Taming Big Data with Business Intelligence

A CM Perspective

Sergio Aranda e-Builder

Marty Turner, CCM CH2M

A CMAA Emerging Technologies Committee Article

The authors have worked to ensure that all information in this book is accurate at the time of publication and consistent with standards of good practice in the construction management industry. As research and practices advance, standards may change. For this reason, it is recommended that readers evaluate the applicability of recommendations in light of particular situations and changing standards.

CMAA: Construction Management Association of America
7926 Jones Branch Drive, Suite 800, McLean, VA 22102
Phone: 703.356.2622
Email: info@cmaanet.org

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Taming Big Data with Business Intelligence: A CM Perspective

A CMAA Emerging Technologies Committee Article

By Sergio Aranda, *e-Builder*, and Marty Turner, CCM, *CH2M*

What is Your Business Intelligence Quotient (B-IQ)?

Television programming abounds with commercials promoting the virtues of Business Intelligence (BI). You have all seen the ads telling of "a new way to work" or "how you can make smarter decisions" or "how you can act faster and perform better." Sounds great, but were you left wondering if Business Intelligence was really needed in the world of construction management or if the promises of mining Big Data had any useful applications in helping you run your project, your region or your business operations?

The CMAA Emerging Technologies Committee pondered these very same questions and set about to find the answers. This Whitepaper seeks to explain what Business Intelligence is, what it does and why every CM professional should be applying this technology on their projects and in their organizations.

Data, Data Everywhere…

Intuitively, you probably recognize that data drives most, if not all, of your business and project decisions. As in most industries, data gathering is a way of life for the construction industry. Data is collected to track performance, safety, quality and risk information. In a litigious environment, it also serves as a defensive mechanism against claims. All levels and disciplines of the project team routinely create, send, share and store massive amounts of source data related to a wide array of subjects and categories including cost, schedule, material data, daily reports, RFI's, NCR's just to name a few.

As source data is generated, it is routinely stored and maintained in files and databases. Large scale data storage and access is typically managed within ever larger cloud-based repositories known as data warehouses. Over time, the accumulation and expansion of data volume, variety, and velocity has come to be known as Big Data. As you would expect, Big Data requires larger scale and more robust tools and systems to manage the storage, access, and security of the information. Absent these tools, over time, the compounding effect of data aging and sheer volume of stored data makes it less manageable and less useful to the active professional

working on the latest issue or problem. However, hidden within the mountains of accumulated "raw" source data lie patterns and trends that if properly identified and harnessed, provide the key to real actionable information that can dramatically transform decision making and operational performance.

Business Intelligence – The Power of Analytics

Picture the following scenarios:

- You get to work, log into your workstation, and find a number of messages on your screen alerting you to items that need your immediate attention. Included with the alerts are active links that guide you to the specific project, issue, and a summary that states the potential impact on schedule, cost, and/or quality that this issue will have if not addressed within a specific time period. You immediately take the necessary action and avert a crisis.
- You are on the job site or at a client meeting, and your phone starts buzzing and as you look at it you see a text message saying "The current risk of going over budget has increased 20% due to an unresolved agency issue and if not addressed within 5 days, this risk will increase to 25%. If addressed immediately, risk will disappear."

This is the power of Business Intelligence.

Gartner defines Business intelligence (BI) as "the applications, infrastructure, tools, and best practices that enable access to and analysis of information to improve and optimize decisions and performance."

Business Intelligence connects the power of analytics (the systematic computational analysis of data or statistics) to a source database or data warehouse where it quickly and accurately scours through mountains of "raw" data to identify patterns and trends within the information. The identified patterns and trends within the source data are commonly referred to as "metadata," or the "data within the data." Once analyzed and organized, a BI tool instantly reports the findings to the user in an organized actionable format.

Simply put, BI is able to analyze and process massive amounts of source data, organize and sort the data into recognizable categories and report this information to the end user in a visually engaging and interactive "dashboard." This information can then be further shared across a project, throughout an organization or even with an owner-client, allowing for more collaborative and informed decision making as seen in the sample dashboard below (Figure 1). Best of all, this process is all accomplished in real time.

Figure 1: Sample Business Intelligence Executive Level Dashboard

BI Functionality – How it Works

In order to understand what a BI system does, you must understand the basic system processes that all BI tools perform.

As shown in Figure 2, the originating source data is mined from files or databases created and used by the project or operations organization through a process referred to as "Extract, Transform and Load," or ETL. The BI tool extracts the data from the source file, and transforms the data into a common format that is then loaded into the system's own data warehouse for analysis. In terms of our industry, the source data would refer to such items as schedules, budget and cost sheets or even risk register information contained in the project's Project Management Information System (PMIS) or server files.

Once loaded into the data warehouse, BI tools perform an on-line analytical processing of the data, or OLAP. OLAP functionality is generally expressed as an OLAP Cube, which is a data structure that allows fast analysis of data according to the multiple dimensions that define a business problem.

To gain some industry perspective, we spoke with Scott Bash, President with FCS Group, an industry consulting firm that provides utility, finance, management consulting and economic and cost recovery services to public sector clients. Scott spent decades working with major firms in the industry, and shared some insights on what BI is all about and the use of systems and tools to enable BI. “Any time you have data that’s structured in a tabular formula or database you have the ability to present that information or export that into a format like Excel, but this is really reporting. The piece that’s missing is analytics and the ability to do predictive analysis to determine how projects may perform.” Scott adds, “In my opinion you don’t buy PM software as a BI tool, you buy it to support business processes and you buy a BI tool separately because what it should do is integrate data from multiple disparate data sources into a single BI platform so that you can look at data from all these data sources and conduct your analyses.” In this scenario, PM software represents one data source that is compiled with other sources to track performance, logistics, processes, productivity, and other indicators.

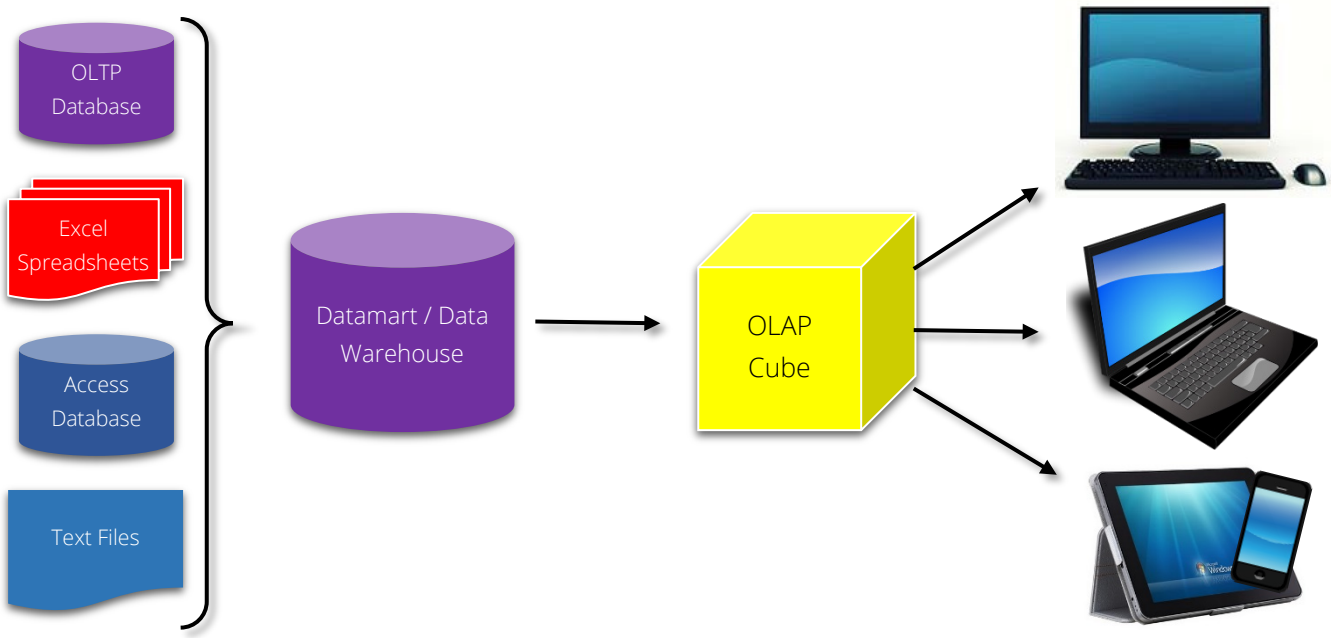


Figure 2: Business Intelligence-Basic Functionality

Scott provided an example. “One of my water utility clients has a Maintenance Management System (MMS) for treatment plants and another one for storm water and sewer assets. They also have an electronic OM manual, an inventory system, a SCADA system, a lab management system, GIS and a financial system. What this agency wants is to be able to take all the data from all those systems and be able to look at those systems and project data to analyze cost performance and monitor performance of the assets (e.g., how much they’ve spent on materials). Right now, they have to go into each of those individual databases, run a report

from each one, and bring it into a single report, and this takes a lot of time. A commercially available $30K software application would allow this company to do it all at a fraction of their current cost."

The Power of KPI's

Business Intelligence true power comes from the ability to set and monitor Key Performance Indicators, or KPI's. To illustrate this point, suppose a CM firm wanted to understand and track all of their transportation projects across the US market. With a few simple inputs, this firm could very easily set up a KPI alert system and a dashboard that could identify all projects that were losing money, breaking even or making "x" margin. Further customization of the KPI's could be applied to analyze the following dimensions within the firm's databases: Project manager, region, state, budgeted cost of work scheduled, budgeted cost of work performed, actual cost of work performed, month and year. From these simple inputs, a BI tool would be able to identify such useful information as:

1. Comparative project cost performance of all projects within a specified region (east, west, etc.).
2. Comparative cost performance by state within a region (e.g. California, Oregon, Washington, etc.).
3. Comparative project performance of all regions by month and year.
4. Specific project cost performance by month and year (historical and current). NOTE: A BI tool not only provides summary level information but can also drill down into the specifics of any project that is included in the example company's database system.

Similarly, the above example could just as easily be configured to analyze data on a smaller level scale, such as a program or project. By simply replacing PM with contractor and changing region and state to project segment, the BI tool would be able to report on comparative contractors' performance by site.

The possibilities are endless because the tools are designed to allow customization of the key performance indicators (KPI's) to track the metrics that are most important to your own project team or organization, thus allowing an end user to quickly identify areas of performance that are not meeting the established levels. What is Your Core Services Offering – Consider the Obvious.

Benefits of Business Intelligence

Being able to quickly access critical project or enterprise data in a clear, understandable, and actionable format is something even the most non-technical CM can appreciate when it comes to making timely and informed decisions (refer to Figure 3 – Sample Project Management Dashboard).

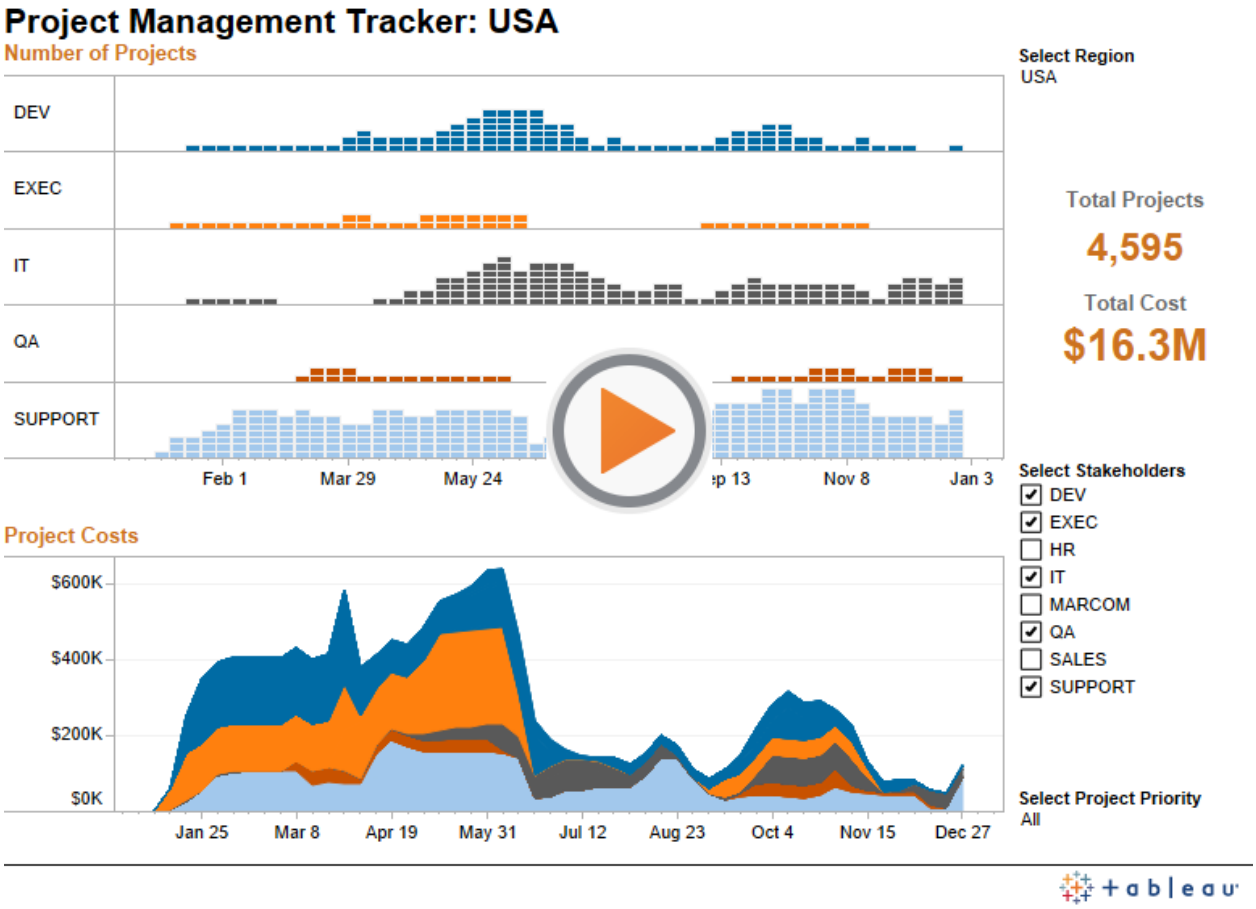
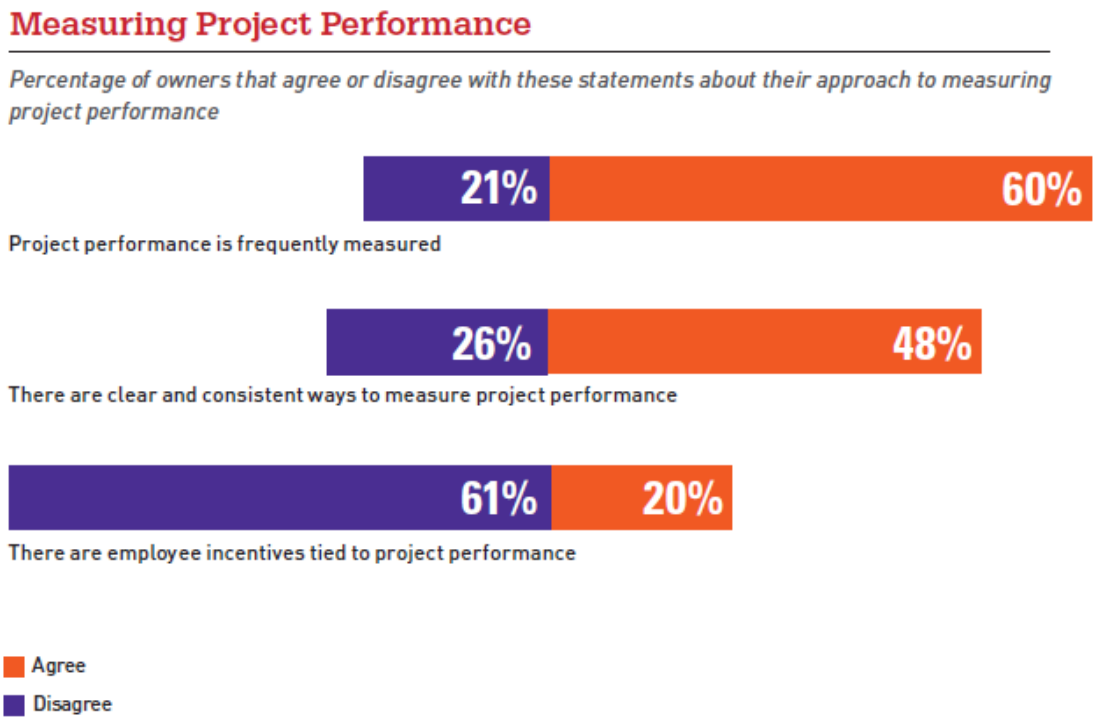


Figure 3: Sample Project Management Dashboard

In a recent industry study conducted by e-Builder, Dodge Data Analytics, and the Lean Construction Institute shed more light on the benefits of Business Intelligence. The study sought to determine which policies, practices, tools and tactics correlate with the best project performance and best-in-class owners. The research focuses on these key metrics from 174 owners about their projects completed in the last three years:

- **Cost:** Final construction cost compared to the original budget at the time of capital allocation
- **Schedule:** Date of final completion compared to the original schedule for construction established at the time of capital allocation

- **Quality:** The quality of the final building compared to original expectations at the time of capital allocation, based on two components: (1) how well the building design incorporated features or functionality compared to initial goals, (2) how well the building construction was executed and its workmanship.



The research identified 6 practices employed by top performing organizations:

1. Ability to effectively recruit and nurture talent
2. The culture of the capital projects organization
3. Policies related to measuring project performance
4. Use of a project management information system (PMIS)
5. Ability to effectively engage internal stakeholders in the project process
6. Use of third-party consultants and internal staff for specific project activities.

Three of the six practices (highlighted above) are closely aligned with the use of Business Intelligence – Policies related to measuring project performance, use of project management information systems and ability to effectively engage internal stakeholders in the project process.

It's no surprise that top-performing organizations measure project performance frequently, have clear and consistent ways to measure project performance, and tie employee incentives

to project performance. That's precisely where BI can make a difference. Business Intelligence tools provide fast, reliable forecasting information to predict outcomes and analyze performance to make adjustments on the fly. Since a well-established BI system will provide real-time access to information, your ability to respond to issues is accomplished in a fraction of the time it would take using traditional methods.

The e-Builder and Dodge SmartBrief findings are further supported by the 2016 Wisdom of Crowds - Business Intelligence Market Survey conducted by Dresner Advisory Services, LLC. The Dresner survey compiled the responses of 1,574 BI users from across 23 industries (including construction) and concluded there are five primary benefits from using Business Intelligence software including:

1. Better decision making
2. Improved operations efficiency
3. Growth in revenues
4. Increased competitive advantage
5. Enhanced customer service

As proof that BI is making a difference in business, the survey found that 83% of the respondents stated they actively share BI derived insights with their colleagues resulting in a very high ability to take action on their data. In addition, the ease of data access and sharing through live interactive collaboration is greatly reducing bottlenecks and wasted time resulting in lower overheads and increased profitability.

It's no secret that today's CM's must increasingly "do more with less" and often find personnel resources stretched under ever tightening budgets and profit margins, with many being forced to wear multiple hats of PM, CM, project controls and even administration. In these stressful times, it is important to recognize that a BI tool solution can dramatically improve the speed and efficiency of accessing, sharing and reporting of vital project data. BI's ability to mine data from multiple source databases and then convert that effort into simplified actionable data is unparalleled.

There is a measurable time and cost savings associated with being able to access and report on data from multiple data sources vs having to manually access, collate, and report on data from each source separately. This translates into more efficient use of project resources – primarily labor.

Example: The following dashboard (Figure 4) was created to provide safety tracking data related to vehicle accidents involving bikes and pedestrians. This interactive dashboard was created by a first time BI-tool user, in less than four hours. The results saved more than 80 hours of repetition and re-entry of data to an Access database and provided the client with a much more powerful and impactful representation of their safety data.

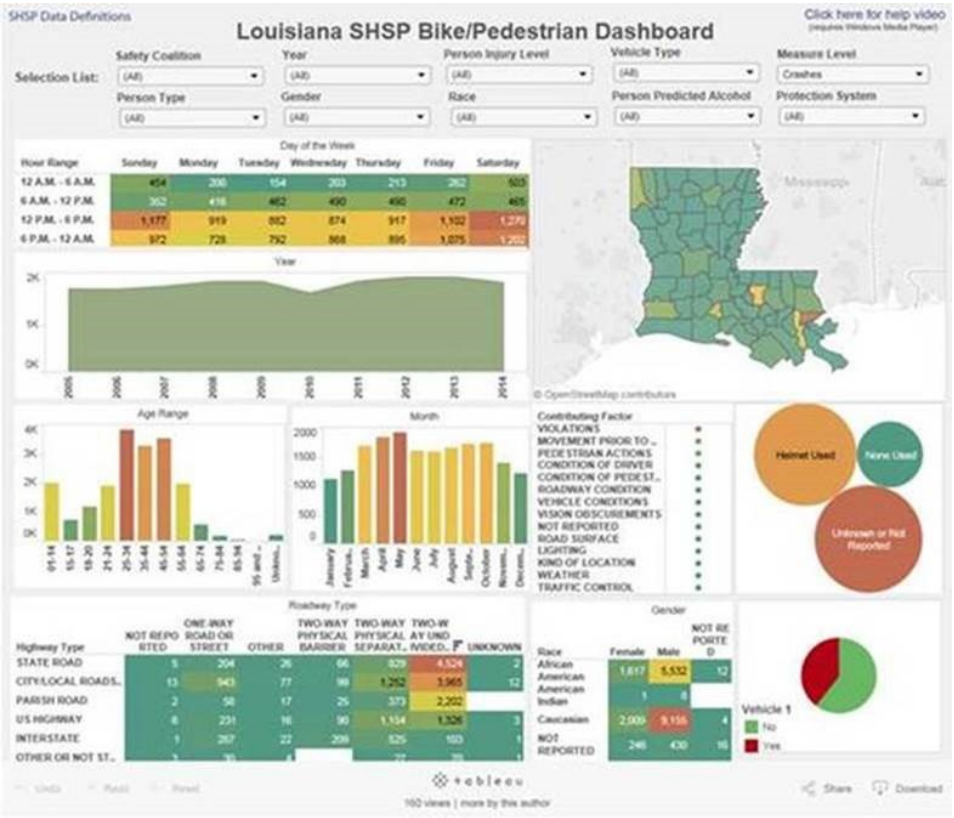


Figure 4: Sample Dashboard

Challenges for Use and Implementation

While it is clear that BI solutions are becoming easier to use and can provide tremendous results, the question remains, why aren't more EPC and program management companies using them?

One major challenge is the simple lack of data standards which results in breakdown between communication protocols. Often, the cost required to establish the basics like naming conventions and data governance can be expensive to develop and maintain, despite the software itself being relatively inexpensive. Terminology and reference can vary dramatically by industry, agency, region, and even district. For instance, the water utilities group may use "facility" to refer to a treatment plant. People on the sewer side may use the term manhole in the same context, but another department will use facility to name a library or police

department. To obtain consistent and homogeneous results, you must first spend the time to define standards and then implement a uniform standard for data governance. This same problem existed in the telecom marketplace until recently when the US adopted standards that allow you to use your existing phone when you switch networks.

Interviews conducted by the CMAA Emerging Technologies Committee with several member organizations provided additional insights into the reasons why CM's have not adopted the use of Business Intelligence within their organizations or projects. The top reasons expressed for not using Business Intelligence included:

1. Perception that BI technology is unproven
2. Perception that the cost and time to implement a new tool/system is too high
3. Not convinced that BI will provide a return on investment (ROI)
4. Current system(s) are perceived as adequate
5. Company or organization does not have an established, standard process to evaluate and implement new tools.
6. Security of proprietary data

In an effort to clear up some of these misconceptions, let's address them one by one:
With regard to BI technology being unproven, hopefully the previous segments of this article have demonstrated that these systems are powerful, effective tools for generating real-time results. BI technology has been around since the late 80's but has really taken some quantum leaps forward in the past three to five years in terms of the modern self-service applications that are available today.

The time required to implement these tools has been cut from months down to hours and implementation can be accomplished by novice, fairly non-technical end users instead of highly technical IT staff. Moreover, the cost of the modern tool is very reasonable (on average $400-$1,200) for a single user license and even more reasonable when purchased for an entire team or enterprise.

From a cost-benefit standpoint, most BI vendor websites proudly display countless documented success stories that attest to significant cost and time savings achieved through faster and simplified access to actionable data. Many of these testimonials come from very recognizable companies and organizations such as Lockheed Martin, the United States Navy, Nike, EBay, Walmart, and even a few CMAA member firms as well!

And for those that think their current system of management is adequate (we're talking to you, Excel users), consider: Excel is a database and not an analytic tool and there are inherent risks with relying on a spreadsheet to manage and interpret corporate metadata. Not only is Excel prone to errors through versioning and broken cells, logic, etc. but there is also a size limitation to what can be effectively viewed and managed within a spreadsheet. While Excel does provide some functionality to sort, calculate, and manage tabular data, it was not designed to provide true analytical functionality and it definitely cannot keep pace with the demands and complexities required to oversee or analyze the financial and performance metadata of large projects (or worse yet, the financials of a multi-billion dollar company enterprise). By contrast, the modern Business Intelligence tools are expressly designed for analytics (the mining and managing) of Big Data. To use an analogy, you wouldn't excavate a large foundation with a shovel (you'd use an excavator) and you shouldn't try to analyze the financial performance of hundreds of projects or analyze a company's profitability using Excel.

If you or your organization is struggling to find a uniform method to evaluate new tools, one must realize there are other resources available. Remember that CMAA is a leading force in the industry and draws from the experience and knowledge of thousands of members and hundreds of companies. There are people and processes that you can tap into to help you make effective decisions relative to PMIS, BI and other tool selections. In terms of Business Intelligence, the annual Gartner Magic Quadrant provides a very thorough and methodical evaluation of all of the major tool providers and their helpful pros and cons that can help you narrow your selections down to the one or two that would best meet your specific needs. (For more information: https://www.gartner.com/doc/reprints?id=1-2XXET8P&ct=160204)

Finally, security of data is always a driving concern when considering any hardware or software solution. However, Business Intelligence providers are already aware of your biggest issues such as concerns over contamination of source data, internal/external data breach, and viruses. It should be noted that all of the leading BI providers already include as part of their base application an appropriate level of security protocols built-in to the software. These protocols prevent unauthorized access to sensitive data by both internal and external users. Security features can also be customized by the user to provide the appropriate level of protection to sensitive or proprietary information. User authentication layers can limit input, access or sharing of data to specifically assigned areas within the BI tool based on project or organizational requirements and outside non-secured access is prevented entirely. In addition, the best tools on the market are able to connect with the user's database as a read-only system interface, meaning there is no danger to corrupting the source database, thereby keeping your sensitive and proprietary information safe, secure, and free from accidental data deletions or changes.

Conclusion

Cost effective, powerful analytical BI tools are readily available to simplify your data management, speed up your response times, improve your data accuracy and enhance your organization's overall cost effectiveness. The obvious benefits and results achieved from Business Intelligence make a strong case for why CM organizations should consider using them as part of an overall project delivery system.

The CMs Role in Making BI an Effective Tool

It is important to keep in mind that a CM's primary role is to add value. Construction management firms are hired for competencies that their owner clients may not have in house. This also applies to the effective and efficient implementation of tools like Business Intelligence. There is a great opportunity for CMs to engage with clients and not only present the benefits we have outlined in this white paper, but also guide their clients in defining KPIs, and deploying commercially available systems that provide BI. Owners are becoming better informed about the availability of different systems – from their peers, from vendors, and from their consultants. Much has been written about the transition from home grown or consultant developed systems towards a commercial-off-the-shelf approach. The key takeaway is that these systems provide consultants with powerful analytical and project management capabilities that enhance overall project delivery, improves responsiveness, and simplifies the owner's life.

The choice is yours. Keep in mind that it will be the firms that embrace the new tools and technologies and find new ways to add value that will continue to find success, while the late adopters will fall behind and eventually find themselves out-maneuvered in today's fast paced world.

About the Authors

Sergio Aranda, e-Builder
A Technology Business Development professional with 15+ years of experience in B2B Software and Services industries, 9 of which have been with e-Builder, a provider of PM software for owners in the construction industry.

Marty Turner, CCM, LEED GA, CH2M
A Senior Project Controls Manager and Regional Controls Lead with over 20 years of experience in Program and Project Management, Project Controls and Construction Management working on projects of national significance.

References & Credits

- Scott Bash, FCS Group: www.fcsgroup.com
- Gartner's Magic Quadrant Report: www.gartner.com/doc/reprints?id=1-2XXET8P&ct=160204
- Software Advice: www.softwareadvice.com/bi/
- Laney 2001: blogs.gartner.com/doug-laney/files/2012/01/ad949-3D-Data-Management-Controlling-Data-Volume-Velocity-and-Variety.pdf
- e-Builder & Dodge Data & Analytics SmartMarket Brief (2015) - The Optimized Owner Organization: An Owner's Guide to Top Capital Project Performance: www.e-builder.net/white-papers/optimized-owner-organization
- Dresner Advisory Services, LLC: The Wisdom of Crowds, Business Intelligence Market Study (2016)

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