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Using Performance Metrics to Guide Management and Predict Client Satisfaction

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Abstract
Fluctuating macro-economic conditions require design and construction teams to effectively and efficiently respond to project risks through improvements in management practice. The lack of meaningful performance metrics, infrequent assessment of project deficiencies and inaccurate prediction of Client satisfaction result in misaligned project management strategies. This paper begins with an illustration of these three challenges faced by the project execution team using a four-month case study on a healthcare project in California.

The motivating challenges necessitate a need for Client-based, tactical-driven project management using real-time measurement of relevant metrics. The Dynamic Performance Monitoring and Management (DPMM) framework draws on literature in the areas of organizational effectiveness for key performance indicators; strategic management for continuous improvement and client satisfaction; and applied microeconomics for measuring management practices. Next, a breakdown of the framework will illustrate the convergence of literature to conceptualize the constructs embedded. Our empirically derived approach starts with a survey of project key stakeholders to establish a representative set of metrics to be tracked and assessed. The project execution team will interpret metrics results and shift attention to deficient performance areas. Improvements in management practice are directly correlated with large increases in productivity and decreases in project risk.

Keywords
Performance Metrics, Strategic Management, Client Satisfaction, Continuous Improvement, KPIs

1. Introduction

Project execution is based on a reference framework that is intuitive and gathered from professional experience and judgment. Initial project planning involves mental models of risks and challenges for that particular contract and those particular stakeholders. Project managers use analytical skills to adjust as

needed so that the project is achieving towards project outcome objectives. The ad-hoc process is not formally documented; only informally deduced.

In current practice, performance measures tracked in the dimensions of quality, cost and schedule are not effective predictors of project success. Consequently, the project team cannot consistently interpret performance to identify deficiencies in their management process. Specifically, we observe three weaknesses with current practice faced by the project execution team regarding performance monitoring. To empirically demonstrate these issues, the authors conducted one 4-month case study in Northern California on a hospital project (approximately $80 million contract value; 2 year scheduled construction duration; 66,000 sf). We implemented three performance metrics to evaluate existing management practices.

2. Management process deficiencies cannot be readily identified because certain performance measures are not tracked at all.

Client Satisfaction was introduced to the case study. The Client reported weekly on a scale of 1 to 5 (most satisfied) how satisfied they were with one party of the design and construction team on each of the following aspects of project execution:

- Overall quality performance
- Flexibility in aligning with Client priorities
- Responsiveness in terms of efficiency
- Responsiveness in terms of effectiveness

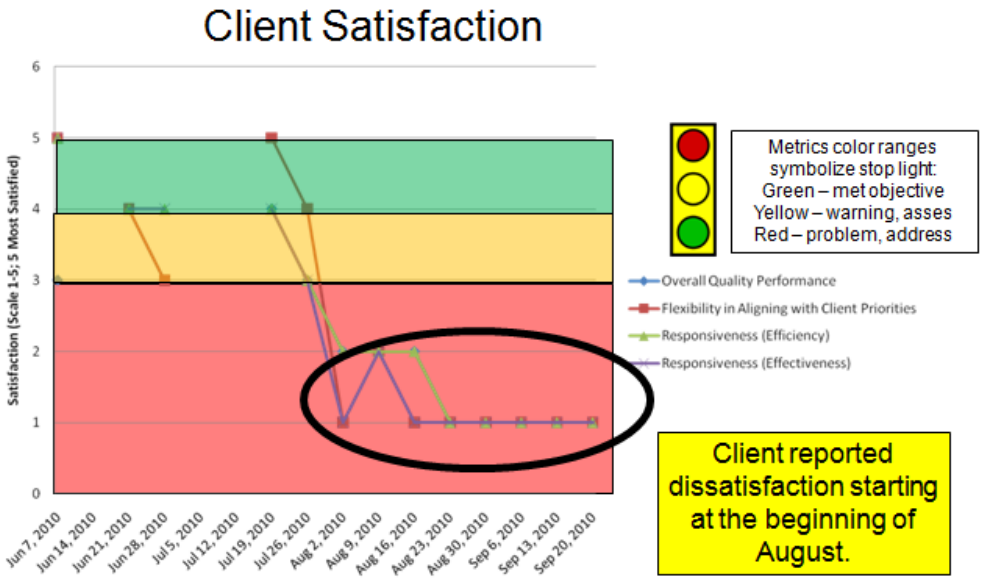


Figure 1: Results of Client Satisfaction Metric

From Figure 1, the Client developed an issue towards the beginning of August for the next two months. All measures of Client Satisfaction went down to a 1 and 2 satisfaction rating (5 most satisfied).

Meanwhile, the design and construction team reported on another new metric: Latency of Critical Issues. Project team members were asked at the week's end to list 5 of the most critical issues. For each issue, they were asked to report latency defined as the time from asking a question to receiving a useful

response back. We interpret results (Figure 2) to signify that high latency started to emerge in August – around the same time that the Client was dissatisfied.

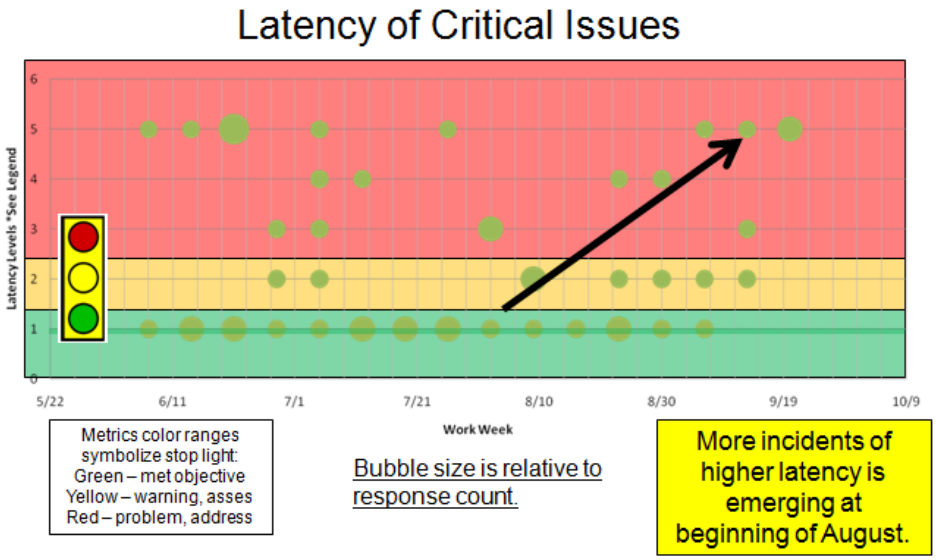


Figure 2: Results on Latency of Critical Issues Metric

Client satisfaction and Latency of Critical Issues were independently reported and not publically revealed. Only the research assistant received the survey results. Client satisfaction ratings and Latency of Critical Issues were modeled using a simple ANOVA analysis with Client satisfaction ratings as the dependent variable and levels of Latency as the independent variable. While not statistically significant, results show an inverse linear relationship between the Latency of Critical Issues and Client satisfaction ($p>.05$ in all cases).

Results of this case study shows preliminary evidence that measuring and reporting latency of critical issues on a project could indicate to the management team where their process is deficient. Management focus can be justifiably diverted. Furthermore, certain metrics can bring insight to strong correlation between management deficiencies and client satisfaction whether it is causal or not.

3. Project teams cannot tactically align to project deficiencies and Client priorities because performance monitoring is not frequent and public.

Six months into the project, one party of the design and construction team was replaced. Had the latency and client satisfaction metrics results been revealed sooner to the entire project execution team, perhaps the party could have identified an issue and mitigated it.

Current measures such as monthly cost reports and weekly 3-week look-ahead schedules do not indicate if management objectives are being met. These performance measures cannot be easily interpreted and translated into actionable measures because they are not frequent enough nor public enough.

4. Performance measures that are tracked do not effectively predict client satisfaction.

Managers currently track latency of Requests for Information (RFIs). The average latency of all RFIs was reported to the authors during the case study.

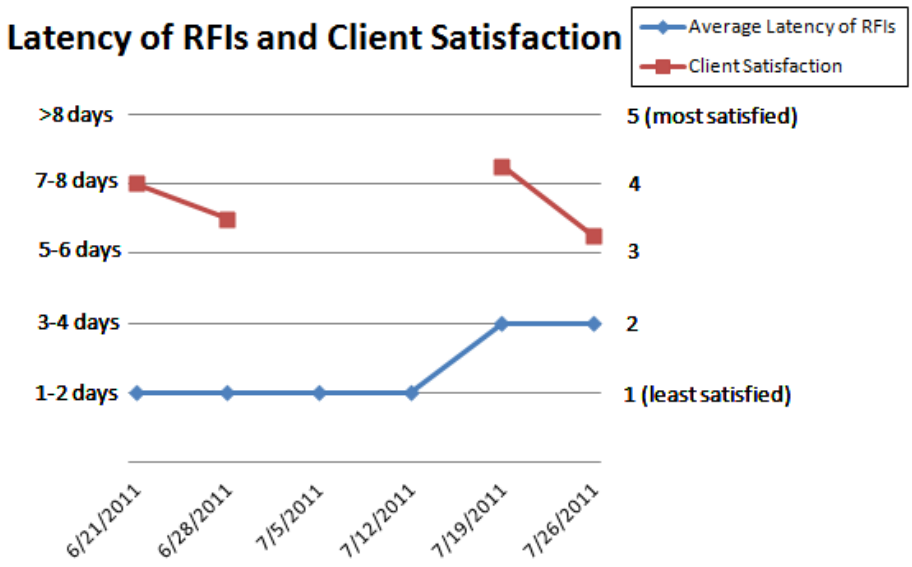


Figure 3: Latency of RFIs and Client Satisfaction Reported Over Time

As described above, Client satisfaction was also measured between June and July, 2011. However, there does not appear to be direct correlation between latency of RFIs and Client satisfaction. High latency of RFIs in a week was not paralleled with low Client satisfaction. Beyond RFIs, cost reports and schedule updates that are reviewed weekly or monthly do not lend themselves to an immediate identification of management deficiencies. While this may be an appropriate metric, a different way to measure and interpret latency of RFIs is necessary to better direct management focus.

The motivating problem necessitates a need for Client-based, tactical-driven project management using real-time measurement of meaningful metrics. Project teams must tactically align with project needs during project execution to sustain Client satisfaction. The alignment has to be efficient and effective and not only be based on the perception of satisfaction but controllable performance deficiencies. These deficiencies can be identified by the implementation of performance metrics involving tracking and reporting. Relevant metrics should be defined explicitly by the Client and implicitly through evidence that they affect Client perception. Finally, frequency of measurement is in real-time to initiate fast response to deficiencies.

5. Dynamic Performance Monitoring and Management (DPMM) framework

There is a theoretical essence of project execution that calls for a new framework which measures, explains and predicts management performance efficiently and consistently. The framework is called **Dynamic Performance Monitoring and Management (DPMM)**. Figure 4 below is a conceptual model of how the components of the framework address the three industry challenges presented previously.

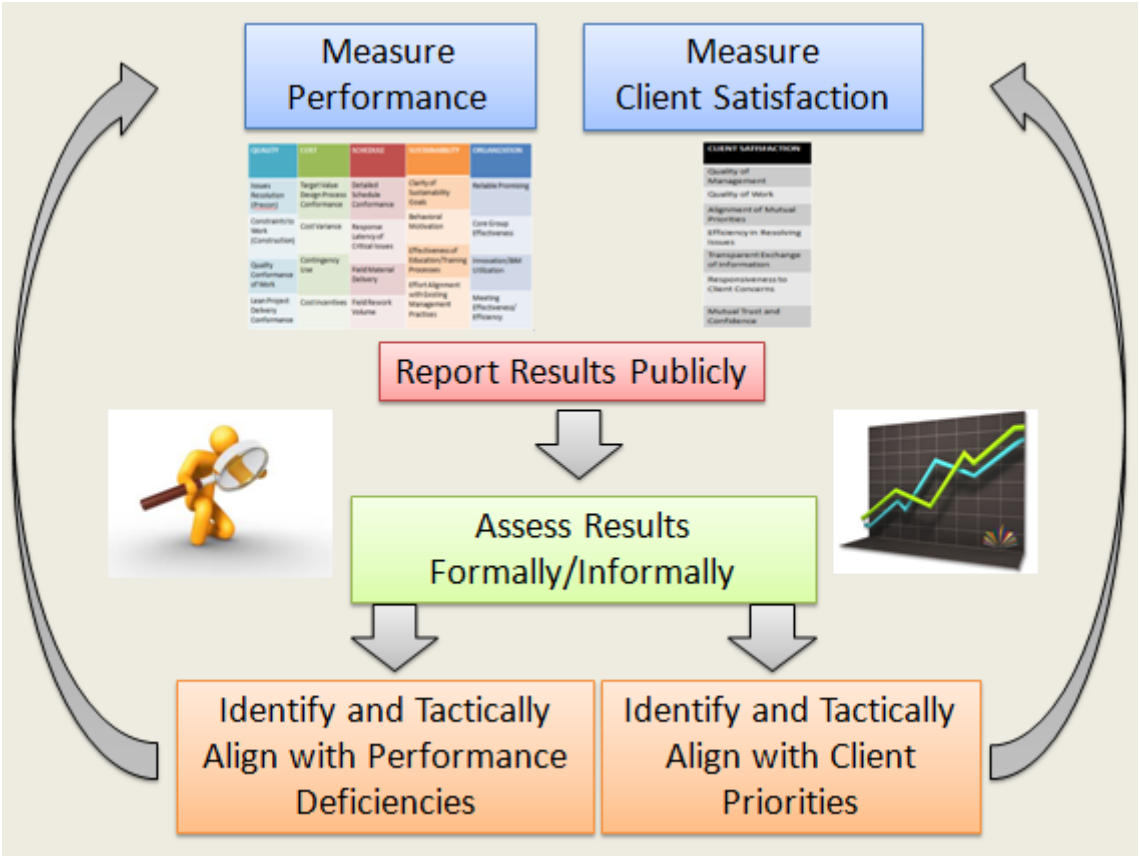


Figure 4: Dynamic Performance Monitoring and Management Framework

Problem 1: Management deficiencies cannot be readily identified because certain performance measures are not tracked at all.

> **DPMM Contribution:** *Performance Metrics and Client satisfaction metrics together comprehensively evaluate project execution across the dimensions of quality, cost, schedule, organization and sustainability.*

Problem 2: Project teams cannot tactically align to project deficiencies and Client priorities because performance monitoring is not frequent and public.

> **DPMM Contribution:** *Cyclical process of measuring performance and Client satisfaction, reporting results publically, assessing formally and informally and finally identifying and tactically aligning with performance deficiencies and Client priorities.*

Problem 3: Performance measures that are tracked do not effectively predict client satisfaction.

> **DPMM Contribution:** *Statistical correlation between Performance Metrics tracked and measured Client satisfaction. Assessment of the impact if dashboard metrics to actual client satisfaction.*

6. Points-of-Departure and Theoretical Limitations

Before we describe the construct of the Dynamic Performance Monitoring and Management framework, there are several practical and theoretical points in literature we would draw from.

In practice, inherent characteristics of construction projects are the sources of the overall complexities faced by the management team: projects operate in complex environments (Kreiner, 1995); teams are detached from formal authority (Cohen and Bailey, 1997); team members work on relatively autonomous tasks but in project environments that are highly reciprocally interdependent (Hartmann, 2008, Gann & Salter, 2000; Thompson, 1967). Constituents of the management team include design, construction and owner parties composed of multiple firms. Fragmentation and multi-firm non-collocation also influence the effectiveness of traditional management practices.

Many managers still execute project delivery in an intuitive fashion as they attempt to manage and allocate resources across project areas (Freeman and Beale, 1992). Current management practices (such as Integrated Project Delivery) have generated very little empirical research supporting their effectiveness beyond anecdotal evidence. This is in part because no theory on measuring management performance has been articulated to guide the empirical researcher.

In literature, the intuition calls for research in the broad area of management theory. The fields to be explored for points of departure and limitations are first in organizational effectiveness on *key performance indicators in evaluating project success*. Secondly, in strategic management research, Total Quality Management emphasizes the need for *continuous improvement and customer-oriented goal seeking*. Finally, in the area of applied microeconomics research, the relationship is empirically founded between *performance monitoring* and good management practice.

7. Key Performance Indicators in evaluating project success

Literature has explored the definition of project success but no consensus has been achieved. Chan and Chan (2004) performed a systematic critique of existing literature to develop a consolidated framework for measuring construction success quantitatively and qualitatively using Key Performance Indicators (Figure 5). Based on their findings, project success can be defined as the set of principles or standards by which favorable outcomes can be completed within a set specification. Nevertheless, definitions on project success are dependent on project type, size and sophistication, project participants and experience of owners.

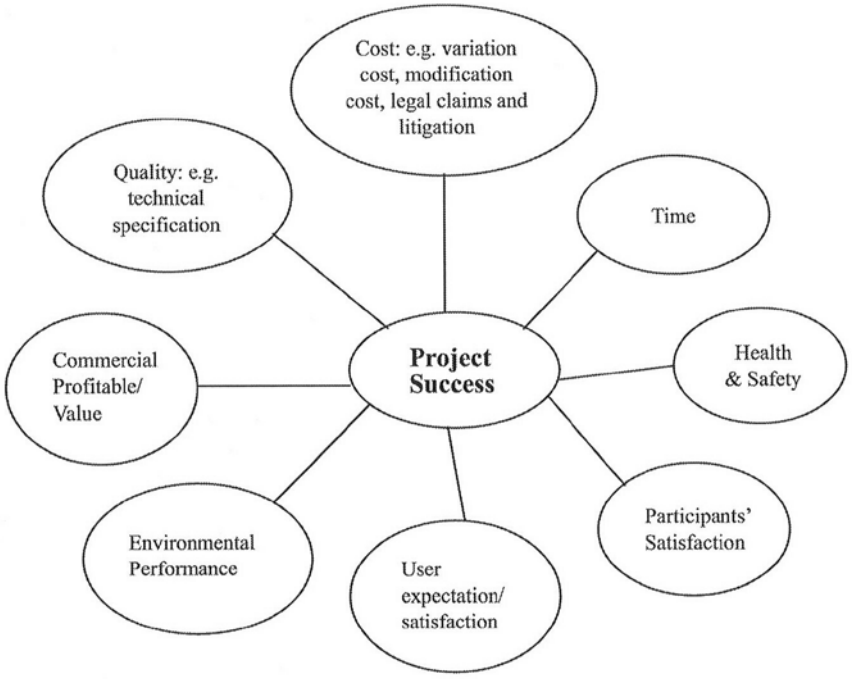


Figure 5: Consolidated Model for Project Success (Chan & Chan, 2004)

Of the consolidated KPI model, time, cost and quality are the fundamental criteria of measuring success (Belassi and Tukel, 1996; Hutush and Skitmore, 1997; Walker, 1995, 96). These three criteria have been named the "iron triangle" by Atkinson (1999). However, controllable process factors that facilitates achieving low cost, on-time and high-quality is not well understood and will be the contribution of this research.

User satisfaction is another KPI claimed by Liu and Walker (1998) to be an attribute of success. Torbica and Stroh (2001) believe that if end-users are satisfied measured post-occupancy, the project can be considered being successfully completed in the long term. The extension of this claim for our work is that during project execution, user or client-satisfaction is similarly important.

Variations in the definition of project success necessitate variations in KPIs. The process of developing KPIs should involve the following considerations: focus on critical aspects of outcomes; have a manageable number for regular use; having too many and too complex of KPIs can be time and resource-consuming; the systematic use of KPIs is essential to maximizing the value of KPIs; data collection must be made as simple as possible; large sample size is required to reduce the impact of project specific variables; measures must be accepted, understood and owned across the organization; KPIs need to evolve and be subject to change and refinement, graphic displays need to be simple in design, easy to update and accessible (Collin, 2002). DPMM will formalize these considerations into a framework and make advancement in organizational effectiveness research.

8. Total Quality Management (TQM) for continuous improvement and customer-oriented goal-seeking

Deming, Juran and Ishikawa were the original researchers that theoretically founded TQM ideology. TQM provides a unique approach to improving organizational effectiveness, one that has a solid conceptual foundation while applicable to practice by offering strategies for improving performance that takes account of how people and organizations actually operate (Wruck and Jensen, 1994).

Two core concepts of TQM will be extracted to lay the foundation for this research: customer-oriented goal-seeking and continuous improvement. While variations about TQM have been explored, the common view is that organizations' primary purpose is to stay in business to satisfy its customers. To achieve quality conformance, it is essential to know what customers want and to provide products or services that meet their requirements (Ishikawa, 1985). Information about customer requirements is critical for quality improvement for organizations to be able to focus specifically on those aspects of work processes that are most consequential for customer satisfaction. The limitation of TQM is that it does not explore the specific characteristics of what customer want. Hence, this research will benchmark the antecedents of customer or Client satisfaction, or the perceived factors that influence satisfaction in the construction domain. Subsequently, the actual correlation of the measuring the antecedents (independent variable) will be revealed by setting Client satisfaction as the dependent variable.

One main principle in the implementation of TQM is the focus on work processes. Management must guide the organization to measure, analyze, and improve work processes (Juran, 1974; Ishikawa, 1985, Deming, 1986). This is the concept of continuous improvement. Successful organizations commit to constant examination of technical and administrative processes in search of better methods. Opportunities to develop better methods for carrying out work always exist, and a commitment for continuous improvement ensures that people will never stop learning about the work they do (Juran, 1969; Ishikawa, 1985; Deming, 1986). The principle of continuous improvement will be used our research as the guiding motivation.

9. Performance monitoring

Good management has been difficult to define even though management literature has long stressed the importance of it. The barrier has been the absence of high quality data that are measured in a consistent way across firms. Especially on construction projects, industry heterogeneity such as differences in costs and benefits of implementing better practice prevent firms from adoption. Bloom and Van Reenen (2007) developed an innovative tool to systematically measure management practices across manufacturing firms. The methodology combined the econometric advantages of large sample surveys with the measurement advantages of more detailed case study interviews. Research findings included that better management practices are significantly correlated with higher productivity, profitability and sales growth rates (Bloom & Van Reenen, 2006). They explicitly developed indicators of managerial best practices. The research also explored why firms do not all adopt certain management practices they know are beneficial for them and why there is variation across firms and nations within industries in the practices. Reasons detected were industry heterogeneity, costly investment, contractual restrictions, managerial entrenchment and learning effects. These could explain similar obstacles to the adoption of certain management practices in the AEC industry.

Scoring management practices can be subjective as it is often contingent on a firm's environment. While some management practices are too contingent to be evaluated as "good" or "bad", others can potentially be defined in these terms. Performance monitoring is one of the practices that was defined as either "good" or "bad" and will be applied in the current research. Bloom and Van Reenen's evaluation tool defined "good" practice if: performance is continuously tracked and communicated, both formally and informally, to all staff using a range of visual management tools; performance is continually reviewed based on indicators tracked; all aspects are followed up to ensure continuous improvement; results are communicated to all staff; regular review/performance conversations focus on problem solving and addressing root causes; purpose, agenda and follow-up steps are clear to all; meetings are an opportunity for constructive feedback and coaching. The methodology of quantifying management is general enough to be applied to other sectors. We are extending the indicators of "good" performance monitoring from manufacturing to AEC into our framework.

Bloom and Van Reenens' research design surveys managerial practices from the employer perspective rather than the worker perspective. Our study alters the survey methodology to include all of the members of the design, construction and owner team that affect the outcome of project execution.

10. Dynamic Performance Monitoring and Management (DPMM) framework

10.1 Performance Metrics

A preliminary representative set of performance metrics make up the Performance Metrics Dashboard (See Figure 6). These metrics were established by a set of cross-sectional industry interviews and literature review in the area of KPIs. Designers, contractors, and Clients were asked about their perception of metrics that are antecedents (have influence) of Client's perceived satisfaction. Some of the metrics are directly interpreted from several industry standard contract agreements (Target Value Design Process Conformance – IPD agreement). The matrix of metrics are expected to evolve from project to project. More focus can be put on any of the five dimensions of quality, cost, schedule, sustainability and organization. The number of metrics also can vary. However, Collin's study on KPIs says a manageable number of measures is effective.

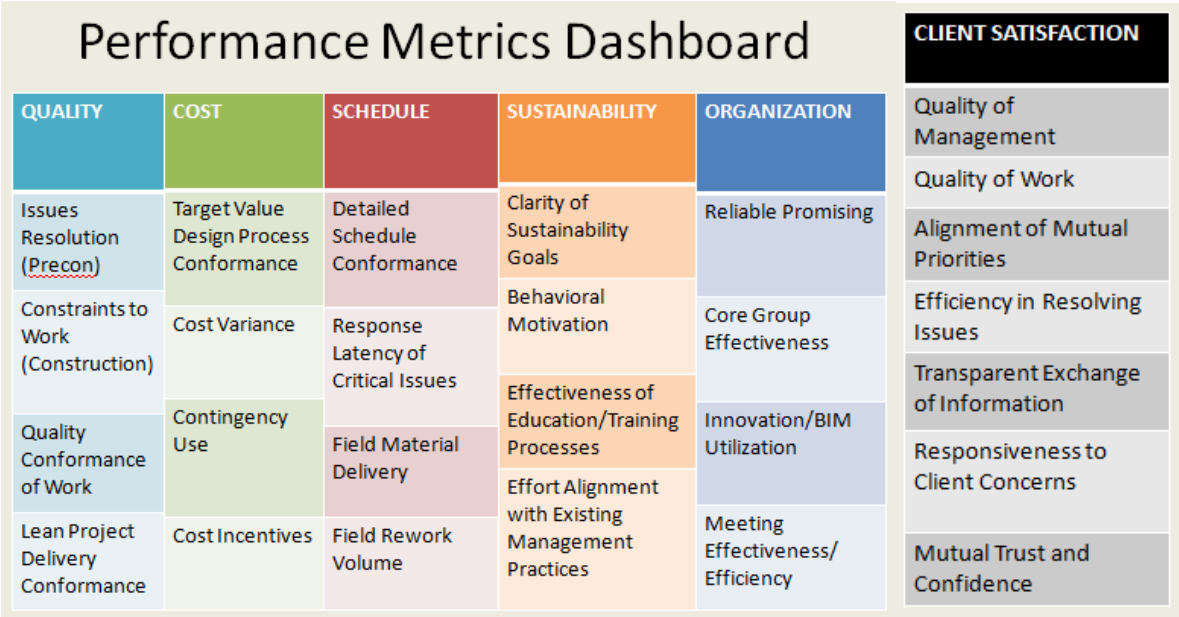


Figure 6: Performance Metrics Dashboard and Client Satisfaction Metrics

10.2 Metrics Reporting

Members of the design and construction team as well as the Client team (facility owners, developers or construction management representatives) will be surveyed on specific metrics that pertain to them given their roles and responsibilities on the job. The authors of this research will facilitate the online surveys as part of the framework validation. Client satisfaction metrics will only be reported by the Client team members. Each metric consists of less than five survey questions. Most survey questions are multiple choice. Few require describing a specific example or issue. All questions have a field for additional comments. See Figure 7 for a metric survey prototype.

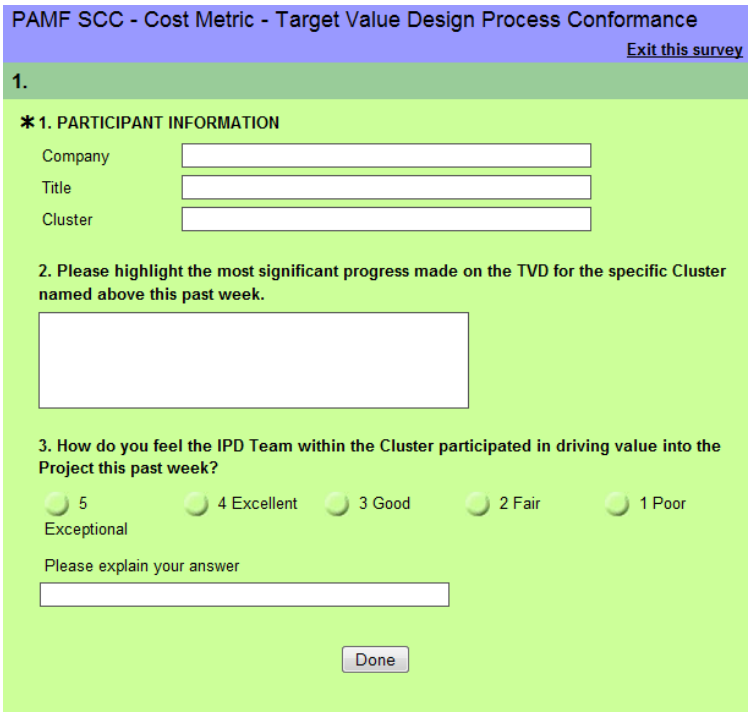
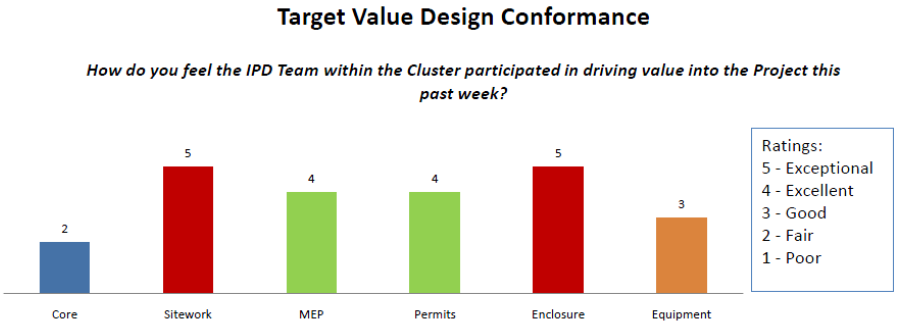


Figure 7: Sample Metric Survey

10.3 Metrics Assessment

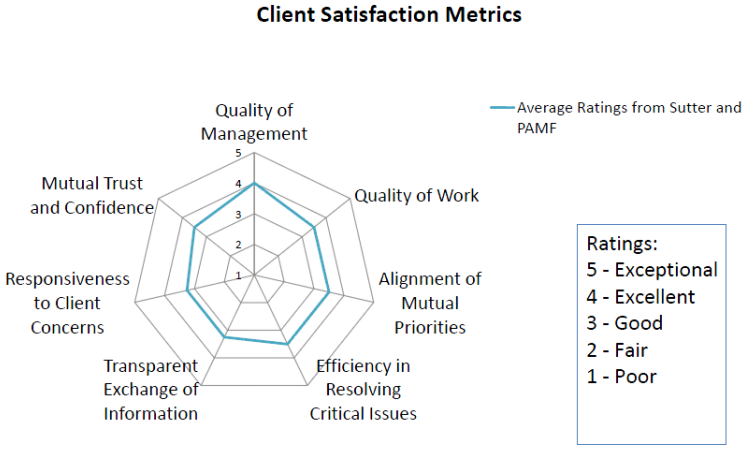
One week after the surveys are distributed for completion, the authors of this paper will report the results in graphical format. KPI literature states that graphic displays need to be simple in design, easy to update and accessible (Collin, 2002). The distribution will be via a project-specific website viewable only by project team organizations. Senior executives from stakeholder organizations will also be distributed the results for high-level guidance and intervention if necessary. A sample of how the results are displayed is presented in Figure 8 and Figure 9.



Examples of significiant progress made on TVD:
"development and pricing of A3s"
"organized Core Gas A-3 for CG approval (2.5 yr payback and will save PAMF $30,000/year); finalized availability of Big Room space"
"identifying immediate tasks and schedule for completing tasks; assigning responsible persons"
"determined Pro-X header is not a cost savings but king studs at window jambs is, and requested KHSS to provide more accurate cost difference"
"it is too early in the project start-up to judge"

Click here to view detailed responses:
http://www.surveymk.com/sr.aspx?sm=MXG7PYCdc3bfDLgYEAtSGB6u_2fxUMhe2vM0WggNERw14_3d

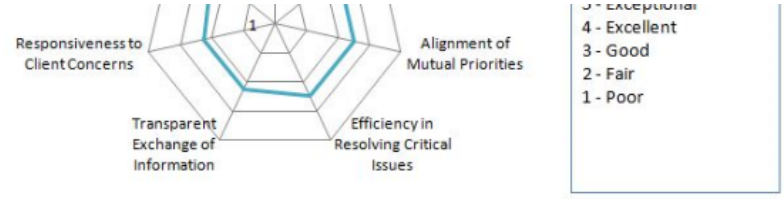
Figure 8: Metric Results for Target Value Design Conformance



Click here to view detailed responses:
http://www.surveymk.com/sr.aspx?sm=9zPV1OURiSBghCETvU6ik_2fpqiuXGTGmv1TRILA4P1_2fo_3d

Figure 9: Metric Results for Client Satisfaction

Assessment is done formally during routine project meetings or informally via the project website where results are posted. Comment fields relating to each metric result will serve as a forum to facilitate informal interpretation and discussion (Figure 10).



detailed responses here: **http://www.surveymk.com /sr.aspx?sm=9zPV1OURiSBghCETvU6ik_2fpqiuXGTGmv1TRlLA4P1_2fo_3d**

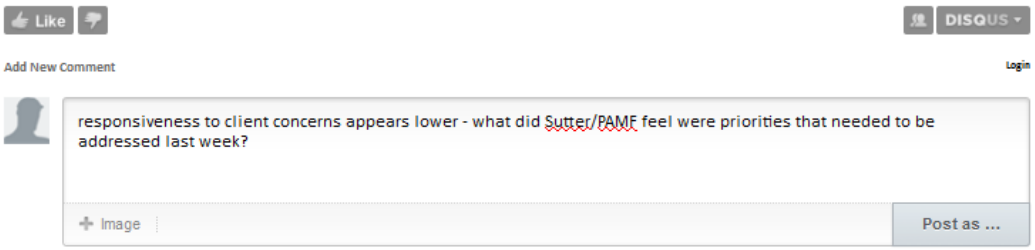


Figure 10: Informal Discussion Forum

10.4 Tactical Alignment

DPMM is expected to influence managerial behavior change. Variations in that change can be rationalized by differences in the interpretation of metrics data. Post-assessement of management deficiencies will attract attention to those deficiencies. Informal and formal interpretation of metrics results are mechanisms for tactical change. Project teams will respond to areas reported to be Fair or Poor by the Client. Meanwhile, the project team will be guided by specific process metrics from the Performance Metrics Dashboard to identify controllable process deficiencies across the dimensions of quality, cost, schedule, sustainability and organization.

11. Analysis and Validation

The purpose of this paper is to present the need for DPMM and the construct of the DPMM framework. Validation of the framework has yet to be completed. Five case studies are in place to be used for implementing DPMM for three different Clients (Sutter Health, Walt Disney and Stanford University).

Regression analysis will be used to find correlation between individual performance metrics and Client satisfaction. The hypothesis is that while certain metrics were gathered from interviews to be antecedents of Client satisfaction, they may in fact not be. Stronger correlation will probably be found with metrics such as Latency of Critical Issues, weaker with Constraints Resolution based on preliminary analysis in the motivating problem case study.

Internal validation for robustness of DPMM will be evaluated on how much it effects behavioral change (based on continuous improvement research) and how well it can predict Client satisfaction over time. Longitudinal case studies on five projects over at least six months each will provide sufficient evidence of variations in performance and Client metrics results. One baseline case study will serve as the control case with no intervention to show relative impact of DPMM.

External validation on the representativeness of the Performance Metrics Dashboard will be ascertained by resurveying different industry members by a different interviewer. In addition, repeatability of results on varying case studies with varying Clients and project execution teams will also show external validation.

12. Concluding Remarks

The DPMM framework is empirically developed and theoretically founded based on three major strands of literature. Project execution can be better managed with a systematic, real-time performance monitoring strategy. Meaningful metrics can guide the management team to tactically align with both performance deficiencies and Client priorities. DPMM can be validated in two ways. Since project success is ambiguously defined and cannot be used to validate the predictive value of DPMM, the Client's perceived satisfaction of project execution is a starting point to provide evidence that DPMM is improving the project. Second, evidence regarding tactical alignment can be measured by changes in behavior. More strongly, regression analysis at the end of the case studies can be done to find correlation between certain performance metrics and their effect on Client satisfaction metrics.

13. References

K. Kreiner, In search of relevance: project management in drifting environments, *Scandinavian Journal of Management* **11** (1995), pp. 335–346.

D.M. Gann and A.J. Salter, Innovation in project-based, service-enhanced firms: the construction of complex products and systems, *Research Policy* **29** (2000), pp. 955–972.

T. Hartmann, A Grassroots model of decision support system implementations by construction project teams, Ph.D. Dissertation Department of Civil and Environmental Engineering, Stanford University, Stanford, 2008.

S. Cohen and D. Bailey, What Makes Teams Work: Group Effectiveness Research from the Shop Floor to the Executive Suite Journal of Management June 1997 23: 239-290.

J.D. Thompson, Organizations in action. New York: McGraw-Hill, 1967.

M. Freeman, Measuring project success, Project Management Journal, 1992, vol. 23, Issue 1, 8.

A. Chan and A. Chan, Key performance indicators for measuring construction success, Benchmarking: An International Journal, Vol. 11 Iss: 2, 203-221, 2004.

W. Belassi, and O. Tukel (1996), "A new framework for determining critical success/failure factors in projects", International Journal of Project Management, Vol. 14 No. 3, 141-51.

Z. Hatush and M. Skitmore (1997), "Evaluating contractor prequalification data: selection criteria and project success factors", Construction Management and Economics, Vol. 15 No. 2, 129-47.

D. Walker (1996), "An investigation into construction time performance", Construction Management and Economics, Vol. 13 No. 3, 263 - 74.

R. Atkinson (1999), "Project management: cost, time and quality, two best guesses and a phenomenon, its time to accept other success criteria", International Journal of Project Management, Vol. 17 No. 6, 337-42.

J. Collin (2002), "Measuring the success of building projects - improved project delivery initiatives", July 2002.

K. Wruck and M. Jensen (2002), "Science, specific knowledge, and total quality management", Journal of Accounting and Economics, Vol 18 Iss 2, 247-287.

K. Ishikawa (1985), "What is total quality control? The Japanese Way", Englewood Cliffs, N.J., Prentice Hall.

N. Bloom and J. Van Reenen (2007), "Why do management practices differ across firms and countries?", Journal of Economic Perspectives, Vol 24, No 1, Winter 2010, 203-224.

N. Bloom and J. Van Reenen (2006), "Measuring and explaining management practices across firms and countries", NBER Working Paper No. 12216, May, 2006.