (1) Background Information (i.e., respondents' experience, roles during PPP delivery and projects involved); (2) Performance Measurement Perspectives; and (3) KPIs used within each phase of a PPP project. As there had been a limited number of social infrastructure PPPs procured in Australia, purposive sampling was adopted to distribute the questionnaires (Foreman, 1991; Jin, 2010). Moreover, respondents from the public and private sectors were required to be knowledgeable of all aspects of a PPP lifecycle. As web-based survey tools are efficient for data collation and management (Nulty, 2008), the questionnaires were distributed to the selected respondents via *SurveyMonkey*.

Using a 5-point Likert scale respondents were asked to draw upon their experience and knowledge to identify the significance of the performance measures and KPIs that had been derived. The data was analysed by using CFA, which is within the scheme of *Structural Equation Modelling* (SEM). It is a multivariate process formulated to examine how well the

variables being measured represent their construct(s). The process to conduct the analysis was adapted from Yuan *et al.* (2012), which is presented in Figure 1. Notably, insignificant items observed were eliminated from the conceptual PMS according to the 'factor loadings' (i.e., coefficients) of the CFA structural models.

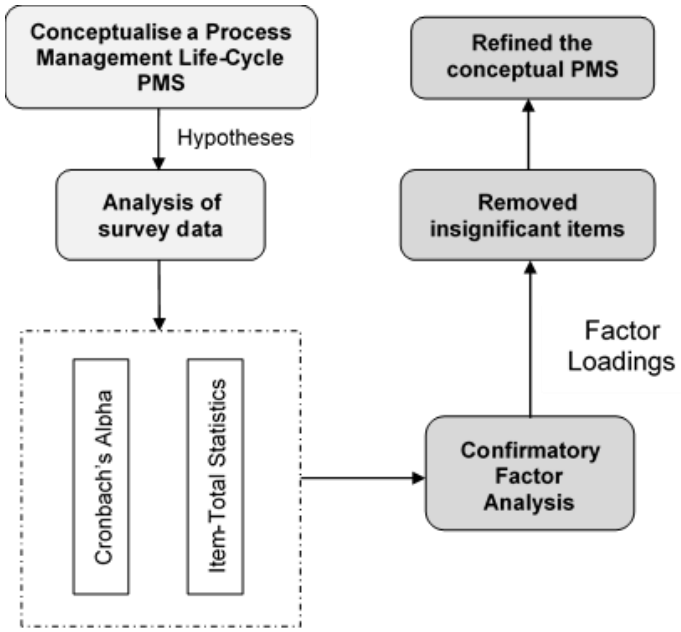


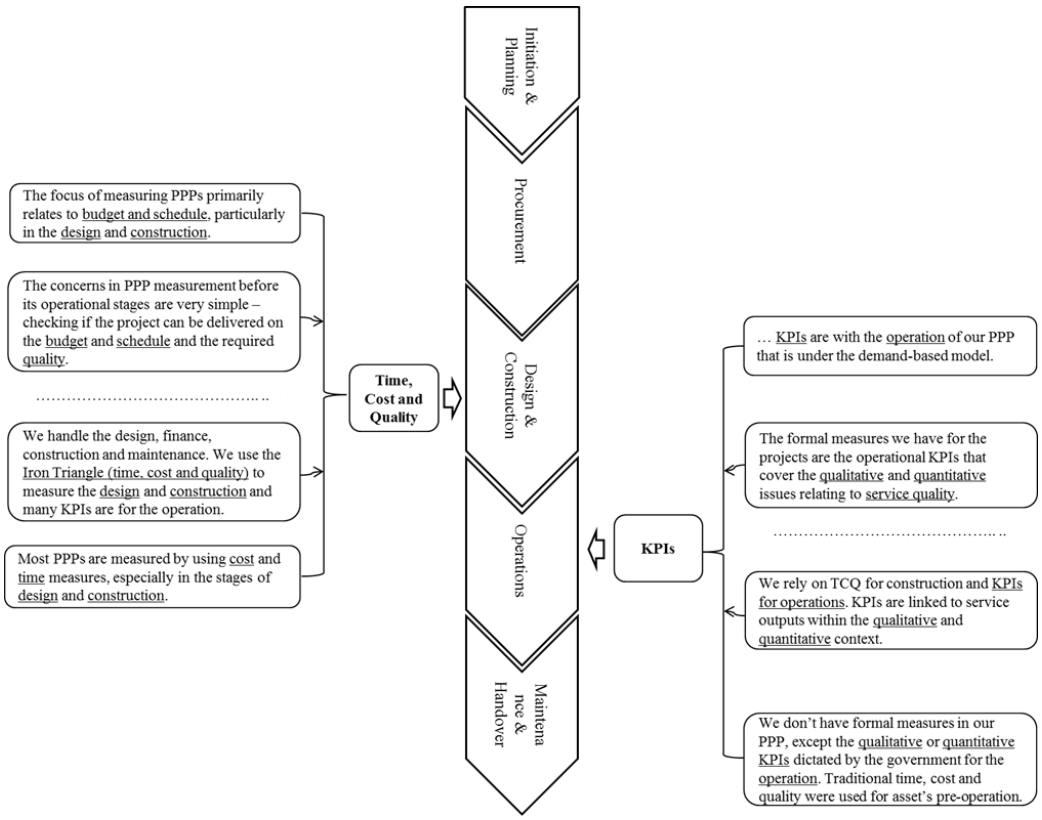
Figure 1. Data analysis process (adapted from Yuan *et al.* (2012))

CFA is a theory-driven technique, relying on a pre-constructed knowledge. It aims to confirm theoretical relationships rather than to explore the linkages between the observed items (Schreiber *et al.*, 2006). In particular, CFA is suitable for examining the feasibility of a conceptual model developed from a qualitative study or an in-depth literature review (Yuan *et al.*, 2012). The configuration of CFA is formed according to the theoretical interrelationships between observed and unobserved variables. Mathematically, CFA can be represented as:

$$y_i = \nu + \Lambda\eta_i + \varepsilon_i \quad \text{(Eq.1)}$$

where ν is a vector of intercepts; Λ stands for a matrix of factor loadings; η_i represents

285 factor values; and ε_i denotes the vector of residual values. CFA has been widely used in a
286 variety of types of research and considered to be a robust tool for the hypothesis testing
287 undertaken for factor analytical problems (Yuan *et al.*, 2012).
288
289 **Understanding Current Practice in Performance Measurement of PPPs**
290 Information derived from the interviews indicated that performance measurement of a PPP
291 project is comprised of two parts: (1) an evaluation for design and construction; and (2) a
292 measurement for asset operation. Put simply, as noted by the interviewees, design and
293 construction in PPPs are primarily evaluated by using TCQ, which are referred to as the 'Iron
294 Triangle' in project management. Contrastingly, measurements for operations of a built asset
295 are dependent on a series of KPIs, which are determined and agreed between stakeholders. A
296 summary of the key findings derived from the interviews is presented in Figure 2.
297



298
299 Figure 2. Current practice in performance measurement of PPPs

Deficiencies of Current PMS within PPPs

Existing performance measurement that are applied to social infrastructure PPPs were deemed to be myopic as they focus on TCQ. As a result, there is a tendency for long-term needs of stakeholders to be overshadowed, particularly in the case of schools or hospitals (KPMG, 2008). This was acknowledged by a design manager who stated:

> "Delivering a PPP on time and on budget is very important, but there may be a need for measures to capture some intangible factors, for example, innovation in design. This is actually what the private sector should bring to a public project, but the approach we are using cannot reflect it."

Reflecting on the use of TCQ as a measure, a senior financial advisor proffered that the V*f*M assessment considered by the *Public Sector Comparator* (PSC) offers a mechanism for *ex-ante* evaluation which intends to provide the business case for PPPs and then enable potential non-financial benefits to be considered. However, it was made explicit that no mechanism was in place to measure whether nor not value and non-financial benefits were being attained. This issue has been repeatedly identified as a failing of PPPs, with an *ex-post* evaluation simply being a review of the final product rather than an assessment of the project's entire performance (EIB, 2011b; Haponava and Al-Jibouri, 2012). A financial advisor interviewed stated that the lack of performance measures of non-financial benefits in *ex-ante* evaluation adversely impacts decision making and hinders the realisation of V*f*M.

There were insufficient measures for systematically evaluating the 'intangible' issues that are critical to successful design/construction of the projects, for example, innovation, asset

sustainability and key stakeholder expectation. The public sector not only relies on private-sector entities to financially invest in infrastructure, but also draws on its expertise to engender innovation and develop a sustainable asset that is able to meet and possibly exceed stakeholders' needs.

Attention is drawn to Grimsey and Lewis's (2004) definition of V*f*M, which defines that "the optimum combination of whole-of-life-cycle costs, risks, completion time and quality in order to meet public requirements" (p.1); here emphasis is placed not only on time and quality, but ensuring minimal maintenance and sustainability during operations as well as public expectations. According to Grimsey and Lewis (2005) and EIB (2011b), too much emphasis is placed on the financial benefits that can be acquired from PPP projects; more importance needs to be placed on non-financial measures that examine social benefits to the community. Previous research supports this view, as PPPs have tended to act as drivers of non-financial benefits (i.e., in terms of asset design, choice of construction methods, material selection multi-functionality and contextual fit), therefore can significantly contribute to lowering the cost and risks or improving the physical outcomes (Himmel and Siemiatycki, 2017; Van den Hurk and Hueskes, 2017).

An effective and efficient PMS can provide a PPP with the drive and direction towards the achievement of its strategic goals and the basis for decision-making. Within a PPP, key areas of focus (i.e., critical success factors) are defined and used to identify the needs of key stakeholders. In fact, KPIs are a mechanism for ensuring the needs of stakeholders have been satisfied. The interviewees (n=23) stated that KPIs are only specific to the operation in PPPs, though it was acknowledged that they should be distributed to other key areas such as initiation, design, construction and facility maintenance (FM). This is because KPIs can indicate the key areas needed to be improved, though they were deemed to be 'static' and

unable to respond to changing conditions of the operation of the built asset.

An effective PMS must reflect the context where the relevant organisation operates; yet it would appear that this issue has not been adequately considered. Within the State of WA, a significant number of PPPs are now in operation. The KPIs being used were devised prior to the construction stage of the project. Therefore, the sustainability of such operational KPIs was deemed questionable by some interviewees. The interviewees defined the sustainability of KPIs in PPPs by their ability to be relevant and accommodate changes to an asset over its life. For example, PPP procurement director stated that "some private prisons in Australia are still currently under the KPIs that were designed in the 1990s though the capacities of the assets have been modified."

This experienced professional considered the operational KPIs of PPPs to be unsustainable to accommodate the change within the local business environment. A number of issues other than KPI sustainability emerged during the interviews with the two procurement advisors. For instance, limited attention was being given by public sector to measure project's performance during its inception stages (e.g., business case, planning and procurement). This can contribute to substantial delays and budget overruns being experienced. For example, the Victorian Comprehensive Cancer Centre in Melbourne, Australia, took more than 25 months to reach financial close (Victoria Department of Treasury and Finance, 2012). Further, the process of measuring an asset's impacts on the public (i.e., local communities) had not been considered and most likely would not be, as this would require a modification to the contractual conditions that were in place. Also, the scope of operational KPIs is limited, being unable to indicate whether the long-term success of the project has been achieved. In recognising these, an operation manager suggested:

375

376 "The KPIs for operations of PPPs are too narrow. The indicators about long-term
377 impacts of the procured assets/facility on the public (i.e., local communities/regions)
378 are being overlooked, though they are very important. The government will have to
379 carefully consider how to design them."

380

381 The views that were derived from the interviews about the practice in PPP performance
382 measurement above can be summarised as follows: (1) traditional TCQ is unable to capture
383 CSFs and uncertainties that exist in PPPs; (2) the financial-based assessment for V*f*M cannot
384 completely reflect potential non-financial benefits provided by PPPs; (3) operational KPIs are
385 not applicable to reflect whether or not all key stakeholders' expectation have been met within
386 a long-term period; (4) no formal mechanism is available for refining the launched KPIs; (5)
387 gaps are in systematically measuring the preliminary outputs of PPP projects; and, (6) the
388 social impacts of the assets are substantially ignored.

389

390 **Improving Performance Measurement System of PPPs**

391 While acknowledging performance measurement is an imperative and there is a need for
392 amelioration, interviewees were pessimistic that such an initiative would be implemented.
393 Inertia of this nature appeared to stem from political unwillingness, structural rigidity
394 hampered by contractual conditions and the absence of technological innovation. In WA, for
395 example, the economic environment has changed as a result of the falling price of iron ore, oil
396 and a reduction in the Goods and Services Tax. A rapid fall in revenue to the State's budget
397 has resulted in a reduction of infrastructure spending and therefore PPPs have become a
398 valuable proposition for new infrastructure investment. A procurement director of the state
399 government suggested "now it's possibly the right time to address performance measurement

400 in PPPs so we can look at future proofing our assets".

401

402 *Process-based Measurement with Life-Cycle Learning Mechanism and VfM*

403 Most interview respondents (n=18) proffered that the PMS devised for PPPs need to address a
404 life-cycle perspective so as to be able to accommodate inherent uncertainties (e.g., those
405 relating to documentation, financing, taxation and technical details) that can materialise from
406 the *pre-construction* phases of a project. In stark contrast, the procurement director of state
407 government and an experienced financial advisor considered that a life-cycle approach for
408 measuring PPPs was cumbersome to implement due to the complexity associated with the
409 stakeholder network and a project's longevity. However, innovative ideas to overcome such
410 hurdles were promulgated. A leading procurement consultant suggested that a process-based
411 evaluation is ideal for addressing a life-cycle perspective to measuring PPPs.

412

413 A process-oriented approach is akin to the use of 'stage gates' and focuses on measuring the
414 deliverable (i.e., tangible and intangible deliverables or outputs) of each project phase using a
415 sequence of KPIs. This approach was reiterated by an architect, suggesting that "PPPs should
416 be measured against the whole development processes of the projects rather than the finally-
417 procured assets." The whole process of a PPP is complex and uncertain due to their long-term
418 contractual arrangements (up to 25 years). In addressing this issue, a procurement advisor
419 interviewed suggested that a robust learning mechanism is required to support a
420 comprehensive performance measurement in PPPs. He stated:

421

422 "It is necessary for constantly refining the performance measures through an
423 implementation of a learning mechanism, because the asset, macro environments
424 and technology are subject to changing conditions over the project's life-cycle. This

mechanism must be useful and robust for helping the client and SPVs to effectively and efficiently absorb the lessons learned from external and internal environments to identify what actions should be taken for improving outputs and renewing/updating existing KPIs to enhance the effectiveness of the project's PMS. And, a balanced abatement regime considering both public and private sectors' benefits might be requested as well for supporting a life-cycle evaluation of PPPs."

Interviewees who advocated a life-cycle performance measurement indicated that a realistic V*f*M assessment, which can be integrated with tangible and intangible issues was required to underpin this approach. Thus, it may be essential to place a strategic emphasis on the creation of V*f*M with its evaluation for both quantitative and qualitative outputs. Thus, a consideration of the contribution of a PPP to the local community will be required, for example, in the case of a school, its ability to enhance educational quality, and for a hospital to improve local/regional healthcare level. As stated by many interviewees (n=14), V*f*M is referred to as whether or not the built asset can be continuously valued throughout its lifecycle.

Stakeholder-Oriented Performance Measures

A process-based performance measurement during a project's lifecycle needs to reflect the deliverables produced from each project phase. Bearing these considerations, then "what type of performance measures should be devised in a life-cycle PMS for PPPs?" It has been acknowledged that a complex stakeholder network acts as one of the defining features of PPPs. The majority of the interviewees (n=19) stated that a stakeholder orientation was a rational strategy for designing performance measures. The stakeholder-oriented measures should not only examine satisfaction, but also expectations and commitments. The public, who are customarily asset end-users or consumers, is a pivotal component of the stakeholder

network. Therefore, their needs must be married with the measures of a PMS. Furthermore, a contract management adviser reinforced the requirements to enable employees to be satisfied throughout the asset's operational phase, especially the impact that changing technology and functional use can have morale and productivity.

A number of interviewees (n=13) also considered that measuring the performance of PPPs is challenging as both public- and private-sector organisations needed to be considered. Therefore, the fundamental capabilities of the involved organisations should be addressed as the measures in the project's performance measurement (e.g., the private-sector entity's financial infrastructure, skilled workforce, structure of service team and internal learning mechanism). They stated that these issues are useful for key stakeholders in a PPP to identify what problems are pertaining in the project and what actions will have to be taken for future.

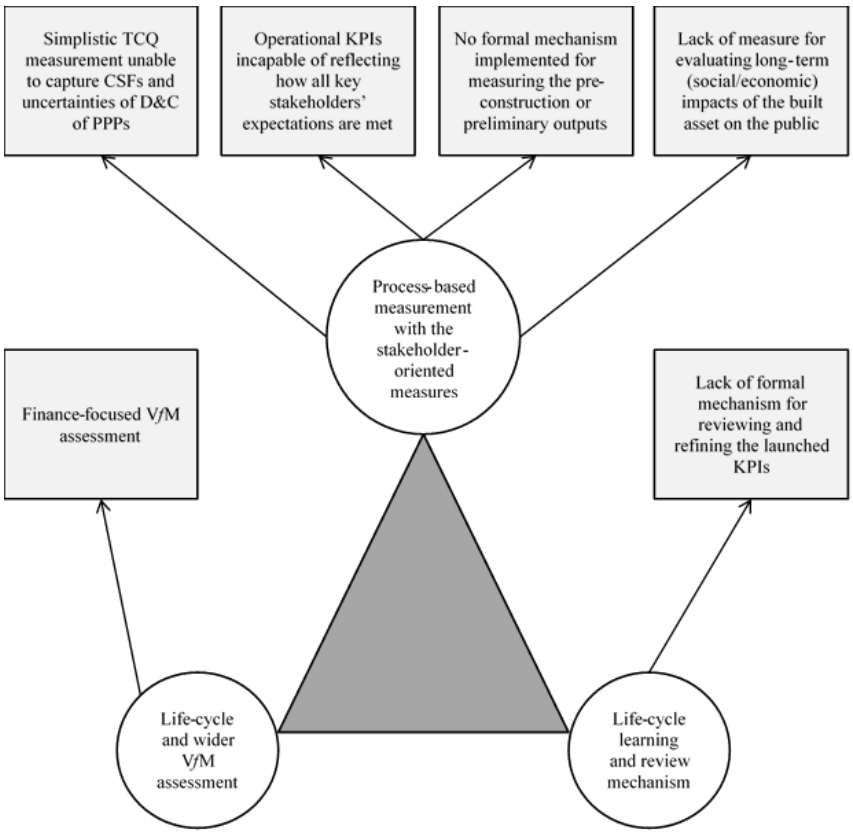


Figure 3. Recommendations for improving current PPP performance measurement

In summary, a sequence of recommendations is proposed from the interviewees for ameliorating PPP performance measurement. These include an implementation of a process-based measurement, which is supported by the stakeholder-oriented measures as well as a life-cycle learning mechanism and V*f*M assessment. Figure 3 illustrates how these perspectives are able to contribute to addressing the problems that are innate within the current practice of PPP performance measurement.

Process Management Life-Cycle Framework and Relevant KPIs

From the interview findings, a process-oriented framework that is integrated with stakeholder-oriented measures for evaluating performance of PPP project was developed (Figure 4). The framework is comprised of a total of five measurement perspectives: (1) stakeholder expectation measures; (2) stakeholder commitment measures; (3) project delivery process; (4) project strategic goal (i.e., life-cycle V*f*M); and (5) foundations of the involved organisations (i.e., capabilities of public authority and private SPV). Learning and process-based measurement mechanisms underpin this framework. The developed framework, denoted in Figure 3, is contextualised according to a PPP's lifecycle and presented in Figure 5.

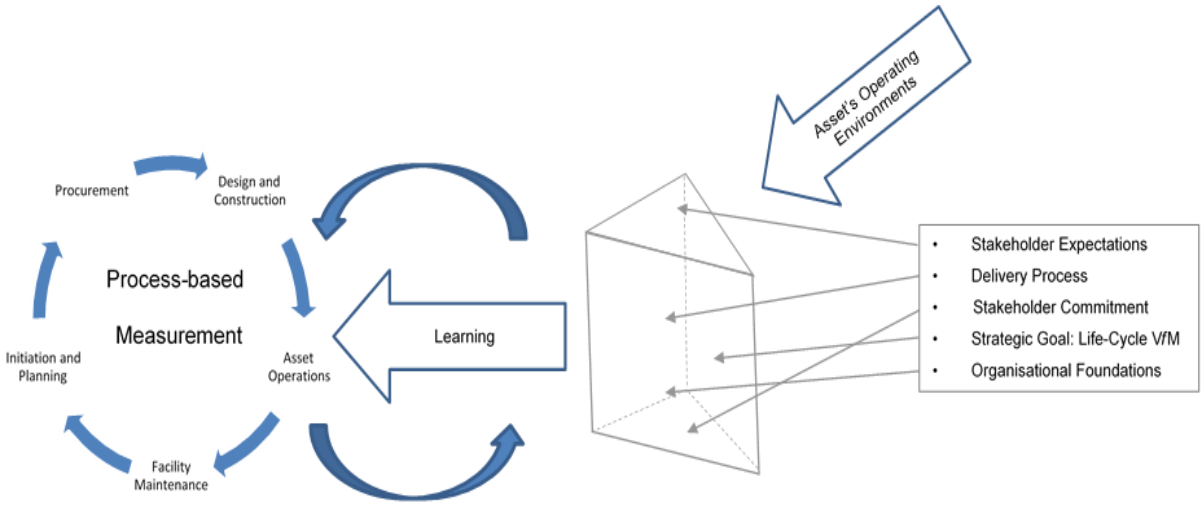


Figure 4. Process Management Life-Cycle Framework (adapted from Neely *et al.* (2001))

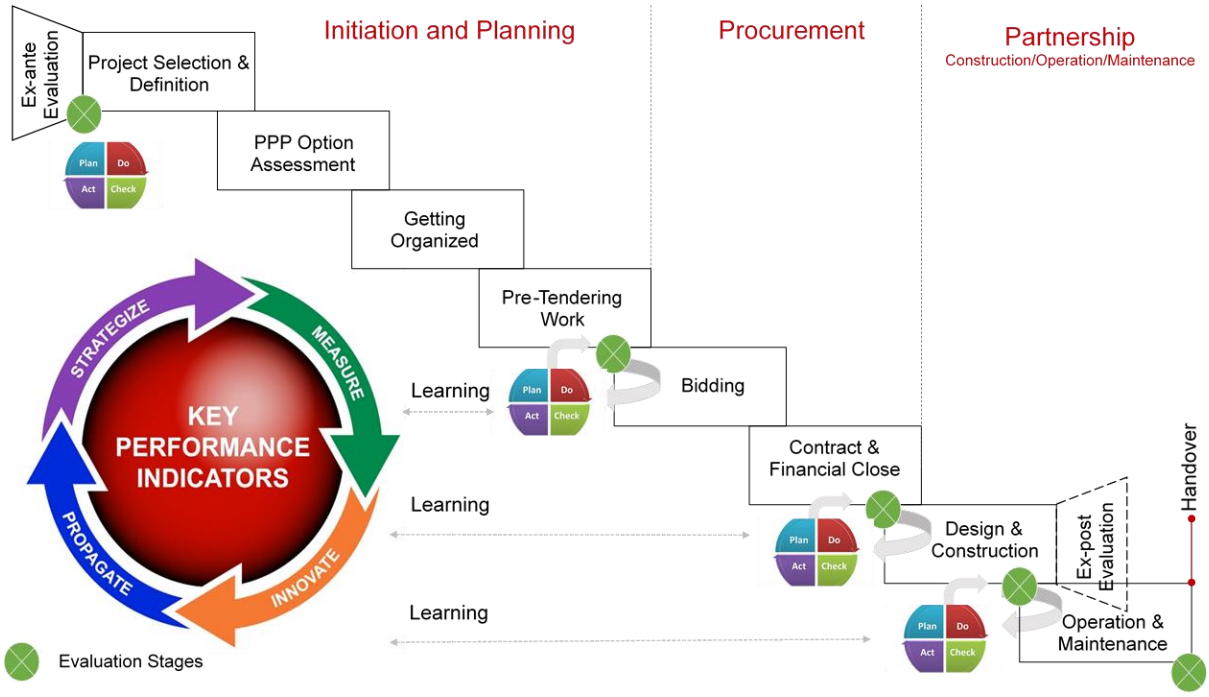


Figure 5. Process Management Life-Cycle PMS for PPPs

A sequence of KPIs can be derived according to the measurement perspectives of the proposed PMS (e.g., key stakeholder expectation, project strategic goal, delivery process and key stakeholder expectation) (Appendix 1). Life-cycle V*f*M in terms of 'future proofing' of the built asset has been identified as a strategy of PPPs from the exploratory interviews. V*f*M is conventionally defined as 'the optimum combination between the project's whole life cost and quality' (Office of Government Commerce, 2002). Nevertheless, it was implied from the interviews that a life-cycle approach to enabling V*f*M refers to not only the cost and quality of a project, but also an asset's long-term ability to continue to be value into the future (i.e., future proofing). Thus, KPIs relevant to the 'facet' of 'Strategic Goal' in Appendix 1 ($KPI_{F2\text{-}1}$ to $KPI_{F2\text{-}3}$) are underpinned by this concept.

Furthermore, the key stakeholders of a PPP throughout the project's life-cycle include public client, concessionaire, subcontractor(s), creditors (i.e. banks), shareholders, suppliers and end-users of the built asset (EIB, 2011a). As a consequence, KPIs relevant to the stakeholder's expectation and commitment encompass public client's expectation on innovative design and construction and sub-contractors'/suppliers' performance (e.g., KPI_{F1-1} to KPI_{F1-12} and KPI_{F5-1} to KPI_{F5-12}). Notably, skilled employees, for example, procurement/legal/financial advisors, engineers and facility management (FM) professionals were identified as key stakeholders of a PPP; thus, KPIs with their expectations/commitments (i.e., KPI_{F1-2}, KPI_{F1-4}, KPI_{F1-6}, KPI_{F5-3}, KPI_{F5-5} and KPI_{F5-10}) were proposed. Bourne *et al.* (2003) supports this point of view and has argued that employees are key stakeholders within the organisation as their performance is correlated to the organisational performance.

Additionally, a sequence of process KPIs was derived. The indicators devised to measure the effectiveness of delivery process of PPPs need to capture the works to be completed in each phase of the projects (Liu *et al.*, 2015a). Essentially, a number of interconnected tasks can be identified throughout PPP development process, for example, evaluation for macroeconomic conditions, risk analysis/allocation, selection of concessionaire, finance close, asset's design, construction and operations/maintenance. Hence, KPIs under the process perspective of the developed PMS relate to the works listed above.

Interface management (IM) is derived as the KPIs that have been emphasised across all phases of the life-cycle of a PPP project (KPI_{F3-9}, KPI_{F3-13} and KPI_{F3-24}). IM is the management of communication, coordination, and responsibility across a common boundary between two organizations, phases or physical entities which are interdependent. PPPs are the

projects that incorporate complex phases and are synergised by public authority and multiple private entities. The importance of IM in PPPs has been acknowledged by academia and practitioners (Chan *et al.*, 2005). Moreover, the organisational foundations of the public authority and private-sector entity involved with PPPs have been considered by interviewees above to be a focus of performance measurement of the projects. Therefore, a total of 15 relevant KPIs were identified ($KPI_{F4\text{-}1}$ to $KPI_{F4\text{-}15}$), such as skilled workforce, technological innovation, training and learning mechanism/system and knowledge management ability.

Testing the Process Management Life-Cycle PMS

To test the feasibility of the developed the Process Management Life Cycle PMS, a CFA with the questionnaire-survey data was performed. A pilot survey was undertaken with 28 senior professionals within the Australian PPP industry in order to pre-examine the effectiveness of the research instrument. The responsive rate of the pre-survey achieved 89% (25 out of 28), which comprised of: (a) public sector: procurement consultants (6) and financial advisors (5); (b) private sector: architects (3), project managers (5), operation managers (3) and FM managers (3).

After the pilot survey, 368 questionnaires were distributed to practitioners from the public and private sectors across Australia. A total of 141 responses had been received, 6 of which had to be discarded because of incompleteness. As a result, 135 valid datasets were used for quantitative analysis and the sample information is indicated by Table 3. While 63 respondents (47%) were associated with the public authorities, the remaining 72 (53%) served for the private-sector entities within PPP projects. Ideally, CFA, which is under SEM, relies on a larger sample size; however, numerous studies have run CFA under a sample smaller than 200 (Chinda and Mohamed, 2008; Aibinu *et al.*, 2011; Rajeh, 2014). As identified by

551 Bagozzi and Yi (2012) and Molwus (2013), a sample size ranging from 100 to 200 is
552 acceptable for SEM.
553
554
555
556 Table 3. Questionnaire survey samples

Groups of sample	Distributed	Received	Response rate (%)
Public sector:			
Business case study	40	26	65.00%
Procurement	71	22	30.99%
Contract Management	62	15	24.19%
Private sector:			
Design	46	13	28.26%
Construction	59	20	33.90%
Operations	51	18	35.29%
Maintenance	39	21	53.85%
Total:	368	135	36.68%

557
558 The reliability of the research instrument was then tested by using *Cronbach's* α. A α value
559 that is greater than 0.70 indicates a reliable measurement of a construct (Scott, 1981). The
560 corrected item-total statistics were used with the α value throughout the reliability tests to
561 identify what items would have to be discarded in subsequent modelling. The items being
562 observed in a research instrument must be discarded if the values of their corrected item-total
563 statistics cannot exceed 0.30 (Nunnally and Bernstein, 1994).
564
565 According to α values derived from the entered dataset, a total of 4 items (e.g., KPI_{F1-1}, KPI_{F3-2}, KPI_{F3-14} and KPI_{F5-4}) had to be excluded from the Process Management Life-Cycle PMS,
567 because their corrected item-total statistics were below the threshold value of 0.30. Again, the
568 reliability test had been performed after eliminating aforementioned items. The results show
569 that modified instrument has a higher α value of 0.97 and the increased item-total statistics

570 ranging from 0.36 to 0.81. The empirical evidences indicate a high degree of internal
571 consistency, suggesting that the questionnaire was reliable (Tabachnick and Fidell, 1996).
572
573 A CFA was run after *Cronbach's* α value tests. As mentioned above, CFA possesses the
574 theory-oriented nature regarding observed and unobserved variables. Thus, based on the
575 developed Process Management Life-Cycle PMS (Figures 4 and 5), the measurement
576 perspectives and their relevant KPIs addressed as the observed variables, while the
577 deliverables/outputs of each project phase of PPPs are viewed as the unobserved variables.
578
579 A hypothesised model of CFA (Figure 6) was initially formulated to estimate a covariance
580 matrix of the survey population, which is used for comparing with an observed covariance
581 matrix. In other words, this model was constructed for a purpose of examining whether or not
582 the observe items (for example, measurement perspectives and KPIs) were significant to be
583 implemented for measuring PPPs. Noteworthy, the items with comparatively low factor
584 loadings (i.e., coefficients) that were under 0.40 were eliminated to modify the initial model
585 and develop an optimal one.
586
587 The CFA-hypothesised model is capable of capturing the Process Management Life- Cycle
588 PMS, in which the process-based KPIs are under five measurement perspectives assumed to
589 be causally significant to PPP performance. The path arrows and the coefficients in Figure 5
590 are deemed to be the causal effects in terms of the contributions of the observed items to the
591 outputs/deliverables of each phase and entire project life-cycle performance. Based on Figure
592 6, the factor loadings of all performance measurement perspectives (e.g., P1: Key Stakeholder
593 Expectation; P2: Project Strategic Goal; P3: Project Delivery Process; P4: Organisational
594 Foundations; and P5: Key Stakeholder Commitment) that are emphasised by the developed

PMS (Figures 4 and 5) are 0.78, 0.82, 0.77, 0.75 and 0.76. These coefficients are under 5% significance level, indicating that the perspectives proposed are significant to evaluate the performance of PPP projects.

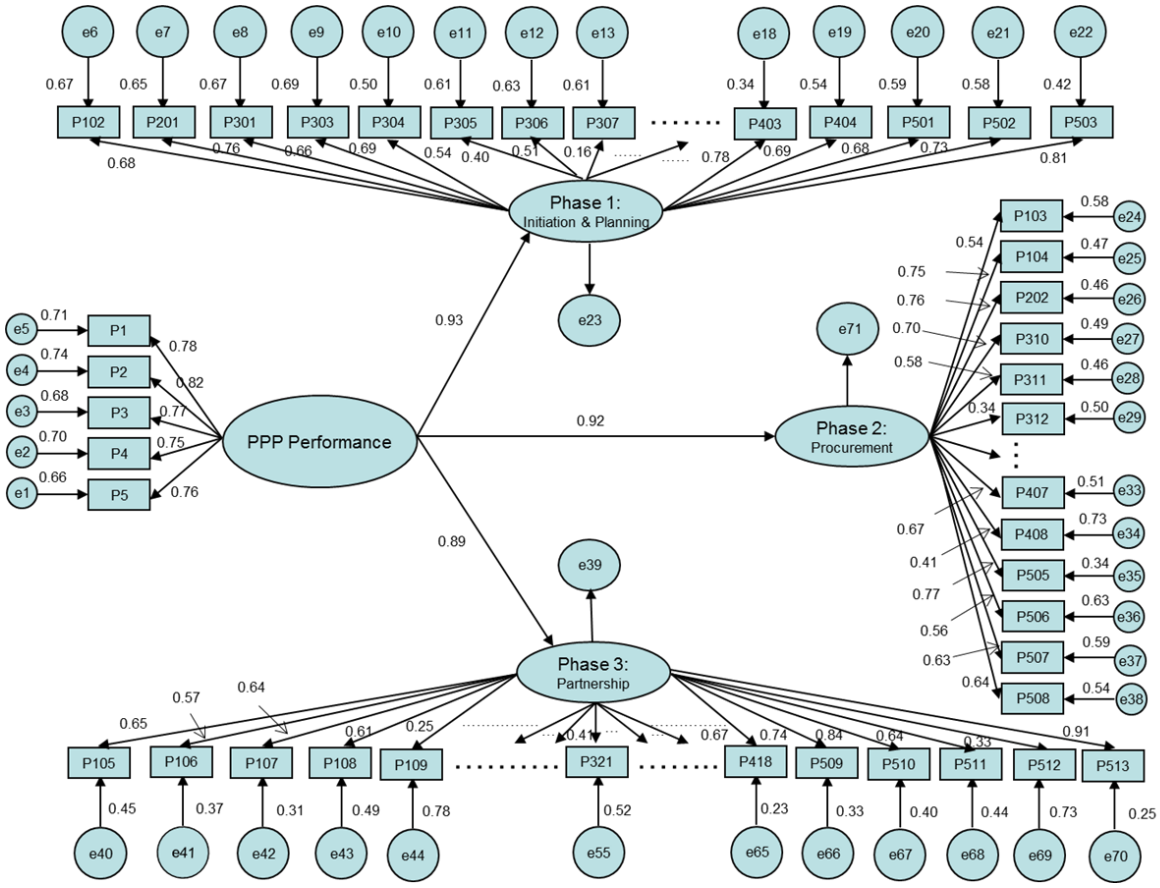


Figure 6. Initially-hypothesised model of CFA

A series of important implications are able to be derived from the empirical evidence relating to KPIs. For instance, in the pre-construction phases (Phase 1: Initiation and Planning; Phase 2: Procurement), the coefficients of most KPIs are larger than 0.50 and are significant at 5% significance level. This implies that the majority of the observed KPIs are valuable for measuring PPPs. However, such four KPIs as P305 (KPI_{F3-5}), P307 (KPI_{F3-7}), P312 (KPI_{F3-12}) and P408 (KPI_{F4-8}), were identified to be statistically insignificant, due to their comparatively

low factor loadings, that is., 0.40, 0.16, 0.34 and 0.42, respectively.

The procurements of PPPs across Australia are underpinned by the auspices of well-designed national guidelines and process to enabling V*f*M is obtained (Infrastructure Australia, 2008). Therefore, the Australian state governments and an array of private entities have acquired considerable experience in delivering PPP projects. There exists a high degree of familiarity with resolving the issues with financing options, design of an appropriate concession period, governance of tendering and financial close. This may explain why the KPIs of PPP's for the finance option ($KPI_{F3\text{-}5}$), concession period ($KPI_{F3\text{-}7}$), financial close efficiency ($KPI_{F3\text{-}12}$) and the government's ability in governing procurement phase ($KPI_{F4\text{-}8}$) were considered to be insignificant by the respondents.

The empirical evidence generated by CFA also indicate that the coefficients of most KPIs under the *Partnership* phase (i.e., Phase 3) of PPPs exceed 0.50, except P109 ($KPI_{F1\text{-}9}$), P321 ($KPI_{F3\text{-}21}$) and P512 ($KPI_{F5\text{-}12}$), which have factor loading values of 0.25, 0.41 and 0.33, respectively. When the research was conducted, it was suggested that the effects of building product suppliers can be ignored when measuring a PPP's performance. A possible reason for this situation was due to the stability of the Australian construction materials market. Due to a decline in demand from China for minerals such as iron ore, material prices have fallen. The private consortia of PPPs have rarely faced challenges of unavailability/shortage of essential raw building materials during the delivery of their projects. This view is supported by the data issue by the *Australian Bureau of Statistics* (ABS) (2016), which indicates that the building material market in Australia is stable.

In Figure 6, profitability is identified as an insignificant KPI. As addressed above, the

delivery of social infrastructure PPPs, particularly such projects as hospitals, prisons and schools, is normally under the availability-based model. In this instance, private entities rely on service payment received regularly from the government (i.e., monthly or quarterly) for maintaining the availability of the facilities rather than the profits yielded by the operations of the assets. The public and private sectors in social PPPs are concerned with effective and efficient delivery of the projects with quality outputs/outcomes, rather than an enhancement of revenues generated by the assets (Yong, 2010). Hence, project profitability as a KPI is not as important in Australian PPPs as in the projects in some other countries where the demand-based PPP regime plays a major role.

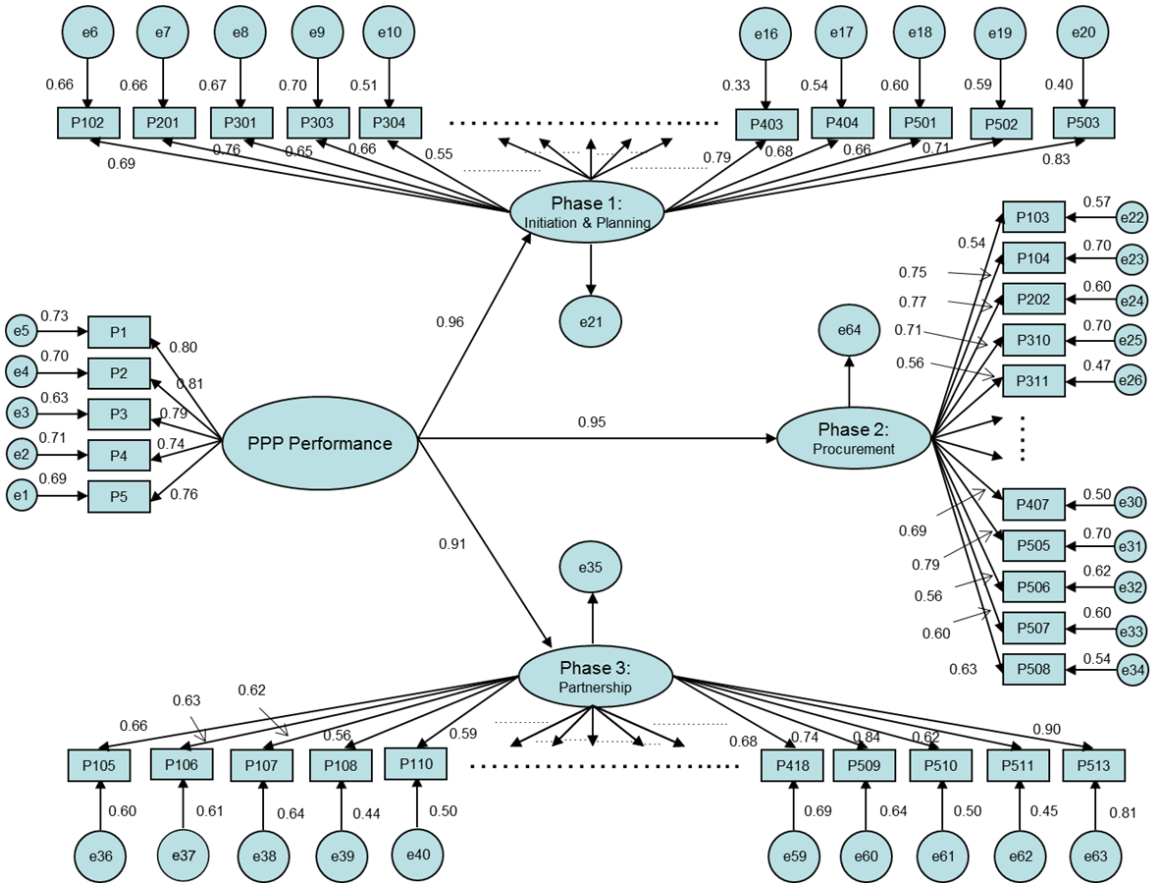


Figure 7. Optimally-revised model of CFA

An optimally-revised model was constructed after removing a set of insignificant KPIs (e.g.,

$KPI_{F1\text{-}9}$, $KPI_{F3\text{-}5}$, $KPI_{F3\text{-}7}$, $KPI_{F3\text{-}12}$, $KPI_{F3\text{-}21}$, $KPI_{F4\text{-}8}$, and $KPI_{F5\text{-}11}$) (Figure 7). As illustrated it, the factor-loading values of all observed items (i.e., five performance measurement perspectives and 60 KPIs) in the CFA optimal model are larger than 0.50 and are significantly correlated to the project performance of PPPs at 5% significance level.

Theoretically, an examination of the fit of CFA model depends on three Goodness-of-Fit Indexes (GFIs), including *Chi-squared* (x^2) statistic, *Comparative Fit Index* (CFI) and *Root Mean Square Error of Approximation* (RMSEA). Goodness-of-Fit Indexes are widely being used to indicate how well the structural model fits observations (Sanders *et al.*, 2006). Table 4 provides the benchmark values of such GFIs. The constructed structural model is deemed to be 'fitted' if its GFIs are within the intervals of the benchmark values.

Table 4. Benchmark values for examining the CFA model

Goodness-of-Fit Indexes	**Benchmark Values**
x^2	$1 \le x^2/Df \le 5$
CFI	≥ 0.90
RMSEA	$0.05 \le$ Good Model Fit ≤ 0.1

The GFIs of the CFA optimal model (Figure 7) are 2.32 (*Chi-squared* statistic), 0.92 (CFI) and 0.076 (RMSEA), which indicate a good model fit. Therefore, the proposed measurement perspectives are all significant; 60 out of 71 derived KPIs passed the quantitative tests. These findings rejected the null hypotheses of the questionnaire survey that were proposed from the interviews and confirmed the feasibility of the developed Process Management Life-Cycle PMS (Appendix 2 for the refined KPI dataset).

Discussion

A Process Management Life-Cycle PMS of PPPs has been quantitatively tested above through

671 the use of CFA. Due to its characteristics, the developed system is capable of enabling PPPs
672 to realise long-term success by substantially improving the deliverables of each project phase.
673 The learning mechanism and process- and stakeholder-oriented measurement perspectives of
674 the Process Management Life-Cycle PMS not only enhances the suitability and applicability
675 of the KPIs, but also positively affect the project's planning, design, construction, operation
676 and facility maintenance. These can contribute to improving the sustainability of an asset and
677 increase end-user's satisfaction, enabling PPPs to provide V*f*M over the long-term period.
678
679 The empirical results of the strategic goal factor loading values for the KPIs are high
680 throughout a projects' lifecycle (Phases 1 to 3), ranging from 0.75 to 0.77 (Figure 7). Based
681 on this finding, it is reliable to argue that the concept of future proofing needs to be addressed
682 in performance measurement of PPPs. This complies with the view of Love *et al.* (2015), who
683 have suggested that future proofing is critical for the long-term sustainability of infrastructure
684 procurement.
685
686 As noted in Figure 5, additional factor loadings of the three phases of PPP projects were 0.96
687 (Initiation and Planning), 0.95 (Procurement) and 0.91 (Partnership). These values indicate
688 that the outputs of all major PPP phases are significantly correlated to the successful delivery
689 of projects. The coefficients of Phases 1 and 2 are larger than that of Phase 3. The traditional
690 approach to project evaluation has identified the partnership phase of a PPP as the most
691 significant for contributing to a project's success (Yong, 2010; EIB, 2011a). The findings from
692 this research, however, suggest that the quality of the deliverables of pre-construction works
693 (e.g., business case, V*f*M assessment, bidding and contract negotiation) is just as important.
694 Thus, performance measurement of PPPs should be wider in scope and cover all phases of a
695 project's lifecycle, rather than simply focusing on construction and operations. The empirical

696 evidence derived from CFA confirms that the perspective developed from the interviews may
697 enable improved performance measurement and management through a PPP lifecycle that
698 encapsulates stakeholder-focused measures. Moreover, the proposed approach is underpinned
699 by a learning mechanism that can enable the client and SPV to enact continuous improvement
700 as the project progresses each phase of its life-cycle.
701
702 ## Conclusions
703 It has been widely acknowledged that there is paucity of effective PMS, which has
704 contributed to the poor performance of PPPs. In addressing this issue, a total of 25
705 exploratory interviews with experienced professionals were undertaken to understand the
706 current practice of performance measurement of PPPs. It was revealed that existing PPP
707 performance measurement is referred to as the product-oriented evaluation focusing on
708 construction TCQ as well as the operational outputs of the asset. In addition, there was a lack
709 of a formal mechanism for measuring pre-construction activities such as the business case,
710 tendering/bidding and contract negotiation.
711
712 From interview findings, a Process Management Life-Cycle PMS was developed and tested
713 by using CFA via a questionnaire survey. The analysis of the survey findings indicates that the
714 developed framework accurately reflected practitioners' aspirations for future performance
715 measurement for PPPs. The Process Management Life-Cycle PMS accommodates the
716 nuances of the dynamic business environment within which infrastructure is procured. It
717 incorporates performance measures to support a process and stakeholder-orientation as well
718 as a life-cycle learning mechanism.
719
720 The research presented in this paper not only contributes to body of knowledge of PPPs, but

721 also supports the development of performance measurement for organisations operating in a
722 complex network. The Process Management Life-Cycle PMS can provide governments and
723 private-sector entities that are embarking on PPPs with a robust tool to enhance the outputs
724 and outcomes of their assets' development, production and operation. Future research,
725 however, is required to accommodate a balanced abatement mechanism, which should form
726 an explicit function of the proposed PMS so that it can be utilized in practice. In particular,
727 emphasis will need to be placed on developing incentives so that the SPV are able to
728 understand, control and minimize availability and performance risks, and therefore enhance
729 V*f*M for the public sector client. With payment mechanisms being effectively calibrated and
730 service delivery monitored and measured using the framework provided by the Process
731 Management Life-Cycle PMS, the likelihood of PPP contracts providing long-term value to
732 all stakeholders will be engendered.
733

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739

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Appendix 1. Conceptually-derived KPIs for the developed life-cycle PMS for PPPs

Phases / Perspectives	**Initiation and Planning (Phase 1)**	**Procurement (Phase 2)**	**Partnership (Phase 3) (Construction, Operation and Maintenance)**
Key Stakeholder Expectation (P1)	KPI_{F1-1}: Public client's expectation on asset's feasibility, constructability and maintainability KPI_{F1-2}: Skilled employees' expectation on promising work environment	KPI_{F1-3}: Public client's expectation on experienced bidder with a rational proposal KPI_{F1-4}: Skilled employees' expectation on promising work environment	KPI_{F1-5}: Public client's expectation on innovative D&C and quality output KPI_{F1-6}: Skilled employees' expectation on promising work environment KPI_{F1-7}: Main contractor's expectation on on-budget and on-time delivery KPI_{F1-8}: Subcontractor's expectation on profits KPI_{F1-9}: Building product supplier's expectation on profits KPI_{F1-10}: Shareholders' expectation on reward KPI_{F1-11}: Creditors' expectations on cost efficiency KPI_{F1-12}: End-users' expectations on quality services
Project Strategic Goal (P2)	KPI_{F2-1} to KPI_{F2-3}: Life-cycle V*f*M (Future poofing: the ability of the built asset to continue to be value into the future)		
Delivery Processes (P3)	KPI_{F3-1}: Comprehensiveness of macro-environmental analysis (political, economic, social and legal) KPI_{F3-2}: Appropriateness of definition on service need and desired outputs KPI_{F3-3}: Effectiveness and efficiency of risk management (e.g., identification, analysis and allocation) KPI_{F3-4}: Comprehensiveness of feasibility/business-case study (financing, technical and engineering) KPI_{F3-5}: Appropriateness of financing option KPI_{F3-6}: Appropriateness of concessionaire selection criteria KPI_{F3-7}: Appropriateness of concession period KPI_{F3-8}: Appropriateness of legal, commercial, technical and engineering structure KPI_{F3-9}: Effectiveness of interface management	KPI_{F3-10}: Transparency and competitiveness of bidding process KPI_{F3-11}: Comprehensiveness and efficiency of final approval and negotiation KPI_{F3-12}: Effectiveness and efficiency of financial close KPI_{F3-13}: Effectiveness of interface management	KPI_{F3-14}: Compliance of legal and regulatory framework KPI_{F3-15}: Proper design and efficient design process KPI_{F3-16}: TCQ and material management KPI_{F3-17}: Occupational health and safety KPI_{F3-18}: Environmental and macro impacts of the project KPI_{F3-19}: Effectiveness of contract management KPI_{F3-20}: Effectiveness and efficiency of dispute solution KPI_{F3-21}: Profitability KPI_{F3-22}: Effectiveness of operations management KPI_{F3-23}: Effectiveness of facility management KPI_{F3-24}: Effectiveness of interface management
Organisational Foundations (P4)	KPI_{F4-1}: Skilled employees/workforce KPI_{F4-2}: Training and learning system KPI_{F4-3}: Innovation for strategic planning and process design KPI_{F4-4}: Innovation for project financing	KPI_{F4-5}: Skilled employees/workforce of the public authority and private SPV KPI_{F4-6}: Training and learning systems in the public and private sectors KPI_{F4-7}: Innovation for procurement (bidding/tendering) KPI_{F4-8}: Public sector's governance (for procurement)	KPI_{F4-9}: Skilled employees/workforce in the private SPV KPI_{F4-10}: Training and learning system of the private SPV KPI_{F4-11}: Reliability of financial infrastructure KPI_{F4-12}: Public sector's governance KPI_{F4-13}: Advanced technologies and equipment KPI_{F4-14}: Innovation for technology KPI_{F4-15}: Technology transfer and knowledge management KPI_{F4-16}: Appropriateness of professional staff structure
Key Stakeholder Commitment (P5)	KPI_{F5-1}: Public client's performance in the establishment of investment environment KPI_{F5-2}: Public client's performance in the establishment of a sound legal framework KPI_{F5-3}: Skilled employees' performance/contribution	KPI_{F5-4}: Public authority contribution to concessionaire selection KPI_{F5-5}: Skilled employees' performance/contribution in tendering/bidding KPI_{F5-6}: Private contractors' willingness to participation to the project KPI_{F5-7}: Shareholders' willingness to participation to the project KPI_{F5-8}: Creditors' willingness to participation to the project	KPI_{F5-9}: Public client willingness to active involvement KPI_{F5-10}: Skilled employees' performance/contribution in SPV KPI_{F5-11}: Subcontractors' performance KPI_{F5-12}: Suppliers' performance KPI_{F5-13}: Users' willingness to the use of the procured asset

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Appendix 2. Refined KPIs for the developed life-cycle PMS for PPPs

Phases / Perspectives	**Initiation and Planning (Phase 1)**	**Procurement (Phase 2)**	**Partnership (Phase 3) (Construction, Operation and Maintenance)**
Key Stakeholder Expectation (P1)	KPI_{F1-2}: Skilled employees' expectations on promising work environment	KPI_{F1-3}: Public client's expectation on experienced bidder with a rational proposal KPI_{F1-4}: Skilled employees' expectations on promising work environment	KPI_{F1-5}: Public client's expectation on innovative D&C and quality output KPI_{F1-6}: Skilled employees' expectation on promising work environment KPI_{F1-7}: Main contractor's expectation on on-budget and on-time delivery KPI_{F1-8}: Subcontractor's expectation on profits KPI_{F1-10}: Shareholders' expectations on financial rewards KPI_{F1-11}: Creditors' expectations on cost efficiency KPI_{F1-12}: End-users' expectations on quality services
Project Strategic Goal (P2)	KPI_{F2-1} to KPI_{F2-3}: Life-cycle V*f*M (Future poofing: the ability of the built asset to continue to be value into the future)		
Delivery Processes (P3)	KPI_{F3-1}: Comprehensiveness of macro-environmental analysis (political, economic, social and legal) KPI_{F3-3}: Effectiveness and efficiency of risk management (e.g., identification, analysis and allocation) KPI_{F3-4}: Comprehensiveness of feasibility/business-case study (financing, technical and engineering) KPI_{F3-6}: Appropriateness of concessionaire selection criteria KPI_{F3-8}: Appropriateness of legal, commercial, technical and engineering structure KPI_{F3-9}: Effectiveness of interface management	KPI_{F3-10}: Transparency and competitiveness of bidding process KPI_{F3-11}: Comprehensiveness and efficiency of final approval and negotiation KPI_{F3-13}: Effectiveness of interface management	KPI_{F3-15}: Proper design and efficient design process KPI_{F3-16}: TCQ and material management KPI_{F3-17}: Occupational health and safety KPI_{F3-18}: Environmental and macro impacts of the project KPI_{F3-19}: Effectiveness of contract management KPI_{F3-20}: Effectiveness and efficiency of dispute solution KPI_{F3-22}: Effectiveness of operations management KPI_{F3-23}: Effectiveness of facility maintenance KPI_{F3-24}: Effectiveness of interface management
Organisational Foundations (P4)	KPI_{F4-1}: Skilled employees/workforce KPI_{F4-2}: Training and learning system KPI_{F4-3}: Innovation for strategic planning and process design KPI_{F4-4}: Innovation for project financing	KPI_{F4-5}: Skilled employees/workforce of the public authority and private SPV KPI_{F4-6}: Training and learning systems in the public and private sectors KPI_{F4-7}: Innovation for procurement (bidding/tendering)	KPI_{F4-9}: Skilled employees/workforce in the private SPV KPI_{F4-10}: Training and learning system of the private SPV KPI_{F4-11}: Reliability of the financial infrastructure KPI_{F4-12}: Public sector's governance KPI_{F4-13}: Advanced technologies and equipment KPI_{F4-14}: Innovation for technology KPI_{F4-15}: Technology transfer and knowledge management KPI_{F4-16}: Appropriateness of professional staff structure
Key Stakeholder Commitment (P5)	KPI_{F5-1}: Public client's performance in the establishment of investment environment KPI_{F5-2}: Public client's performance in the establishment of a sound legal framework KPI_{F5-3}: Skilled employees' performance and contribution	KPI_{F5-5}: Skilled employees' performance/contribution in tendering/bidding KPI_{F5-6}: Private contractors' willingness to participation to the project KPI_{F5-7}: Shareholders' willingness to participation to the project KPI_{F5-8}: Creditors' willingness to participation to the project	KPI_{F5-9}: Public client willingness to active involvement KPI_{F5-10}: Skilled employees' performance/contribution in SPV KPI_{F5-11}: Subcontractors' performance KPI_{F5-13}: Users' willingness to the use of the procured asset

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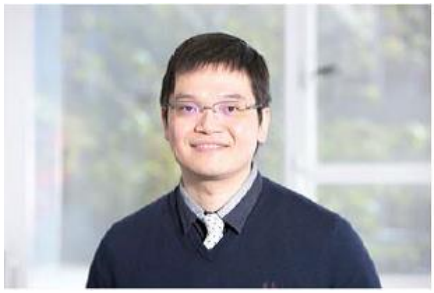

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