CHAPTER 10

A PRICE REVIEW FRAMEWORK FOR MAINTENANCE, REPAIR AND OPERATIONS PROCUREMENT CONTRACTS IN THE PUBLIC SECTOR

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INTRODUCTION

Procurement is a vital clog in the supply chain of most organizations. Improving the performance of the purchasing function can make a significant contribution to the overall performance of an organization. In mature organizations especially, improved procurement performance has been shown to have a positive impact on financial performance (Schiele, 2007).

Not unlike the typical arrangements in private enterprises, the public sector establishes various long term contracts to acquire services (such as maintenance of equipment). Due to the nature of such contracts that may span several years, cost escalation is usually included in the contractual terms for adjustment of manpower unit rates periodically to take into account inflation and targeted productivity gains. Manpower unit rates are usually priced in various tiers. The price adjustment methodology is generally straightforward, in that benchmarks against labour cost and productivity indices can be conducted, then applied to the various tiered rates.

On the other hand, cost escalations for indirect materials are more complex to handle within a contractual relationship. Indirect materials, also commonly referred as known as Maintenance, Repair and Operations (MRO) materials, are those parts that are not used directly in production of goods or provision of services. Compared to direct materials, MRO materials have demand that is more internally

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driven, have order sizes that are small and account for a small percentage of dollar spend (but a large percentage of purchase orders) (Eisenmann, 2001). Moreover, MRO parts come in a wide variety of forms. MRO has long been viewed as one of the least systematic and most problematic areas of purchasing (Barry et al., 1996).

MRO material costs are typically managed using the fixed-price model or the cost-plus model. The former generally favors buyers who would bear little risk of price fluctuations in a volatile market. However, such benefits apply only if the unit rates are appropriately priced to reflect the true price of the material at the time the rates are fixed. The latter (cost-plus) model generally benefits service providers and is often linked to the "principal-agent" problem (Soudry, 2007; Yukins, 2010, among others). Conflict of interest arises when the agent seeks to increase its commissions through higher purchase prices, contrary to the principal's objective of seeking prices that are as low as possible. The agent has little motivation to reduce costs and this is unfavourable to the principal.

This research seeks to develop, via a case study, a price review framework for the procurement of MRO parts in public sector organizations where there has generally been a lack of attention on expenditures on such supplies. The secondary objective is in assessing whether the Singapore-based public sector organization in the case study had been cost effective in its MRO procurement.

Singapore has a hybrid centralized model of public procurement (Jones, 2002). Government Procurement Entities (GPEs) are provided with the ground rules of procurement which must be followed, but are given discretion to interpret the rules in light of their operational needs and the type and amounts of goods and services to procure. Approval of lower value procurements is typically decentralized for greater efficiency and responsiveness (Singapore Parliamentary Report, 2015). Under such a model, Singapore public sector organizations retain a large degree of autonomy in MRO procurement.

This research is centered on Department M, which has been selected as the subject of a case study, not least because internal historical data is reliable and well-archived within an Enterprise Resource Planning (ERP) system (SAP). In addition, Department M makes for an interesting case study, as it is a progressive organization that has adopted e-procurement for many years and

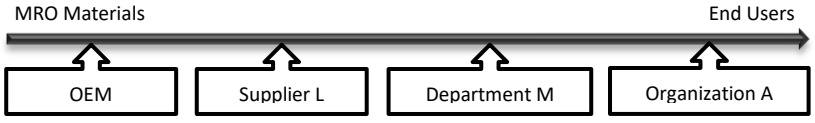
procures through the Singapore Government Electronic Business (GeBIZ) system (www.gebiz.gov.sg). It is also not averse to procurement outsourcing and continuous improvement initiatives.

Department M is responsible for maintaining all types of motor vehicles belonging to public Organization A. Organization A owns a large fleet of motor vehicles to support its transportation operations. Department M assumes full ownership of providing comprehensive maintenance services to Organization A's entire fleet of vehicles. Department M is measured on two key performance indicators (KPIs):

a. Vehicle Serviceability Rate (SR) – Percentage of the fleet that is in serviceable status
b. Repair Turnaround Time (TAT) – Percentage of maintenance service jobs that are completed within a targeted number of workdays

Factors that can affect SR and TAT include vehicle breakdown rates, repair lead times and very crucially the availability of MRO parts to support maintenance activities. While Department M has a pool of skilled technicians to maintain the motor vehicles, the procurement and supply management functions are deemed non-core competencies. As such, the procurement and supply management of MRO parts have been outsourced to Supplier L, a third-party logistics and sourcing company. Figure 1 shows the flow and management of MRO parts along the supply chain.

FIGURE 1
Flow of MRO Parts along the Supply Chain



The working relationship between Department M and Supplier L is intended to be highly collaborative. Information sharing, joint forecasting and supply base development are critical success factors to achieve the desired outcomes of the collaboration. In theory,

Department M practises Just-In-Time (JIT) inventory and practically holds zero inventory of MRO parts, while Supplier L is responsible for the transactional execution of initiating purchases from original equipment manufacturers (OEMs), performing quality inspections, warehousing, stock keeping and delivering MRO parts to the maintenance depots that are strategically located in various parts of Singapore.

At this point, it may appear that outsourcing procurement would be an easy way for Department M to achieve efficiency gains, but the reality is not that straightforward. While the literature does suggest that procurement outsourcing can potentially reduce operational costs by 15–20% (Brewer et al., 2014), a Deloitte (2014) global study found that the adoption of procurement outsourcing has been very slow. The main barriers include the need to gain a deep understanding and control of spend categories, as well as a shortage of skills. As this paper will also demonstrate, the re-pricing mechanism for the procurement of MRO parts is another area that requires careful examination. Prior to this study, it was not clear how effectively Department M had been managing its contract with Supplier L, and to what extent price escalations put forth by Supplier L for MRO parts had been well-justified. It should be noted that under the existing arrangement, Supplier L and Department M are both agents of Organization A, which could in theory exacerbate the principle-agent problem.

LITERATURE REVIEW

This literature review is organized into three mains parts. Recent developments in public procurement and management of public procurement performance are first discussed, followed by a survey of research on public contract renewal mechanisms. Finally, relevant research in the area of MRO procurement and the Linear Performance Pricing approach are reviewed.

The topic of public procurement has been dominated by e-procurement strategies in the past 10 to 15 years (e.g. Panayiotou et al., 2004; Croom and Brandon-Jones, 2005; Croom and Brandon-Jones, 2007; Gunasekaran and Ngai, 2008). The benefits are numerous. For example, Neupane et al. (2012) studied fifty countries to explore the role of public e-procurement technology in reducing corruption in public procurement and found that transparency and

accountability is the most important benefit from public e-procurement. Other benefits include increased competition among bidders, improved quality of work and services, and greater consistency in government procurement, which ultimately reduce corruption in public procurement.

Yet, despite the proliferation of e-procurement, there have been few discussions in the literature on public procurement performance management (Murray, 2009). One example is Raymond (2008)'s paper which argued for the necessity of benchmarks for effective implementation of government procurement policies in a case study on Sri Lanka. Another example is Parker and Hartley's (2003) study on the role of transaction costs and the importance of trust in relational contracting in public private partnerships (PPP). The theoretical framework developed in that study was applied and illustrated through a case study of UK defence contracting, in an attempt to assess whether the use of PPPs will necessarily lead to improved economic efficiency. The case study highlighted a number of major potential transaction costs in defence procurement, arising from incomplete information, asset specificity and the resulting scope for opportunistic behaviour, which cannot be obviously offset by developing trust relationships. PPPs can be distorted by the incentives within the Armed Forces. Military personnel will not necessarily behave efficiently, since they neither share in any profits from efficient behaviour nor experience losses from poor performance. The conclusion of the analysis is that the use of PPPs will not necessarily lead to improved economic efficiency in defence procurement and that considerable care will need to be taken both in terms of negotiating PPPs, monitoring their performance, and in their renewal.

The optimal way for long term relationships is to write long term contracts to which all parties commit, but the initial contract may no longer remain optimal and may need to be renegotiated (Laffont and Tirole, 1990). On the other hand, some researchers have proposed that a systematic non-renewal of public sector contracts would be necessary to spur suppliers to provide good quality services. For example, Dalen et al. (2006)'s research suggests that in public procurement contracts, suppliers' incentives to produce high-quality services are maximized if 50% of the contracts are renewed, although

the optimal rate of renewal rate has to be balanced against the cost of entry for new suppliers.

Jones (1997a) surveyed 53 public sector organizations in the UK and Republic of Ireland and found that about 70% of them always (or almost always) used fixed price contracts for their procurement activities. Jones (1997a) noted that the concept of a fixed price contract, often in the traditional form of a "bidding pool", is flawed. The process requires bidders to assess all the costs they may face at the outset of the contract and to predict the possible fluctuations in the market. In these circumstances, all or most of the risk is passed onto the suppliers. However, buyers will be aware that sellers will generally tend to have more information than buyers, in trying to match and predict upward price movements. This information asymmetry itself may add to buyers' difficulties in correctly predicting and managing contractual risk. Incentivization within public sector contracts was suggested as a way forward for developing government purchasing. In a subsequent paper, Jones (1997b) described the pre-requisites and a methodology to enable government practitioners to secure an incentivized contract. Yet, one limitation of that study was that it didn't address how public organizations should handle contract renewals, to ensure that the re-tendered price represents a "fair" price.

In a study on the U.S. defence industry, Rogerson (1994) pointed out that fixed price contracts create a type of "regulatory lag" such that firms may discover a way to lower production cost and keep profits created by such reductions until new negotiation takes this new efficiency into account and lower prices on future contracts.

Gautier and Yvrande-Billon (2013) studied operators in the French urban transport industry, whose incentives to reduce costs come from profit maximization during the current contract and from the prospect of contract renewal. They constructed a dynamic incentive scheme and regulation model that captures these features, which show that both the level of cost reducing effort and its repartition during the contracting period depend on the contract-type (cost-plus, gross cost or net cost contract) and specific incentives for renewal. They then estimated a cost frontier model for French bus companies to test their predictions.

While the literature review to this point has discussed public procurement and public contract renewal in general, the past

research papers uncovered have not made distinctions between procurement for direct materials, indirect materials (MRO parts) or services. As Wendin (2001) observed, although purchases of indirect goods may outpace spend on direct materials, acquisition of MRO goods has heretofore not been looked upon as a strategic issue. This attitude probably holds true as well in the public sector.

Barry et al. (1996)'s study of 58 firms suggests that there are three stages of evolutionary growth in MRO acquisition practices, which are accompanied by specific purchasing activities and processes, as well as common user interfaces and perceptions. Compared to private sector firms, public organizations appear to have a "preponderance" of Phase 1 activities which are basic purchasing processes, as various regulations prevent quick adoption of new procurement techniques. In comparison, Phase 2 organizations have enhanced procurement practices that streamline existing MRO purchasing in an effort to reduce price and enhance delivery flow, while Phase 3 ("world-class" MRO procurement) is characterized by the existence of a broad purchasing strategy that support overall corporate and product strategies.

Some researchers also distinguished between various strategies in handling MRO activities, but along the dimension of in-sourcing versus outsourcing. For example, Al-Kaabi et al. (2007) noted that outsourcing MRO procurement is not risk free and may make a company vulnerable to supplier opportunism. They identified four models of MRO procurement (fully-integrated, partially outsourced, mostly outsourced and wholly outsourced) in the context of the airline industry. However, typical levels of performance in each model were not reported in that study.

Le Sueur and Dale (1998) studied the problems associated with MRO supplies, which include non-compliance with policies, lack of process standardization, absence of proper data management, mismanagement of data transfer systems and poor logistics management. They suggested that it is critical to establish expected service levels and translate them into procurement performance criteria. Croom and Johnston (2003) likewise argued that in the context of indirect (MRO) purchases, reduction in non-compliant buying by users is critical to the achievement of cost and efficiency gains from electronic procurement, and that internal customer

satisfaction should be a key concern for e-procurement implementation.

The Linear Performance Pricing (LPP) strategy is one approach that has been used widely in the automobile industry to achieve focused cost reductions in the supply base. Yet, LPP has attracted only limited attention in academia (Newman and Krehbiel, 2007; Proch et al. 2013). In LPP, a technical cost driver that is crucial for the product price of a sourcing category is first identified and it then serves as the basis of objective target prices (A.T. Kearney, 2016). Regression analyses can then competitively link tier-one purchased component content and performance attributes to their cost drivers and subsequent tier-two supplier component cost.

Newman and Krehbiel (2007) examined the application of Linear Performance Pricing (LPP) by an automotive manufacturer that applied LPP models on over 50,000 stock-keeping units (SKUs). It was estimated that LPP models had directly and/or indirectly affected 85% of the SKUs. Benefits gained by using LPP include transparency of cost drivers, internal/external resource optimization, design optimization leading to lower cost of goods sold, better communication between tiers, and more focused negotiations throughout the entire supply chain network.

Proch et al. (2013) further extended the LPP concept and proposed a seven-step approach, which includes: definition of a suitable product group; identification of a performance parameter; collection and analysis of data; identification of potential cost reductions; classification of the supplier base; detailing of performance parameter and defining common measures. The first four steps take place within the company while the latter three are in cooperation with suppliers.

To round up, review of literature has suggested that research in MRO procurement in public sector organizations is practically non-existent. While there is a wealth of literature on public sector procurement, only Barry et al. (1996)'s paper attempted to point out public sector organizations' lack of maturity in MRO procurement. While e-procurement has been widely practiced by governments in the past 10 years, it should be noted that e-procurement is still just a tool and it does not necessarily reveal what the "fair" price of a procured product is. The approach used in LPP holds some promise for application in the MRO space. However, one limitation of LPP

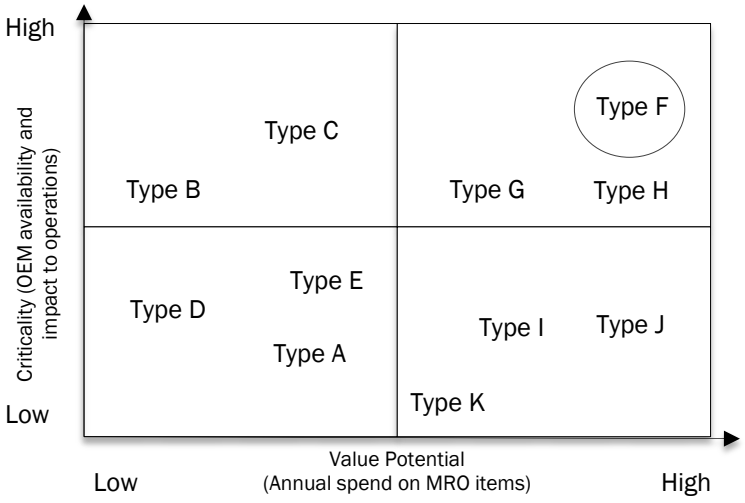
appears to be that it does not necessarily take into account actual prices in the intervening period between the starting and ending dates of a study period. As such, outcomes of LPP analysis can be very sensitive to the choice of reference timeframes. It is also not always easy to identify common technical cost drivers for a large portfolio of MRO parts.

APPROACH

This case study on Department M first examined procured MRO parts associated with several vehicle types by classifying them according to whether they were critical to effective operations and whether the spends were sufficiently large to derive value from an improved procurement process. Figure 2 depicts a portfolio matrix that was used to classify the 11 vehicle types operated by Organization A on two dimensions: "criticality" and "value potential".

Vehicle Type F was characterized by both high criticality and high value potential. It was thus selected for this case study. Both qualitative and quantitative data were collected to support the research.

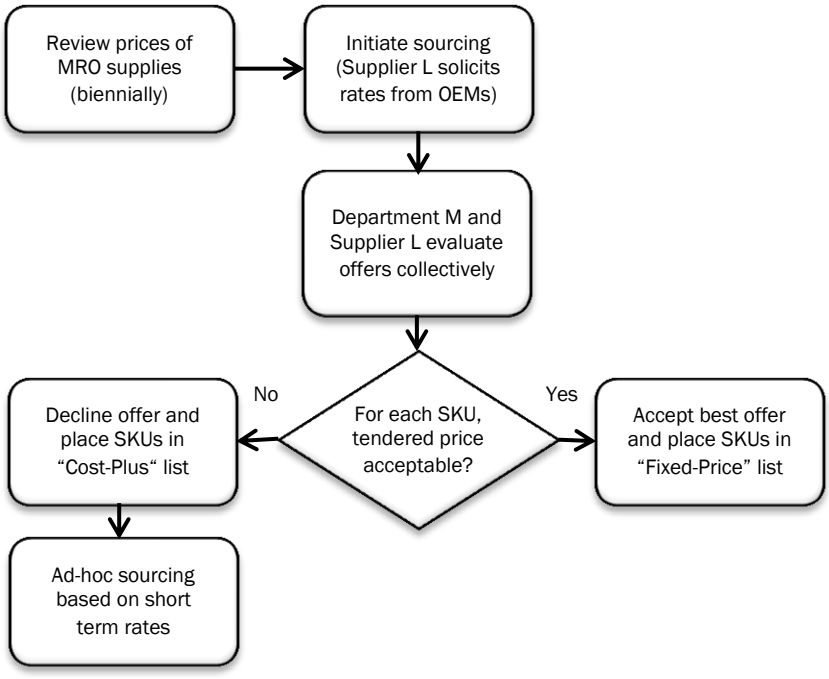
FIGURE 2
Portfolio Matrix on MRO Supplies by Vehicle Type



Qualitative data was obtained from standard operating procedures (SOP) documented in the Operating Manual (OM) and through interviews with Department M's key personnel who managed the contract with Supplier L. This helped in gaining an in-depth understanding of Department M's work processes and in recognizing the challenges faced in managing the contract.

Figure 3 shows the "as-is" internal process as adopted by Department M and Supplier L. Under existing guidelines, a price review was conducted every two years and bids were invited for all MRO SKUs. Should the best quote received for each SKU be deemed competitive, this quote would be accepted and the corresponding SKU placed within a "fixed-price" list. For other SKUs with

FIGURE 3
Management of Purchase Prices of MRO Parts ("As-Is" Process)

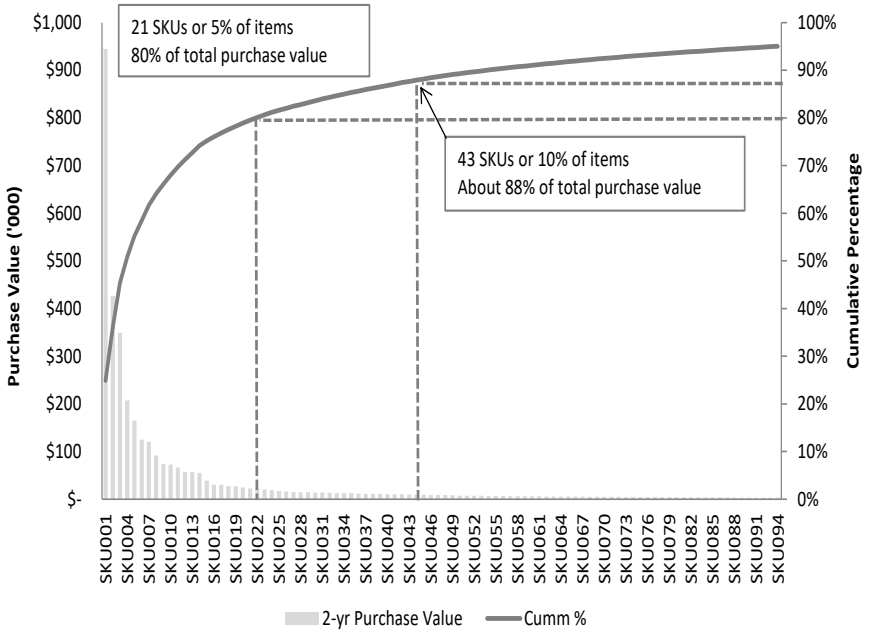


unacceptable quotes (e.g. due to a lack of competition or reluctance of suppliers to commit to competitive multi-year fixed rates), these SKUs would be separately procured via a "cost-plus" contract with the lead procurement agent (i.e. Supplier L) and purchased on an "as-needed" (ad-hoc) basis with short term rates. Based on the observations of this process, we can probably classify Department M as having Phase 2 "enhanced procurement practices", according to Barry et al. (1996)'s development model for effective MRO procurement. However, it should be noted that the fixed-price contract (as practised in the "as-is" process) passes nearly all risks onto the suppliers (Jones, 1997a), who may buffer the risk by applying conservative price mark-ups. This results in the possibility that prices tendered may not be as market competitive as they could have been, even at the onset of the contract.

Quantitative data was collected from Department M's SAP system. SKU inventory data and past purchase records of these SKUs were retrieved. The data collected spanned the period from March 2013 to February 2015, during which 433 SKUs associated with Vehicle Type F were purchased at a total value of S$3.79m (Note: S$1.40=US$1 as of Feb 2016). The purchase value for individual SKU ranged from S$1.40 to S$945,000. It must be emphasized that the spend analysis did not include certain high-value motor vehicle components such as engines and transmission/gearboxes. This may be explained by the "replace-and-repair" strategy adopted by Department M to maintain a float of such components termed "repairables". Faulty repairables were removed from motor vehicles and replaced with working ones. The faulty repairables were then repaired and recirculated back into the float pool.

A Pareto chart was constructed to rank the MRO SKUs according to spend in descending order (Figure 4). The Pareto 20/80 rule suggests that top 20% of items would typically account for about 80% of the total value. However, in this case, it was observed that 80% of the total spend was attributable to only 5% of the SKUs (about 21 SKUs). Analysis of just the top-21 SKUs was insufficient as it would not cover an adequate range of SKUs required to provide insights on price trends. The scope of the study was therefore extended to the top 10% of SKUs that accounted for 88% of the total purchase value.

FIGURE 4
Pareto Analysis on MRO Parts



Forty three (43) SKUs were consequently selected for analysis and the existing pricing method for each SKU was identified (see Table 1). It was found during the study that while the "as-is" process guidelines seemed to be sound, they were not always adhered to and the pricing methodology selected for an SKU may at times appear to be haphazard, without any clear strategy or justifications.

External data on commodity price indices (Department of Statistics Singapore, 2015) was obtained to support data analysis and to benchmark the effectiveness of managing the purchase prices of MRO parts. Three price indices were considered:

a. Imported Price Index (IPI) is an indicator that monitors price trends of imported goods into Singapore. Import price is valued at CIF (cost, insurance and freight).

TABLE 1
Contract Pricing Method for Top-43 SKUs

SKU	Description	Existing Pricing Method	DSPI CG	2-yr Qty	2-yr Value	Value %
SKU01	Car Battery	Fixed Price	CG01	2,008	$ 944,587	24.92 %
SKU02	Tyre	Fixed Price	CG02	1,202	$ 426,487	11.25 %
SKU03	Valve for Tyre (Plastic)	Cost-Plus	CG05	265	$ 348,990	9.21%
SKU04	Lubricating Oil (Hydraulic)	Cost-Plus	CG04	4,550	$ 207,120	5.46%
SKU05	Actuating Cylinder Assembly	Cost-Plus	CG08	198	$ 164,796	4.35%
SKU06	Steering System	Cost-Plus	CG08	649	$ 124,835	3.29%
SKU07	Air Drier	Cost-Plus	CG08	97	$ 120,776	3.19%
SKU08	Lubricating Oil (Engine)	Fixed Price	CG04	1,900	$ 91,960	2.43%
SKU09	Propeller Shaft Assembly	Cost-Plus	CG07	71	$ 73,891	1.95%
SKU10	Transmitter	Cost-Plus	CG09	157	$ 72,731	1.92%
SKU11	Lubricating Oil (Gear)	Fixed Price	CG04	1,250	$ 66,250	1.75%
SKU12	Electric Motor	Fixed Price	CG06	96	$ 57,523	1.52%
SKU13	Speedometer	Cost-Plus	CG08	82	$ 56,835	1.50%
SKU14	Anti-Lock Brake Control	Cost-Plus	CG09	22	$ 55,194	1.46%
SKU15	Drag Link-Tie Rod, 52mm	Cost-Plus	CG08	107	$ 39,055	1.03%
SKU16	Warning Buzzer	Fixed Price	CG09	76	$ 30,590	0.81%
SKU17	Shock Absorber	Cost-Plus	CG08	321	$ 30,322	0.80%
SKU18	Drag Link-Tie Rod, 33mm	Fixed Price	CG08	110	$ 27,830	0.73%
SKU19	Vehicle Light Unit (Rear)	Cost-Plus	CG01	118	$ 26,760	0.71%
SKU20	Air Brake Chamber	Fixed Price	CG08	131	$ 24,918	0.66%
SKU21	Brake Disc (Front Wheel)	Cost-Plus	CG08	132	$ 22,614	0.60%
SKU22	Transmitter (Pressure)	Fixed Price	CG09	118	$ 22,391	0.59%
SKU23	Starter Motor	Cost-Plus	CG06	8	$ 21,064	0.56%
SKU24	Fuel Lid Filler Opener	Cost-Plus	CG08	109	$ 18,863	0.50%
SKU25	Plastic Light Lens (Red/Yellow)	Cost-Plus	CG01	458	$ 16,624	0.44%
SKU26	Vehicle Light Unit (Front)	Cost-Plus	CG01	64	$ 16,555	0.44%
SKU27	Vehicle Seat Frame (Rear, Right)	Fixed Price	CG08	21	$ 15,263	0.40%
SKU28	Vehicle Seat Part Kit	Fixed Price	CG08	108	$ 14,656	0.39%
SKU29	Single-Pointed Bar Face Knob	Fixed Price	CG08	636	$ 14,628	0.39%
SKU30	Wiper Arm	Cost-Plus	CG08	44	$ 14,307	0.38%

SKU	Description	Existing Pricing Method	DSPI CG	2-yr Qty	2-yr Value	Value %
SKU31	Wiper Blade (Front, Std Length)	Cost-Plus	CG03	1,601	$ 13,859	0.37%
SKU32	Fan Switch	Cost-Plus	CG09	216	$ 13,288	0.35%
SKU33	Clutchmaster Cylinder	Cost-Plus	CG07	83	$ 12,997	0.34%
SKU34	Switch	Fixed Price	CG09	324	$ 12,931	0.34%
SKU35	Vehicle Seat Belt (Front)	Cost-Plus	CG08	60	$ 12,782	0.34%
SKU36	Vehicle Seat Frame (Rear, Left)	Fixed Price	CG08	16	$ 11,629	0.31%
SKU37	Wiper Blade (500mm)	Cost-Plus	CG03	1,331	$ 11,521	0.30%
SKU38	Wiper Blade (Rear)	Fixed Price	CG03	524	$ 11,450	0.30%
SKU39	Groove Pulley	Fixed Price	CG07	47	$ 11,023	0.29%
SKU40	Clutch Plate	Cost-Plus	CG07	24	$ 10,924	0.29%
SKU41	Power Cable	Cost-Plus	CG10	10	$ 10,884	0.29%
SKU42	Reverse Warning Sensor	Cost-Plus	CG09	49	$ 10,732	0.28%
SKU43	Change Over Tap (Fuel Tank)	Cost-Plus	CG08	64	$ 9,996	0.26%

a. Singapore Manufactured Products Price Index (SMPPI) is an indicator that measures price fluctuations of manufactured goods in Singapore.
b. Domestic Supply Price Index (DSPI) is an indicator that measures prices fluctuation of goods manufactured in Singapore or imported which are retained for use in the domestic country. Import price is valued at CIF while locally manufactured goods are ex-factory prices.

Among the three indices, DSPI is the most appropriate as it measures price fluctuation of goods retained for use in the domestic economy. In addition, supply chain costs have already been factored into these indices. DSPI thus provides this research a suitable platform to conduct benchmarking on price fluctuation of MRO parts. Major MRO parts can be categorized into various commodity groups, each with its own sub-index. Table 2 shows the commodity groups that are relevant for subsequent benchmarking.

TABLE 2
DSPI Commodity Groups

DSPI CG	Commodity Group Description
CG01	Electrical Machinery & Apparatus
CG02	Rubber Tyres, Interchangeable Tyre Treads, Tyre Flaps & Inner Tubes for Wheels of All Kinds
CG03	Articles of Rubber
CG04	Petroleum Oils & Oils Obtained From Bituminous Minerals
CG05	Tubes, Pipes & Hoses, & Fittings Therefor, Of Plastics
CG06	Power-generating Machinery & Part
CG07	Transmission & Crank Shafts; Housings & Plain Shaft Bearing; Gears; Ballor Roller Screws; Gearboxes & Speed Changers; Flywheels & Pulleys; Clutches & Shaft Couplings; Articulated Link Chain; Parts & Accessories Of The Motor Vehicles
CG08	Parts & Accessories Of The Motor Vehicles
CG09	Elec App To Switch Protect Connect To Or In Elec Circuits; Elec Resistors & Potentiometers Excluding Heat Resistors; Bases With 1 App For Elec Ctrl
CG10	Equipment for Distributing Electricity

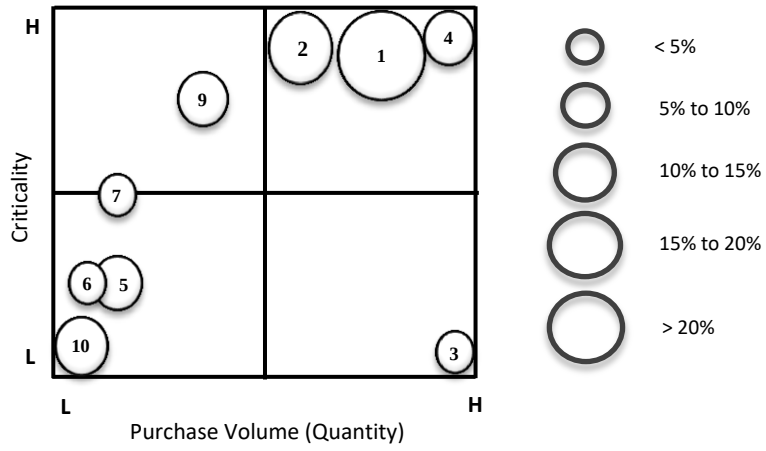
Each of the 43 SKUs identified earlier was further examined to determine the most appropriate DSPI commodity group (CG) that it belonged to. The actual purchase price in March 2013 was rebased to an index of 100% and purchase prices in the subsequent months were converted as a percentage of March 2013's purchase price. Exceptions were made for every SKU without a purchase price in March 2013. For such cases, the first available purchase price between March 2013 and February 2015 was used and rebased to 100%. Similarly, the corresponding DSPI for the same period was rebased to 100%. These adjustments are essential for effective benchmarking on a well-defined baseline (New Zealand Government Procurement Development Group, 2010).

Figure 5 shows (after the SKUs have been classified by commodity groups) an portfolio representation with three dimensions – "Purchase Volume (Quantity)" on the x-axis, "Critically" on the y-axis and "Total Spend" represented by bubble size.

From Figure 5, SKUs from commodity groups CG01, CG02 and CG04 are clustered in the region characterized by high purchase

quantity and high critically. These SKUs should be prioritized if improvement actions are to be taken.

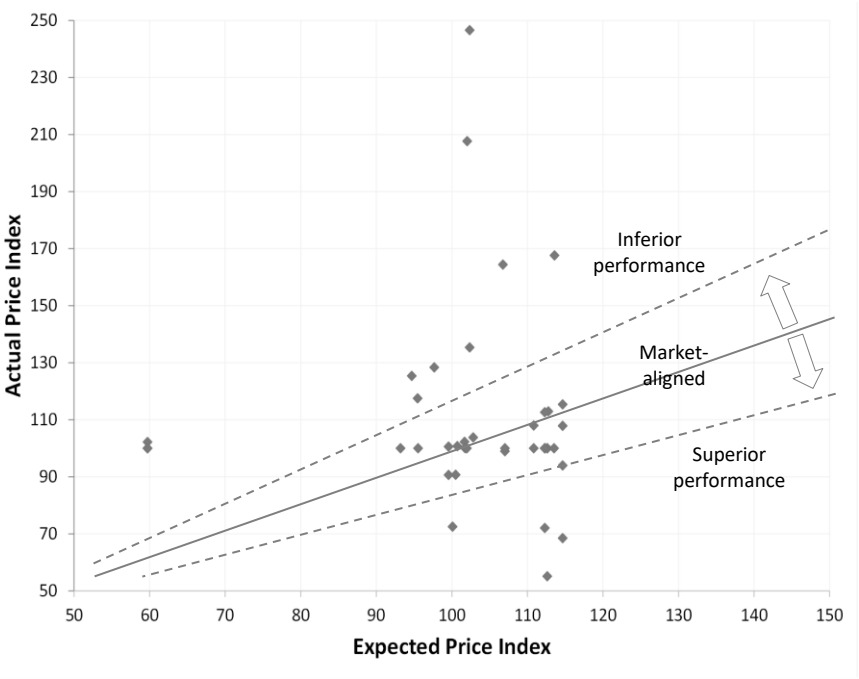
FIGURE 5
Portfolio of MRO SKUs by commodity groups



FINDINGS AND RECOMMENDATIONS

Figure 6 shows the plot of the 43 SKUs on the scales of an actual price paid index versus an expected price index, where expected price was based on the DSPI. The "market-aligned performance" line represents the cases where Organization A paid exactly (or almost exactly) the same rate as what would be expected. As shown in Figure 6, a majority of SKUs fall below the "market-aligned performance" line. As such, it appears at first glance that the MRO pricing efficiency at Department M has been fairly good, with actual price paid generally below the expected price. This analysis is however not weighted by volume or by spend, nor does it take into account data points between the start and end of the study periods. As will be explained shortly, such an approach may overstate or understate actual procurement performance.

FIGURE 6
Actual versus Expected Price for Top-43 MRO Parts for Vehicle Type F



The 43 SKUs that were selected for analysis were classified into the 10 commodity groups as listed in Table 2. For each SKU, a time-series analysis was plotted to compare item purchase price and DSPI while regression analysis was added to test the correlation between these two variables. The R-squared values (i.e. the coefficient of determination that ranges between 0 and 1) derived from regression analysis denote the strength of the correlation between item purchase price and DSPI.

This analysis is similar to the LPP (Linear Performance Pricing) method, in that it tracks the actual price paid against an expected price, except that the DSPI is used as a proxy for a technical cost driver. Moreover, the time series analysis takes into account not just the price paid at the end of a period, but also price changes that may have taken place in the intervening period. This distinction is

important, as (for example) prices may have reset to market rates at the end of an analysis period, but inefficiencies and over-charging could still have occurred prior to a "mark-to-market" re-pricing event. To address the shortcoming of the method of analysing end-of-period actual versus expected prices, a spend-weighted trend analysis needs to be conducted and a rating system established.

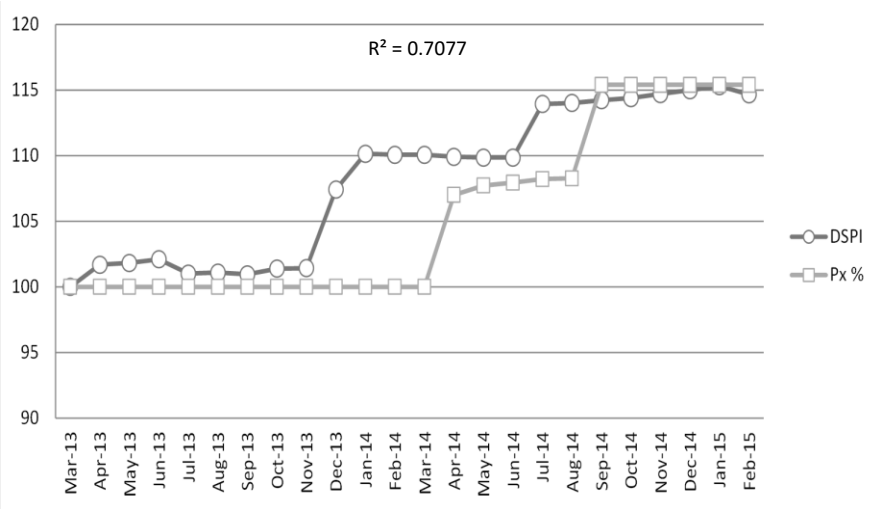
A simple rating system (Table 3) has been designed to rate the effectiveness of Department M in managing Supplier L's performance. The rating system enables performance to be quantified, simplifies the presentation of outcome analysis and facilitates the benchmarking of SKUs from different commodity groups on a common measuring scale.

TABLE 3
MRO procurement performance rating scale

Rating	Definition
1	Very Poor – Purchase price is not responsive to decreases in benchmark
2	Poor – Purchase price declines at a slower rate than decreases on benchmark; OR Purchase price increases at a faster rate than increases in benchmark
3	Neutral – Purchase price is consistent with benchmark
4	Good – Purchase price increment is generally lower than increases in benchmark
5	Very Good – Stable purchase price despite highly volatile benchmark
NA	Inconclusive– Purchase price is uncorrelated with the underlying benchmark, due to various factors such as "end-of-life", scarcity and exclusivity

For illustration, Figures 7a and 7b show the times series and regression analysis conducted on two MRO parts (SKU05 "actuating cylinder assembly" and SKU32 "fan switch") that belong to commodity groups CG08 and CG09 respectively. Both SKUs were sourced by Supplier L under the cost-plus method in the time period studied.

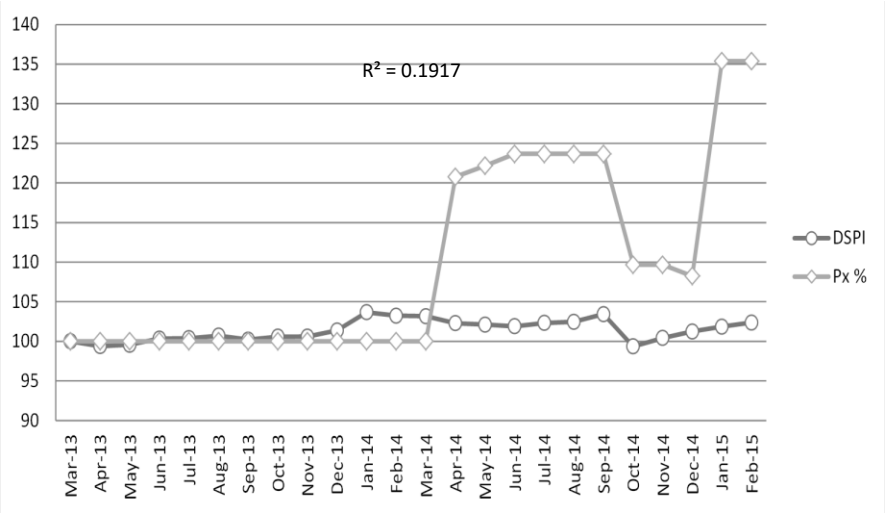
FIGURE 7A
Price Trend Analysis for "Actuating Cylinder Assembly" (SKU05)



It can be observed from Figure 7a that the DSPI for the relevant commodity group trended up and the price paid (Px%) for SKU05 had followed suit (albeit with a lag, which can probably be attributed to the time needed to work through the lower-cost inventory in the supply channel). The R-squared value is 0.7077, indicating a good correlation between the two time series. In this case, it can be concluded that the purchase price had been well-managed and Organization A was likely to have paid "fair" market rates. A rating of '3 – neutral' is assessed.

On the other hand, the variability of price for SKU32 was well above that for the underlying DSPI and the two time series show poor correlation (Figure 7b). The re-pricing events appear to have led to price increases that were excessive, suggesting a poor sourcing outcome. The trends for this SKU also perhaps underscore the limitation of the approach of comparing expected and actual prices, for the conclusion would be highly dependent on the time reference point at which the comparison was conducted. Using March 2013's price as a baseline, a snapshot of price taken in December 2014 would not have detected the excessive price increase that occurred between April and September 2014.

FIGURE 7B
Price trend analysis for "fan switch" (SKU32)



The Appendix summarizes the trend analyzed for each SKU and benchmarked with the DSPI trend for the same period. The R-squared value is also presented and an overall rating for each commodity group is assigned. It could be observed that after rate reviews, four commodity groups (CG01, CG02, CG04 and CG09) saw higher prices than what the relevant benchmarks could reasonably justify, while five groups saw prices that were in line with or better than expectations. The procurement performance for one commodity group (CG08) is inconclusive (due to the wide range of SKUs within this group). This is a weakness of the proposed method, which does not work well for commodities or spend categories that have numerous underlying cost drivers that may have poor correlations with each other or for unique parts that may command a scarcity premium.

Table 4 shows how a final spend-weighted performance measurement indicator is derived. The final weighted-average rating is computed as 1.71 (out of 5) for 68.57% of the total spend analyzed. As a result, procurement performance for this group of MRO parts is assessed to be poor. The weighted-average point

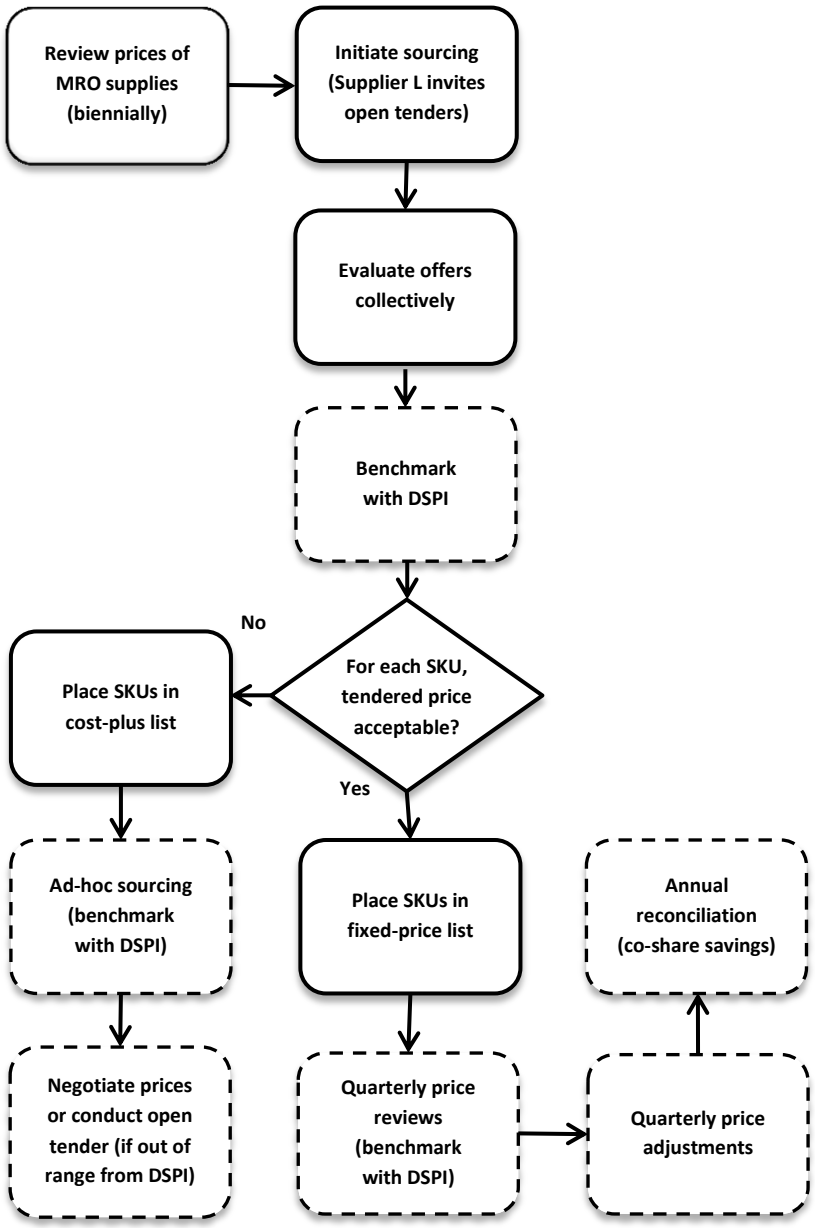
TABLE 4
Performance measurement using weighted-average point system

Commodity Group	% Total Spent (A)	Weight (B = A/T x 100%)	Rating (C)	Weighted Rating (D = B x C)
CG01	26.51	39%	1	0.39
CG02	11.25	17%	1	0.17
CG03	0.97	1%	5	0.05
CG04	9.64	14%	1	0.14
CG05	9.21	14%	4	0.56
CG06	2.08	3%	4	0.12
CG07	2.87	4%	3	0.12
CG08	NA	NA	NA	NA
CG09	5.75	8%	2	0.16
CG10	0.29	0%	5	0.00
Total (T)	**68.57**	**100%**	-	**1.71**

system is a flexible system that enables an organization to derive performance easily. Different weights can be assigned to each commodity group while rating scales can be refined as necessary. While the weighted-average point system is not the most precise approach, it nonetheless provides a basis to quantify the purchasing performance of an organization. It should also be clarified that while the proposed rating system is on a 5-point scale, it is not always realistic (nor desirable) to set a rating of 5 as an organizational target, for the achievement of such a high rating would likely have been at the expense of suppliers who bear the full brunt of price increases/volatility in the market. Therefore, such a high level of procurement performance would probably not be sustainable. For the organization in the case study, a one-time adjustment (e.g. via an open tender) could be made to correct for past deviations from DSPI. An estimated one-time savings of S$0.11m (or 12.4%) could potentially be reaped if the proposed pricing framework is adopted.

The “to-be” process to manage contract price is proposed in Figure 8, with the steps added represented by the dashed boxes. Department M’s rationale for deciding on using fixed-price or cost-plus methods for individual SKUs remains generally sound and should be retained. However, it is recommended that in a steady

FIGURE 8
Management of MRO Contract Prices ("to-Be" Process)



CONCLUSION

Purchasing performance measurement systems play a central role in the alignment process of the purchasing function (Pohl & Förstl, 2011). In private enterprises, MRO procurement performance can be measured by expressing MRO spend as a percentage of sales. A low percentage suggests good performance and that the purchasing department has ensured purchase prices are competitive. Yet, the same method cannot be applied to the public sector, since the latter does not directly generate revenue from its operations. As Rogerson (1994) puts it, the board of directors of a profit maximising firm can delegate authority to management and can monitor results using measures such as profits. There is however no similar analogy in the public sector, which makes the delegation problem more challenging.

This paper has contributed to the literature in three ways. First, based on our review of literature, research on MRO procurement has been found to be scarce and those related to MRO in public organizations are even more so. As such, this paper is one of the few that have focused on MRO procurement practices and performance in the public sector. Second, a price review framework for MRO parts has been proposed and it allows for an objective comparison of MRO procurement performance over time and between public sector organizations. MRO sourcing in public sector organizations is arguably more complex from a procedural/approval perspective and involves a wider variety of supplies than in most private enterprises. While it may not always be realistic or cost-effective to conduct frequent open tenders to bring actual MRO prices back in line with expected prices (as proposed by Dalen et al., 2006), the adoption of a price review framework can at least serve as a deterrent to the principal-agent problem. Agents to whom procurement has been outsourced would then be firmly aware that their performance in price reviews with suppliers is regularly scrutinized and that periodic rate adjustments cannot (and must not) be exploited opportunistically to increase their own commissions. The proposed price review framework therefore demonstrates how an “incentivized contract” as advocated by Jones (1997b) might be applied in the case of MRO procurement in the public sector. Lastly, this paper has contributed a case study to the body of literature on procurement outsourcing, on which there is a dearth of research (Brewer et al., 2014). It describes the MRO

procurement process at a progressive public organization in Singapore which has outsourced its procurement of MRO parts and can probably be classified as having "enhanced procurement practices" (Barry et al., 1996).

The purpose of this paper is certainly not to assert that Department M has been efficient or otherwise in the area of MRO procurement. Rather, it is to describe the MRO procurement experience from the perspective of a public sector entity and hence propose ways in which pricing for MRO parts can become more efficient and systematic. The findings from the case study suggest that in addition to having well-defined guidelines on the appropriate adoption of fixed price or cost-plus methods in MRO procurement contracts, there should be built-in mechanisms in these contracts to allow prices to be re-aligned with the market at regular intervals, since the original contract may no longer be optimal (Laffont and Tirole, 1990).

The methods as presented in this paper are not without their limitations. This research uses a case study method that is based on data from just one vehicle type utilized by the selected organization. The case study method is inherently unable to generalize from a single case study beyond theoretical propositions, although multiple cases can be used to draw a single set of "cross-case" conclusions (Yin, 2013). In addition, the proposed price review framework is unlikely to be suitable for MRO supplies that are scarce (such as those that are approaching end-of-life) or those whose costs of factor inputs are highly volatile. Furthermore, as the case study illustrates, it may not always be possible to assess procurement performance for a large disparate family of parts. More importantly, the proposed price review approach assumes that domestic supply price indices (or measures for alternative cost drivers) are available as a basis for prices to be benchmarked. Lastly, the greatest barrier to the proposed mechanisms to periodically renegotiate and realign long-term MRO contracts may well stem from circumstances in the political economy, in particular a resistance to change from vested interest groups (Chêne, 2009), such as public officials and well-connected suppliers in privileged positions, especially in developing countries.

In conclusion, this paper has developed a framework for conducting price reviews on MRO parts, in the context of the

Singapore public sector. While there is scope for public organizations in Singapore to improve on ways to assess supplier performance, beyond the measurement of price and cost-savings (Jones, 2007), having an assurance that procurement by public organizations represents value for money (Ministry of Finance, Singapore, 2014) is a matter of public interest. Even as non-price factors are considered, there should be a way to measure procurement efficiency in the public sector (Raymond, 2008). The methodology proposed in this paper should thus not be viewed in isolation from measuring other aspects of supplier performance, but rather can be part of a comprehensive scorecard on the procurement performance of a public organization, of which price is just one aspect. Finally, this study has found some instances of deviations from existing guidelines in the selection of pricing methods for some MRO parts at the subject organization in the case study. While the extent to which costs have been inflated is likely small, this is apparently not an uncommon problem (Le Sueur and Dale, 1998; Croom and Johnston, 2003). Hence, it is an apt reminder that for the proposed framework (or any sourcing framework for that matter) to be successful, adherence and organizational buy-in is critical to the achievement of targeted outcomes.

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APPENDIX

TABLE A1

MRO Procurement Performance Rating for Commodity Group 1 (CG01)

SKU	SKU Description	Pricing Method	Trend Analyzed	R-Squared	Rating
DSPI benchmarked: CG01; Total Spent: 26.51%					
SKU01	Car Battery	Fixed Price	Fixed purchase price vs declining DSPI	0	1
SKU19	Vehicle Light Unit (Rear)	Cost-Plus	Increasing purchase price vs declining DSPI	0.3133	
SKU26	Vehicle Light Unit (Front)	Cost-Plus	Increasing purchase price vs declining DSPI	0.4025	
SKU25	Plastic Light Lens (Red/Yellow)	Cost-Plus	Increasing purchase price vs declining DSPI	0.0418	

TABLE A2

MRO procurement performance rating for Commodity Group 2 (CG02)

SKU	SKU Description	Pricing Method	Trend Analyzed	R-Squared	Rating
DSPI benchmarked: CG02; Total Spent: 11.25%					
SKU02	Tyre	Fixed Price	Fixed purchase price vs declining DSPI	0	1

TABLE A3
MRO Procurement Performance Rating for Commodity Group 3 (CG03)

SKU	SKU Description	Pricing Method	Trend Analyzed	R-Squared	Rating
DSPI benchmarked: CG03; Total Spent: 0.97%					
SKU31	Wiper Blade (Front, Std Length)	Cost-Plus	Relatively fixed purchase price vs increasing DSPI	0.3353	5
SKU37	Wiper Blade (500mm)	Cost-Plus	Erratic purchase price vs increasing DSPI	0.0703	
SKU38	Wiper Blade (Rear)	Fixed Price	Fixed purchase price vs increasing DSPI	0	

TABLE A4
MRO Procurement Performance Rating for Commodity Group 4 (CG04)

SKU	SKU Description	Pricing Method	Trend Analyzed	R-Squared	Rating
DSPI benchmarked: CG04; Total Spent: 9.64%					
SKU04	Lubricating Oil (Hydraulic)	Cost-Plus	Relatively fixed purchase price vs steeply declining DSPI	0.8619	1
SKU08	Lubricating Oil (Engine)	Fixed Price	Fixed purchase price vs steeply declining DSPI	0	
SKU11	Lubricating Oil (Gear)	Fixed Price	Fixed purchase price vs steeply declining DSPI	0	

TABLE A5
MRO Procurement Performance Rating for Commodity Group 5 (CG05)

SKU	SKU Description	Pricing Method	Trend Analyzed	R-Squared	Rating
DSPI benchmarked: CG05; Total Spent: 9.21%					
SKU03	Valve for Tyre (Plastic)	Cost-Plus	Purchase price and DSPI fluctuate in similar trends	0.4014	4

TABLE A6
MRO Procurement Performance Rating for Commodity Group 6 (CG06)

SKU	SKU Description	Pricing Method	Trend Analyzed	R-Squared	Rating
DSPI benchmarked: CG06; Total Spent: 2.08%					
SKU12	Electric Motor	Fixed Price	Relatively fixed purchase price vs increasing DSPI	0	4
SKU23	Starter Motor	Cost-Plus	Fixed purchase price, followed by one-time price increase vs increasing DSPI	0.4772	

TABLE A7
MRO Procurement Performance Rating for Commodity Group 7 (CG07)

SKU	SKU Description	Pricing Method	Trend Analyzed	R-Squared	Rating
DSPI benchmarked: CG07; Total Spent: 2.87%					
SKU09	Propeller Shaft Assembly	Cost-Plus	Purchase price and DSPI fluctuate in similar trends but purchase price changes at slower rate	0.0329	3
SKU33	Clutchmaster Cylinder	Cost-Plus	Relatively fixed purchase price vs fluctuating DSPI	0.0118	
SKU39	Groove Pulley	Fixed Price	Fixed purchase price vs fluctuating DSPI	0.0115	
SKU40	Clutch Plate	Cost-Plus	Relatively fixed purchase price vs fluctuating DSPI	0.0415	

TABLE A8
MRO Procurement Performance Rating for Commodity Group 8 (CG08)

SKU	SKU Description	Pricing Method	Trend Analyzed	R-Squared	Rating
DSPI benchmarked: CG08; Total Spent: 19.27%					
SKU05	Actuating Cylinder Assembly	Cost-Plus	Purchase price and DSPI fluctuate in similar trends	0.7077	N.A.
SKU06	Steering System	Cost-Plus	Purchase price and DSPI fluctuate in similar trends	0.7763	
SKU13	Speedometer	Cost-Plus	Relatively fixed purchase price vs increasing DSPI	0.1847	

SKU30	Wiper Arm	Cost-Plus	Relatively fixed purchase price vs increasing DSPI	0.1250	
SKU21	Brake Disc (Front Wheel)	Cost-Plus	Steeply increasing purchase price vs increasing DSPI	0.5562	
SKU43	Change Over Tap (Fuel Tank)	Cost-Plus	Steeply increasing purchase price vs increasing DSPI	0.5100	
SKU07	Air Drier	Cost-Plus	Declining purchase price vs increasing DSPI	0.6508	
SKU15	Drag Link-Tie Rod, 52mm	Cost-Plus	Declining purchase price vs increasing DSPI	0.6673	
SKU17	Shock Absorber	Cost-Plus	Declining purchase price vs increasing DSPI	0.7405	
SKU24	Fuel Lid Filler Opener	Cost-Plus	Declining purchase price vs increasing DSPI	0.0509	
SKU35	Vehicle Seat Belt (Front)	Cost-Plus	Erratic purchase price generally in declining trend vs increasing DSPI	0.8523	
SKU18	Drag Link-Tie Rod, 33mm	Fixed Price	Fixed purchase price vs increasing DSPI	0	
SKU20	Air Brake Chamber	Fixed Price	Fixed purchase price vs increasing DSPI	0	
SKU27	Vehicle Seat Frame (Rear, Right)	Fixed Price	Fixed purchase price vs increasing DSPI	0	
SKU28	Vehicle Seat Part Kit	Fixed Price	Fixed purchase price vs increasing DSPI	0	
SKU29	Single-Pointed Bar Face Knob	Fixed Price	Fixed purchase price vs increasing DSPI	0	
SKU36	Vehicle Seat Frame (Rear, Left)	Fixed Price	Fixed purchase price vs increasing DSPI	0	

TABLE A9
MRO Procurement Performance Rating for Commodity Group 9 (CG09)

SKU	SKU Description	Pricing Method	Trend Analyzed	R-Squared	Rating
DSPI benchmarked: CG09; Total Spent: 5.75%					
SKU10	Transmitter	Cost-Plus	Steeply increasing purchase price vs gently increasing DSPI	0.0944	2
SKU14	Anti-Lock Brake Control	Cost-Plus	Steeply increasing purchase price vs gently increasing DSPI	0.0082	
SKU32	Fan Switch	Cost-Plus	Steeply increasing purchase price vs gently increasing DSPI	0.1917	
SKU16	Warning Buzzer	Fixed Price	Fixed purchase price vs gently increasing DSPI	0.0644	
SKU22	Transmitter (Pressure)	Fixed Price	Fixed purchase price vs gently increasing DSPI	0	
SKU34	Switch	Fixed Price	Fixed purchase price vs gently increasing DSPI	0	
SKU42	Reverse Warning Sensor	Cost-Plus	Purchase price and DSPI fluctuate in similar trends	0.0756	

TABLE A10
MRO procurement performance rating for Commodity Group 10 (CG010)

SKU	SKU Description	Pricing Method	Trend Analyzed	R-Squared	Rating
DSPI benchmarked: CG10; Total Spent: 0.29%					
SKU41	Power Cable	Cost-Plus	Purchase price and DSPI fluctuate in similar trends but purchase price decreases at a faster rate	0.6345	5