Big data in construction projects: Risk and opportunity management

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Abstract

Bid data in construction projects has become the trend as the construction industry is bridging the gap for productivity and embracing disruptive and innovative technologies that rely on large volume of data and information. This presentation will emphasize a value assessment of big data in construction projects. Within a project management framework and using the data information from Virtual Design Construction (VDC) models and project data compiled using Unmanned Aerial Systems or drones throughout construction projects, we will:

· define and discuss the risks associated with big data such as data security and privacy, and bad data or analytics in construction projects.
· identify the value of opportunities and benefits of big data for design and construction projects.

Introduction

The daily business and human activities in the 21st revolves around capturing, handling, sorting or analyzing petabytes ($10^{15}$ bytes). On a daily basis, Google deals and processes about 24 petabytes or 24,000 terabytes. By analogy, that's about 17,500 Trillion full floppy disks. On the other hand Facebook gets more than 10 million photos per hour [1].

Big data is not just about the 4 V’s volumes, variety, velocity and veracity. For business enterprise and full integration s it has to add value.

In big data, volume is what makes data “big”. Over the past 5 to 6 years data storage has been increasing exponentially. Variety in data is a bit more complex because not all data is structured the same way. Unstructured data like pictures or videos is what makes big data analytics powerful Veracity such as accuracy or trustworthiness and the dynamic velocity, frequency of data are some key challenges and potential risks from a management viewpoint. The value of data capturing, processing and analysis will vary from one sector of application to another.

A good example of value added to big data, retail giants like Walmart or Amazon use data mining to identify, predict and react in real time to customers’ expectations (2)

In the construction industry, as in all other sectors, big data refers to the huge quantities of information that have been stored in the past and that continue to be acquired today. However, the construction industry has been lagging behind on integration or implementation of innovation and other mechanisms for change. Although the volume of data may not be as “big” as that of retailers or financial institutions, construction companies get to deal with very heterogeneous quantities of information from drawings, material supply, work breakdown schedule to specs, As data gets bigger and bigger, the need to boil it down to the actionable essentials gets bigger too.
In a survey of construction companies conducted by a software vendor [5] it was found that:

- 57% want consistent, up-to-date financial and project information.
- 48% want to be warned when specific situations occur.
- 41% want forecasting, allowing them to better prepare for best and worst-case building events.
- 14% want online analytics to see for instance precisely which factors are affecting profitability and by how much.

In comparison to other industry sectors, one of the challenges that the construction industry has been facing is a low level of productivity. Many factors or causes have been identified by numerous research, reports and analyses (6). A PMI study from 2013 has also identified the risks for project failure due to poor communication. Hence, over 7% of projects cost is put at risk by ineffective communications, indicating a critical need for organizations to address communications deficiencies at the enterprise level. Whether the cause is related to human factors, or a technical issue it is ultimately a management issue on how to make the project successful on time, on budget with the same quality. Therefore, big data analytics can enable or offer opportunities to address or improve each of the aspects identified as a priority. The variety of inputs in big data allows better levels of certainty about status reports and forecasts. The analytics can provide more helpful indications of levels of risk before a threshold is exceeded and an alert generated. This paper offers an overview of some of the risks and challenges of big data with the integration of BIM and Unmanned Aerial Systems in the management of project on the basis of big data analytics.

This paper will offer a short insight on big data in construction, the challenges and opportunities [particularly when integrating large data input from the integration of Building Information Modeling and Unmanned aerial systems.

**What is big data in construction?**

Building information modeling (BIM) and virtual design construction (VDC) have disrupted the construction sector bringing information and communication technology (ICT) into the realm of construction project management. Building Information Modeling (BIM) can be defined as a reliable, digital, three dimensional, virtual representation of the project to be built for use in design decision-making, construction scheduling and planning, cost estimates and maintenance of construction projects.

Building Information modelling also known as BIM and often also referred to as Virtual Design and Construction VDC, was introduced as a conceptual model with object based design, parametric manipulation and a relational database; which was developed much later into a visual display of conceptual design. Integration of BIM in construction has significantly grown over the last 10 to 15 years. BIM has firstly extended the traditional 2D (planar) technical drawings (plans, elevations, sections, etc.) to a 3D design and furthermore adding time to the three primary spatial dimensions (width, height and depth) to what is defined as a BIM fourth dimension (4D). With cost as the fifth dimension, BIM 5D thereby provides the key attributes of a construction project. Often BIM 4D is what allows for the visual animation of projects, but fundamentally it enables progress tracking of construction projects.
When drones are used in construction: a flight of 30 minutes over a 150 acres site can generate millions of data points in 3D models. Data analytics can deliver any distance or volume measurement in few minutes.

BIM and Unmanned Aerial Systems are some of the most innovative technologies that the construction is slowly adopting. However, big data in construction is not just limited to construction phase of a project. In fact with increasing demand and delivery of green and sustainable buildings constant monitoring of facilities for total building performances generates multiple layers of data and information.

**What is the current state for big data in construction?**

The construction sector has always been slow to adopt innovation at a larger scale because of the risks that can be associated with anything new that has not been well tested. Often associated with prohibitive costs of investment in innovation, the fact that the construction operates with multiple stakeholders who don’t necessarily have the same stake in a project creates a barrier to adoption.

Current use of data analytics in construction can include various applications including but not limited to: identifying causes of construction delays, learning from post-project reviews (PPRs) decision support for construction litigation, detecting structural damages of buildings, identifying actions of workers and heavy equipment. Big data in construction is currently heavily used for: tracking construction equipment, various simulations before construction and after construction with construction time laps, and construction site organization.

One type of project delivery system of contractual agreement for construction that subscribes ideally with the value principle of big data is the design-build-operate model where the lifecycle increasingly defines construction projects. Below are some examples of how data capturing and collection is used at the various level in a D-B-O type project.

1. **During the Design phase:** Big data, including building design and modeling itself, environmental data, stakeholder input and social media discussions during programming phases, can be used to determine not only what to build, but also where to build it. Brown University in Rhode Island, US, used big data analysis to decide where to build its new engineering facility for optimal student and university benefit (9). Drones are used to survey construction sites. Lessons learned from previous projects failures and successes are increasingly presented and brought forward at the bidding or tendering process to adjudicate for specific proposals or designs.

2. **During the Construction Phase:** Big data from weather, traffic, and community and business activity can be analyzed to determine optimal phasing of construction activities. These can also be used during the planning phase. Sensor input from machines used on sites to show active and idle time can be processed to draw conclusions about the best mix of buying and leasing such equipment, and how to use fuel most efficiently to lower costs and ecological impact. Geolocation of equipment also allows logistics to be improved, spare parts to be made available when needed, and downtime to be avoided. Drones used to capture and monitor construction progress, or check on site safety
3. **During the operation phase** Big data from sensors built into buildings, bridges and any other construction makes it possible to monitor each one at many levels of performance. Energy conservation in malls, office blocks and other buildings can be tracked to ensure it conforms to design goals. Traffic stress information and levels of flexing in bridges can be recorded to detect any out of bounds events. This data can also be fed back into building information modeling (BIM) systems to schedule maintenance activities as required.

Sustainable high performance building currently has the capacity to generate and create valuable information and data. Some of it is automated and “smartly” processed to for example turn off lights or adjust and control temperatures. A big gap however remains on full data analytics to learn from the data captured not to simply react but build on it towards even other decision making processes.

**Do the benefits outweigh the risks?**

Most notably the integration of BIM with unmanned aerial systems provides the construction industry with a very powerful tool to make all construction projects not solely successful during the construction management but throughout the whole life cycle. The ability to timely identify issues of material supply chain to site or weather unforeseen conditions can be analyzed and interpreted to reduced risks making project management more effective.

The risks associated with big data are not unique to the construction sector and can directly relate to change in processes, methods, or management. Because of the newness of the technology and the fact that it relies on various skills may impede or limit strong enthusiasm for adoption until the innovation has demonstrated and showcased it can add value.

Risk averse adopters or reluctant to change managers and/or contractors and builders will use the followings against widespread use of tools that capture and then analyze information often available that could otherwise be wasted. Some of the risks are: data security, data privacy, costs, bad data, and finally bad analytics.

Big data analytics can enable opportunities to improve. BIM in construction has demonstrated the capacity to save project costs by up to 20%. Aside from reducing miscommunication between the various stakeholders, such as designers, engineers and contractors BIM reduces requests for information (RFIs) by making all the information viewable and accessible to all stakeholders. For the construction design of a facility in Portland Oregon, Portland state University and Oregon State University have save over $10 M in hourly wage and paper required to make drawings and all the building specifications (12). The data from the BIM model can then be used for construction progress and facility maintenance.

Big data is not a new concept by any stretch of the imagination. It has been around for quite some time but is only now beginning to make its way into the construction industry. This leap into construction has offered a few specific benefits such as: increase capacity to solve problems using information already available; value added ability to enable certainty and thereby reduce some risks; all these benefits however, imply well-organized processes and
effective communication w construction projects or organizations.

**The last few words**

- Is big data a new concept? Definitely not
- Is Big Data Innovative? Absolutely
- Do the benefits outweigh the risks? Of course; Big data analytics is actually an enabler to risk prevention and immediate mitigation
- Is big data costly? Cost of big data will always be directly related to the volume of input data and information, the speed at which it is processed and analyzed to render it usable for other value added decision making or processes. However, larger amounts of data mean you can more accurately track your performance. This includes project profitability and efficiency.

**References:**

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