

## S18-3

## Performance Management System for Benchmarking in Construction Companies

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**ABSTRACT:** In competitive society, performance management is an essential element of business success. Despite the importance of performance management, it has not been widely implemented in construction companies. In the recent years, construction companies have become more aware of its need to identify, implement, and sustain performance improvements more systematically. Thus, the objective of this paper is to develop performance management system (PMS) for construction companies. The roles of performance management system is not only measuring performance but also offering guidance to improve performance. Therefore, PMS needs benchmarking process that provides Best Practice and new knowledge. This paper investigates the case of PMSs in UK, USA, Brazil, and Chile and discusses the lessons learned. To overcome the limitations of existing PMSs, new performance measurement framework, in form of ‘Construction’ BSC, is proposed. Based on the ‘Construction’ BSC, key performance indicators are derived and methodology of performance management is suggested. This paper concludes by developing PMS for benchmarking in construction companies and recommending some further directions on this research topic.

*Keywords:* Key Performance Indicators (KPI), Performance Management System, Benchmarking, BSC

## 1. INTRODUCTION

In a time of globalization and an increasingly competitive environment, measuring performance has become critical to business success [6]. Across industries, the issue of performance measuring of organizations has risen in the academic and business agenda over the past 15 years, in what Neely (1999) described as a revolution [5]. The construction industry is no exception. Especially, construction companies having complex managerial work, including the simultaneous implementation of various projects and the control of many input resources are not too much to emphasize the importance of performance measurement. Performance measurement is used as a management tool for examining and improving overall performance of projects and organizations. Construction companies have strived to develop performance management systems for efficient and systematic performance management.

Despite their effort, only a few have performance management processes, which provide key support for decision-making processes (Lynch and Cross 1995, Kaplan and Norton 1992). Moreover, some companies have too many measures, most of them linked to support functions rather than to the key processes that companies most need to control (Costa and Formoso 2004). This tends to make it difficult for the company managers to determine priorities of management and to define the key indicators that should be used for comparison with other

companies (Schiemann and Lingle 1999). However, the effective implementation of performance management system is not only simple a matter of selecting the right measures but also implying a deeper change in the decision-making processes and the learning approaches adopted within an organization (Lantelme et al. 2001)[1].

Thereupon, benchmarking has become more commonly discussed as a tool of efficient performance management. Benchmarking is an important continuous improvement tool that enables companies to enhance their performance by identifying, adapting, and implementing the best practice identified in a participating group of companies. Benchmarking aims at comparing the performance of companies relative to each other, allowing these companies to recognize their weakness and strengths compared to the industry [14].

According to Garvin (1993), the greatest benefits of the benchmarking process are that it allows more efficient work and that it involves managers proactively in the process rather than depending exclusively on results [1]. In recent years, benchmarking programs have been established in countries such as Australia (Karim et al. 1997), Brazil (Costa et al. 2004), Chile (CDT 2002), Denmark (Byggeriets Evaluering Center 2002), the United Kingdom (Constructing Excellence 2004), the United States (CII 2000), Hong Kong, Singapore, and the Netherlands (Bakens et al. 2005)[1].

However, most performance measurement indicators for benchmarking in the construction industry have

concentrated on the management of project level. Moreover, a management system that could be used to compare an organization's performance or be used for benchmarking is lacking (Cheah et al. 2004)[7]. The objectives of this paper are to select key performance indicators at construction company level and to develop performance management methodology through benchmarking. The procedures used in the research consisted of three phases:

(1) Investigate focused on four performance management systems carried out in Brazil, Chile, the United Kingdom, and the United State and discuss the lessons learned

(2) Select key performance indicators which is adopting new construction performance measurement framework in form of a 'Construction' BSC that this paper suggested

(3) Suggest performance management methodology and develop performance management system.

## 2. Literature Review

### 2.1 Performance measurement and management

Performance management is the process of management contributes to the effective management of individuals and teams to achieve high levels of organizational performance (Armstrong et al. 2004). Performance measurement information is used to manage performance. The use of performance measurement information effects positive change in organization culture, systems and processes by helping to set agreed-upon performance goals, allocating and prioritizing resources, informing managers to either confirm or change current policy or program directions to meet those goals, and sharing results of performance in pursuing those goals(Procurement Executive Association 1999).

Performance measurement is the process of determining how successful organizations or individuals have been in attaining their objectives [and strategies] (Evangelidis 1992). Bititci et al. (1997) explains the distinction between performance management and measurement. Performance management is seen "as a closed loop control system which deploys policy and strategy, and obtains feedback from various levels in order to manage the performance of the system". Whereas, a performance measurement system "is the information system which is at the heart of the performance management process and it is of critical importance to the effective and efficient functioning of the performance management system". Therefore, performance measurement is the process of "determining how successful organizations or individuals have been in attaining their objectives and strategies" (Daniels and Burns 1997).

To put it simply, performance management includes performance measurement and is developed as time goes by. The results of management are used as information of

measurement and the information is provided to performance management. Through these repetitive processes, management and measurement maintain relationships.

### 2.2 Performance measurement framework and Benchmarking

Construction companies have implemented a number of "performance measurement frameworks (KPIs, BSC, EFQM Excellence)" and "performance improvement initiatives/methods (Benchmarking)"[6]. In the construction industry, studies using a variety of performance measurement frameworks have been implemented since the mid 1990s. The recent studies mainly explain the theories and conceptual frameworks of performance measurement. Establishing a suitable implementation framework for performance evaluation and management in construction companies is considered very important [7]. The Balanced ScoreCard(BSC) and the EFQM's Business Excellence Model(BEM) are framework that use measures of an organization's performance to drive organizational improvement. A separate review of the BSC and BEM are to follow.

The Balanced Scorecard is a framework that expresses an organization's strategy as a set of measurable goals from the perspectives of owners/investors, other external stakeholders, and the organization itself. BSC is divided into four perspectives which are financial perspective, customer perspective, internal business perspective, innovation and learning perspective. It has an important underlying principle, which is cause and effect between perspectives. The EFQM Business Excellence Model is a framework designed to assist organization achieve business excellence through continuous improvement in the management and deployment of processes to engender wider use of best activities. It enables that calculation of scores against a number of criteria that can be used for either internal or external benchmark comparisons.

The use of performance measurement frameworks had a significant effect on the development and effectiveness of benchmarking. Conversely, benchmarking adds value to performance measurement because it allows companies to compare their data [1]. Camp (1989) defined benchmarking as, the continuous process of measuring products, services, and practices against the toughest competitors or those companies recognized as industry leaders. The construction industry institute(CII) has adopted the definition of benchmarking as a systematic process of measuring one's performance against results from recognized leaders for the purpose of determining best practices that lead to superior performance when adapted and implemented (Hudson 1997).

### 3. Case Studies

#### 3.1 Performance Management Systems for benchmarking in different countries

In the last few years, there have been performance management systems for benchmarking in different countries; key performance indicators from UK; National Benchmarking System for the Chilean Construction Industry; Construction Industry Institute Benchmarking and Metrics from the USA; and Performance measurement systems for Brazilian Construction Industry.

##### *Key Performance Indicators (KPI) in the UK*

The KPI Program was launched by the U.K. Best Practice Program in 1998. The purpose of the KPI program is to enable measurement of project and organizational performance through a large number of projects and hence provide indicators about performance of the construction industry. This information can then be used for benchmarking purposes, and is assumed to be a key component of any organization's move towards achieving best practice. The KPI framework consists of seven main groups; Time, Cost, Quality, Client Satisfaction, Client Changes, Business Performance, Health and Safety. Within these groups, a range of indicators has been developed to analyze either projects or company performance, or both (KPI 2001). A few hundred companies have been participating in the Best Practice Knowledge Program and a benchmarking club. The companies are responsible for collecting data, introducing them into the database, and updating them. They can access reports and wall charts, containing graphs of performance, so they have advantages of marketing and improving performance opportunities.

##### *National Benchmarking System for the Chilean Construction Industry (NBS-Chile)*

The NBS-Chile was developed by the Corporation for Technical Development (CDP) of the Chilean Chamber of Construction [2]. By comparing Key performance indicators, the CDP hopes to identify best practices and generate short-term improvement opportunities for participating companies (CDT 2002). The program consists of performance measurement for benchmarking and benchmarking clubs (Grillo and Garcia 2003) [1]. The set of indicators is concerned with five sub-sectors of the construction industry; high-rise building, low-rising building, civil works, heavy industrial construction, and light industrial construction [2]. The national benchmarking system mainly used quantitative tools, such as mean, ranking curves, radar graphs, and tables displaying companies' results, for data analysis (CDT 2002).

##### *Construction Industry Institute Benchmarking and Metrics (CII BM&M)*

The CII Benchmarking and Metrics Program started in 1993(CII 2000). It aims to provide performance provide performance norms to the industry, quantify the use and value of best practices, and to help focusing CII research and implementation effort [2]. The CII BM&M collects project data as an ongoing process through its web-based system. In this system, projects can be immediately compared to other projects also in the database, and reports show metrics scores, performance quartiles, and graphic comparisons of individual project performance overtime. Besides the web-site and guides to support the implementation of the system, this program provides annual training the Benchmarking and Metrics Program company members aiming to improve the reliability of the benchmarking process (CII 2003).

##### *Performance Measurement system for the Brazilian Construction Industry (SISIND)*

The SISIND-NET project was established in 1993. The aim of this project was to disseminate performance measurement concepts, principles and practices in the construction industry, by devising a performance measurement system for the sector, named SISIND. SISIND project has been focused on small sized construction firms, since they correspond to a very large percentage of the industry in Brazil both in terms of the number of companies and output. It involves the conception and implementation of a performance measurement system for benchmarking for the Brazilian Construction Industry through the development of a web-site for disseminating and collecting data, the development a web-based tutorial that can be used for training, and the promotion of workshops and training courses in different places in Brazil, aiming to disseminate and implement the set of measures [2].

#### 3.2 Lessons Learned and limitations

Based on the analysis of Performance management systems for benchmarking in the UK, the USA, Chile, and Brazil, key factors for the design and implementation of PMS for benchmarking were identified;

(1) A learning environment within the companies is created through the benchmarking clubs, motivating them to transfer the knowledge from that forum into the local condition. It appears that benchmarking clubs may have an important impact on the construction industry because they encourage the development of a culture of innovation, leading to improvement action instead of only data comparison [1].

(2) PMSs offer an interactive online tool for the collection and evaluation of performance indicators. The participating companies submit data to a database manager. Then, the users are allowed to access an assortment of documents and provided immediate feedback for the benchmarking club members.

In this paper, analysis of current performance management systems has been focused on performance measurement framework and management process for benchmarking. The existing PMSs have three limitations, as follows;

(1) Most performance indicators are KPO (key performance outcome, lag indicator) that are based on project outcome. Although, KPOs are important to assess the success of a company's strategic objectives, KPD (Key performance driver, lead indicator) are also necessary because KPD help to anticipate the impact on future desired results.

(2) Many of existing indicators are more adaptable to individual projects. This limited view communicates only a single metric performance for a specific project. No insight is provided into the overall performance of the company. Clear distinctions and relationships between project level's performance indicators and company level's ones are needed.

(3) Performance management process in system is mainly focused on comparing companies' performance. PMS should be fully described and critically analyzed, with a focus on the transmission of knowledge. There is a need for new performance management process which is not only to the identification of common measures for data comparison among companies but also to learning opportunities that exist by sharing managerial practices among companies.

#### 4. Development of Performance measurement framework

An effective performance management will greatly depend on the performance indicators used to define the performance of the organization from a number of perspectives. Therefore, it is very important to design those indicators so that they relate directly to the various perspectives that an organization decide to adopt [9]. As discussed above, existing performance indicators have limitations that most indicators are KPO based on project level. In an attempt to overcome limitations of the existing indicators, new performance measurement framework is suggested in this paper. Then, key performance indicators are selected through the proposed measurement framework.

##### 4.1 'Construction' BSC

Construction is a technology-intensive industry as well as a labor-intensive industry. It is required the improvement of core capability and the creation of a higher value. On this, there is a large range of opinion on linking strategy to performance management. Recently, construction companies have used a more balanced approach with the monitoring of nonfinancial measures [6]. Balanced ScoreCard (BSC) has an advantage of making up for the weak points in existing frameworks as selecting leading measures as well as lagging measures.

BSC has been described as one of the most influential business ideas of the past 75 years by the Harvard Business Review and is estimated to be used by 50% of the Fortune 1,000 companies, 45% of major companies in Europe.

Therefore, the proposed framework adopts the BSC framework. However, there is a limitation to adopt construction companies which operate many projects. Construction companies' performance has to be evaluated by performance measures of each project, activities of head office and supporting organization. Original BSC have difficulties in measuring both project level and company level.

In an attempt to provide a balanced approach to construction performance measurement, the framework is developed, in the form a 'construction' BSC, for the construction company. This framework consists of two levels (company level, project level) and four perspectives (financial perspective, customer perspective, internal business perspective, innovation and learning perspective) in each level. Four perspectives and their associated key performance indicators are customized for the specific elements of construction. KPIs have relations between four perspectives as well as two levels.

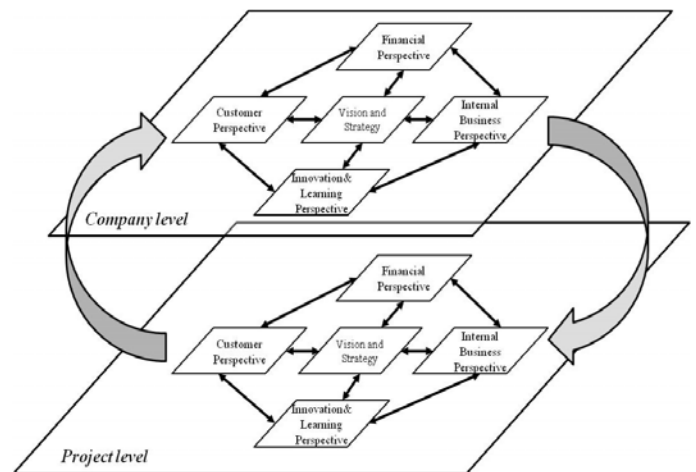


Fig.1. Proposed 'Construction' BSC with two levels and four performance perspectives

According to Walsh, KPIs can be classified as two types, Key performance outcomes (KPO) and Key performance drivers (KPD). Key performance outcomes (KPOs) are measures which indicate progress towards company objectives. The Key performance drives (KPD), on the other hand, are measures which have a direct influence on the outcomes. Improving KPOs will necessitate improving the KPDs [10]. Therefore, in this paper, both KPOs and KPDs are derived as KPI by procedures, as shown in fig.2.

First of all, through survey on the internet and literature review, 22 Critical Success Factors(CSFs) are derived; Profitability, growth potential, stability, external customer satisfaction, internal customer satisfaction, company image, business efficiency, research and development, organization competency, extension of business unit,

business and marketing capability, human resource development, Informatization, business culture, cost management, external customer satisfaction, internal customer satisfaction, safety management, quality management, schedule management, environment management, technological capability.

Then, based on CSF, pre-KPIs are selected. After that, expert interviews are carried out and 47 KPIs are derived; ROE, EVA, ordinary income rate on selling amount, return on net sales, rate of operating expense to sales, net sales growth rate, total asset turnover ratio, debt ratio, current ratio, interest coverage ratio, borrowing ratio, credit rating, advertising costs as a percentage of sales, public contribution expense as a percentage of sales, state of award, employment separation rates, performance reward rate, number of claims, percentage of answering the requirement, the popularity of company brand, R&D expenses as a percentage of sales, intellectual property, level of knowledge sharing, employee productivity, level of business observance, level of business informatization, accuracy of business process, new business development expense as a percentage, a market share rate, tender success rate, ranking of constructability valuation, training time per employee, training investment per employee, percentage of employee with advanced degree, the number of certificate, frequency of employee proposal, frequency of using information system, IT investment as a percentage of sales, the attainment rate of sales goal, the attainment rate of bill collecting goal, number of claim in a job site, employee satisfaction in a job site, injury rate, rework rate, schedule delay rate, the number of pointing out in a job site, training time per employee in a job site.

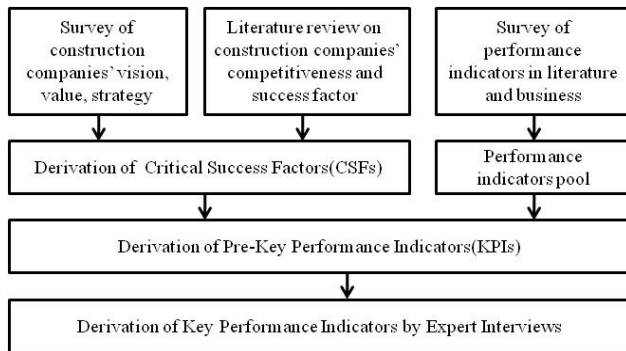


Fig.2. Procedures of the KPI derivation

**5. Methodology of Performance Management**

Based on performance measurement framework, 'construction' BSC, the methodology of performance management is presented.

**5.1 Relations between KPIs**

Kaplan and Norton named link between CSFs 'strategy map'. It is developed from original four perspectives of BSC. However, when looking strategy map, it is not clear which KPI have to manage. There should be relationships

between the KPIs, not CSFs. In this paper, the strategy map which has the relations between KPIs is proposed to be used in business, as shown in fig.3. The suggested strategy map also has relations between company level and project level.

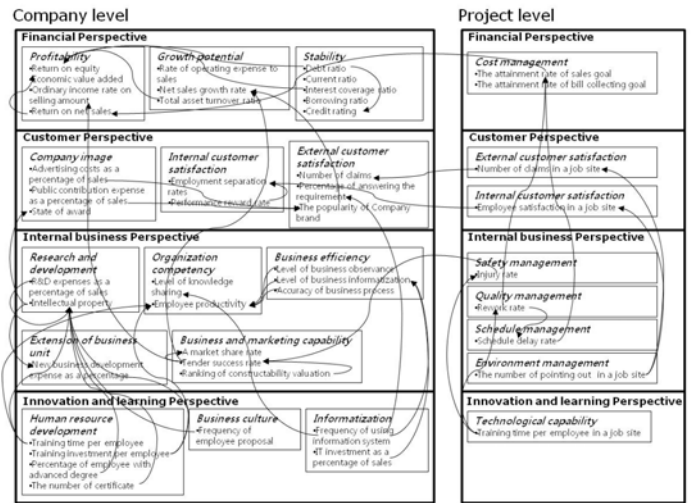


Fig.3. Performance Strategy Map

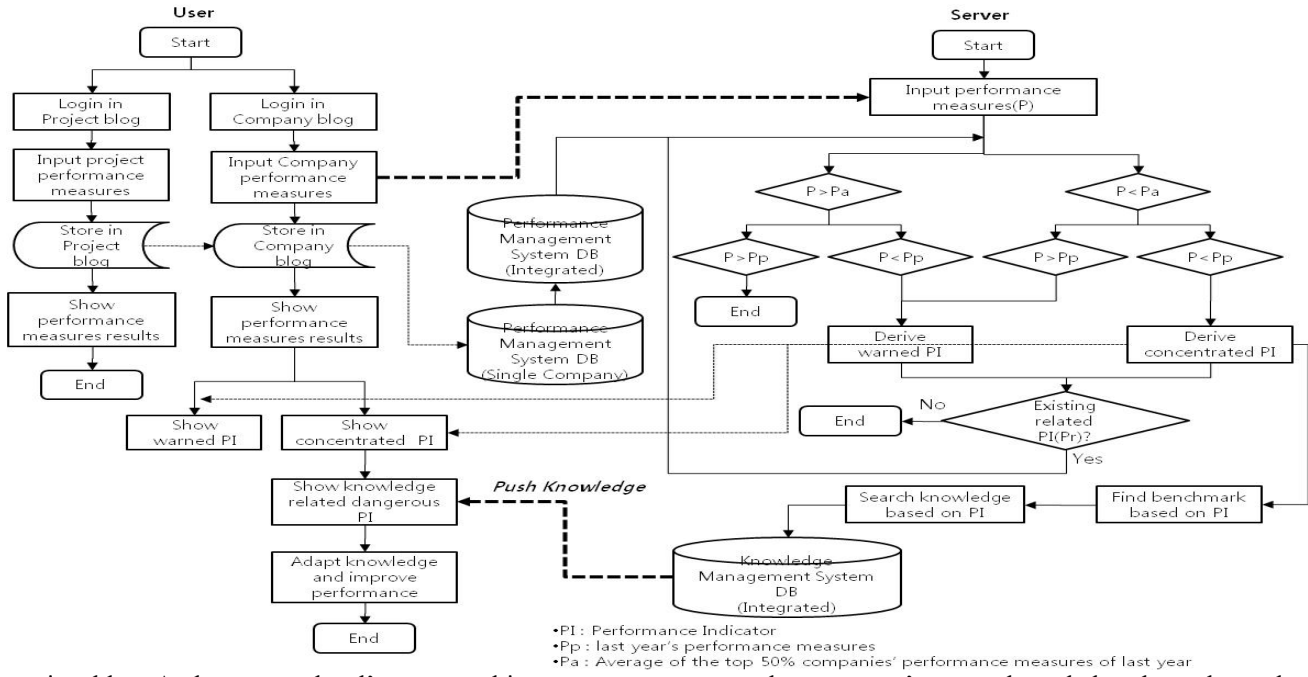
As stated above, KPIs consist of KPD and KPO. Strategy map provides information of which KPDs have to be managed, in accordance with KPO. Through relations between KPO and KPD, the company can find out what actions have to be taken. For example, if the attainment rate of sales goal (KPO) is low, the company has to check the schedule delay (KPD) and rework (KPD) which is linked to the attainment rate of sales goal.

**5.2 Derivation of 'concentrated KPIs'**

The companies input the KPI's measures and the measures are stored in Performance Management System (PMS) database. The results are shown in the form of table and graph. However, the companies can't manage and concentrate on all KPIs. The KPIs have to divide into the things which have to be focused or not. First of all, input measures are compared with the average of the top 50% companies' measures of last year. If input measures are higher, those are compared with the average of the company's own measures of last year. In case, input measures are lower, those are derived as 'warned KPI'. The other hands, if input measures are lower than the average of the top 50% companies' measures of last year and company's own measures of last year, those become 'concentrated KPI' which have to improve.

**5.3 Knowledge push using blog**

Mills (2007) insisted that the Blog can be used as a tool of knowledge management in construction industry. Among companies, it is effective and efficient that blogs are used for sharing their performance information, knowledge and Best Practices. Project level's performance measures and knowledge are stored in



project blog. And company level's are stored in company blog. As Construction Company has a variety of projects, company blog joins project blogs together. The users who

not only company's own knowledge but also other companies' knowledge is able to be pushed.

Project blog and company blog are developed based on

Fig.4. Implementation model of performance management

monitor company's performance can attain the information of 'concentrated KPI' which derived by above 5.2 algorithms. After deriving 'concentrated KPI', a high-ranking company refer to 'concentrated KPI' becomes a benchmark. In Benchmark Company's blog, knowledge related to 'concentrated KPI' is automatically retrieved through knowledge management system database, and knowledge pushes to users. It is shown the implementation model of performance management using knowledge push in fig.4. The implementation model proposed in the paper provides a new approach to solve the performance management system's problems at present.

ASP.net, HTML, and java script. Performance measures and knowledge are sent to company blog in form of XML in real-time. And application is based on Internet Information System (IIS) and Microsoft SQL server (MSSQL).

**6. Development of Performance Management System for construction companies**

Fig.5. shows the key components of performance management system. There are project blogs and company blogs in information system and they are synchronized. Project managers store performance measures in performance management system which is in project blog. Then, all projects' performance measures are put together in company blog. Company managers are able to compare all projects to find out Best Practices and identify performance report, ranking list, etc. In company blog, performance management system and knowledge management system are linked. Therefore, knowledge which is related to performance measures is pushed from knowledge management system to performance management system. As sharing database,

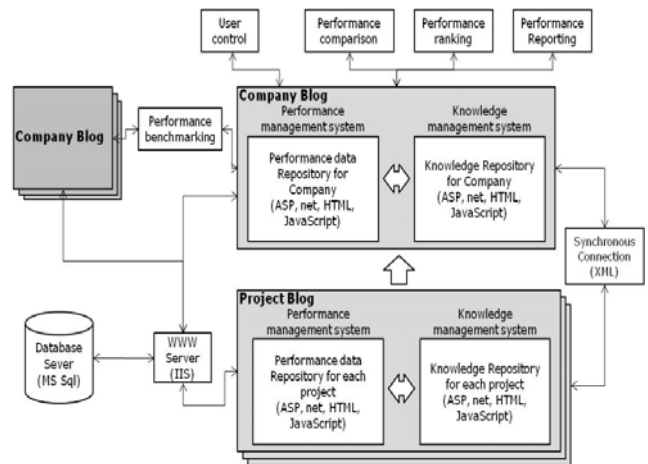


Fig.5. Performance Management System Architecture

**7. Conclusion**

The analysis of existing performance management systems in other countries carried out in this paper. Lessons learned and some limitations which are focused on two parts have been pointed out; performance measurement framework and performance management

methodology. To overcome limitations, new performance measurement framework in form of 'construction' BSC is proposed. There are four perspectives as original BSC and two levels which are able to measure projects and companies' performance. Using 'construction' BSC, Key Performance Indicators are derived. And then, methodology of performance management is suggested to improve on a low-grade KPI. Knowledge related to a low-grade KPI is automatically retrieved and pushed through knowledge management system which is linked with performance management system.

The proposed performance management system in the paper will be able to improve construction companies' competitiveness by offering information of companies' performance and pushing knowledge. However, to be generalized performance management system, the verification should be conducted in the future research.

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