

THESIS

DIFFERENCES FOR EMPLOYEES WHO USE BIM/VDC IN THE CONSTRUCTION
WORKPLACE

Submitted by

Girija Inguva

Department of Construction Management

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Master's Committee:

Advisor: Caroline Clevenger

Mehmet Ozbek
Rebecca Atadero

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ABSTRACT

DIFFERENCES FOR EMPLOYEES WHO USE BIM/VDC IN THE CONSTRUCTION WORKPLACE

There is growing recognition across the US construction industry for the benefits of organizational adoption of Building Information Modeling, also referred to as Virtual Design and Construction (BIM/VDC). One of the key factors that enables successful organizational adoption of new technologies is the adoption of these technologies by key participants, in this case by BIM employees. Their positive experiences at their current organization determine their continuation on a BIM/VDC path, thus leading to consistent organizational adoption and negative experiences could mean that they migrate from a BIM career to a Non-BIM career or to another organization to seek better experiences. This research aims to study the perceptions of BIM employees as compared to the perceptions of Non-BIM employees in the construction industry in four key categories: work life balance, career advancement, workplace experience and skill levels. An online survey is used and responses are compared first using averages and then using Pearson's χ^2 or Fisher's probability test to test for statistical significance where applicable.

Differences inform us of the advantages or challenges of a BIM/VDC career at an individual level. Additionally, differences between men and women are also studied, along with differences between BIM employees from organizations with a separate BIM/VDC department and BIM employees from organizations without a separate BIM/VDC department. The general trends observed in terms of averages indicate that BIM/VDC personnel are generally more

satisfied with their jobs and consider common barriers to career advancement to be of lesser relevance than their Non-BIM counterparts. The fact that most differences are not statistically different also suggests that BIM employees may not be treated that differently from Non-BIM employees. Of all groups, the most positive perceptions are reported by male BIM respondents from organizations without separate BIM/VDC departments.

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CHAPTER 1 – INTRODUCTION

1.1 BACKGROUND

Building Information modeling (BIM)/ Virtual Design and construction (VDC) – These are two of the many phrases and terms used to simultaneously describe software, processes, files, products etc., that involve the use of computer based, virtual modeling tools to improve construction. The use of Building Information Modeling or Virtual Design and Construction (BIM/VDC) is prompting a technological and cultural change in the construction industry.

Between 2008 and 2012, across Architecture, Engineering and Construction (AEC) industries in the United States (US), engagement with BIM/VDC technologies increased from 28% to 71%. Construction experienced the greatest rates of growth. In particular, the construction industry currently leads AEC in BIM/VDC adoption rate, experiences highest returns on investment, shows highest levels of BIM engagement, and invests the most resources in training (Bernstein & Jones, 2012). As a result of the rapid and potentially transformative integration of such technologies into AEC practice, construction companies are eagerly seeking and may consider it imperative to rapidly develop employees with BIM/VDC skills (Smith & Tardif, 2009). Researchers have found that such a paradigm shift of wider application of BIM/VDC may be positively affecting the career paths of many personnel in the AEC industry and opening up new opportunity for young professionals (Uddin & Khanzode, 2014)

The industry is now at a stage where the necessity of BIM/VDC adoption has been recognized by many organizations. An integral part of BIM/VDC adoption is the people who are responsible for it, the BIM/VDC professionals who are now prevalent in these organizations' workforce. This study aims to explore the impact of BIM/VDC on the careers and the work

environments of these individuals to understand the current status quo of a construction career with BIM/VDC as they perceive it, and see what sets their perceptions apart from their Non-BIM construction peers. The differences observed could inform us on the following items (examples):

- The perceived advantages/disadvantages of a BIM/VDC career and the likelihood of an employee to continue on a BIM/VDC career path
- Organizational factors that could encourage or discourage individuals to gain BIM/VDC skills
- An organizational course of action for encouraging careers in BIM/VDC to further the adoption of BIM/VDC
- Whether a BIM/VDC based career could serve as an entry point or an incentive for the recruitment and retention of women and minorities in construction

To this end, this study directs its focus more towards the people involved with the adoption of BIM/VDC- assessing BIM/VDC as a phenomenon that is fundamentally occurring among the workforce of construction industry. For the purpose of this study, we adopt the definition that states:

“Building Information Modelling (BIM) is an emerging technological and procedural shift within the Architecture, Engineering, Construction and Operations (AECO) industry.”(Succar, 2009, p.357).

The focus of this research is to see how, within general contracting companies, having job duties/functions related to BIM/VDC or working for companies with separate BIM/VDC departments impacts individual employees’ perceptions regarding: Work life balance, Career advancement, Work place experience and Skills.

The study is exploratory. Within the study, an additional analysis is performed to see if there are any observations by women in BIM that are significantly different from women in

construction or men in BIM. The researcher aims to provide a basic background by broadly studying multiple aspects of an employee's perception and hopes to encourage further lines of inquiry into any or all of the aspects studied.

1.2 RESEARCH QUESTIONS

(1). How do the perceptions of employees who use BIM/VDC differ from those that do not with regard to (a) work life balance (b) career advancement, (c) workplace experience and (d) skills?

(2). Does gender influence any differences in these perceptions?

1.3 DELIMITATIONS

The study was limited to employees that work in construction operations, from General Contracting companies within USA. Additional emphasis on women for the study is limited to (a) a study in the specific barriers faced by women in construction and (b) parsing all data by gender. The study does not delve into the nuances of the interdisciplinary approaches of women's studies. The study contains limited hard data/metrics and is mostly focused on studying perceptions. For example, instead of analyzing "Is glass ceiling a barrier for career advancement?" the study focuses on "Is glass ceiling *perceived* as a barrier for career advancement?"

CHAPTER 2 – LITERATURE REVIEW

2.1 WHAT IS BIM/VDC?

To begin, the following definitions of BIM/VDC are relevant to this research. Per the mission statement of Stanford's CIFE,

“Virtual Design and Construction (VDC) is the use of multi-disciplinary performance models of design-construction projects, including the Product (i.e., facilities), Work Processes and Organization of the design - construction - operation team in order to support business objectives.” (Center for Integrated Facility Engineering, 2014)

The National BIM Standard (NBIMS) Project Committee of the BuildingSMART alliance defines BIM as,

“A digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward. The BIM is a shared digital representation founded on open standards for interoperability.”(National Institute of Building Sciences, 2014)

According to Succar,

“Building Information Modeling (BIM) is a set of interacting policies, processes and technologies generating a “methodology to manage the essential building design and project data in digital format throughout the building's life-cycle” (Succar, 2009, p.357)

The first documented use of the term “Building Modeling” in English – in the sense that “Building Information Modeling” is used today – appeared in the title of a 1986 paper by Robert Aish. The term “Building Information Modeling” itself appeared in a paper by Nederveen and Tolman in the December 1992 *Automation in Construction*. The term was popularized in the industry by Laiserin and in various forms by different software providers like Autodesk, Bentley, Graphisoft etc. circa 2002. (Eastman, Teicholz, Sacks, & Liston, 2011)

2.2 EXISTING APPROACHES TO BIM/VDC RESEARCH

Academic researchers have long been interested in studying Building Information Modeling (BIM) using various approaches. The number of scholarly articles related to BIM is expanding year by year. In summarizing emerging research directions and trends for BIM in the AEC industry, Becerik-Gerber and Kensek (2009) describe the following areas of interest as expressed by both researchers and industry BIM practitioners:

1. BIM For Design and Engineering
2. BIM for Construction
3. BIM for Facilities Management (FM)
4. Sustainable practices in the AEC industry
5. Linking BIM to analysis tools
6. Sustainability during construction and afterward
7. Energy innovations
8. Integrated Project Delivery (IPD)
9. Interoperability
10. Changes to Practice
11. BIM best practices

A cursory search using a search engine for scholarly articles (journal articles and conference proceedings) with just the words “Building Information Modeling” or “BIM” in the publication title using academic search databases, for example, reveals over 250 results. Including the topics mentioned above, most BIM related research can be broadly categorized as shown in Table 1.

Table 1-Existing approaches to BIM/VDC research

Research category	Approximate number of publications
1. State of BIM (Current state of BIM adoption, challenges, risks, outlook, benefits, etc.) a. Legal issues	26
2. Applications of BIM (BIM For: ____) a. Industry (Design, Engineering, Construction, etc.) b. Sector (Road construction, Historic preservation, Existing Buildings etc.) c. Specific use (Safety, Facilities management, Sustainability, Energy analysis etc.)	112
3. Standards and Interoperability (includes proposed BIM implementation frameworks and methodologies)	31
4. BIM and other processes (Design-build, IPD, Lean, etc.)	9
5. Benefits, Return on Investment, metrics and measurement	9
6. Technological advancement (New developments in software, computing algorithms etc.)	26
7. Case Studies (documenting BIM implementation)	13
8. Education and research trends and needs (curriculum development, proposed research methodologies etc.)	35
9. Organizational concerns (BIM Adoption issues, Human Resources, Organizational structure etc.)	20

The scope of this publication contributes to research that falls under the “Organizational Concerns” category in the classification shown in Table 1.

2.3 ORGANIZATIONAL CONCERNS

Existing research on BIM and organizational/cultural changes can be broadly grouped into two: (1) Organizational factors that determine the outcomes of BIM adoption and (2) Organizational changes that occur due to BIM adoption

2.3.1 Organizational factors

The adoption of BIM from an organizational perspective has been of interest to researchers for a while; however, publications are rarely dated earlier than 2010. In fact, this area could be construed as a fast-growing emerging field of interest as evidenced by the growing number of publications, from just five published during 2010-2012 to fourteen during 2013-2014. However, the idea of addressing *technology* adoption in the construction industry from an organizational perspective is not new. Seminal work in this area has been offered by Tatum during the late 80s to 2000. On the specific topic of organizational factors that influence technology adoption, Panagiotis Mitropoulos and Tatum (2000) state that key individuals, the champions who drive technology adoption are one of the prime factors that drive technology adoption across an organization. More recent research affirms the concept that individual employees are paramount to successful technology adoption. In their book, *Business Process Management*, Jeston and Nelis (2014) state that one of the most significant reasons for the failure of implementing a new business process is a lack of employee buy-in.

When viewed from a BIM/VDC perspective, the key individuals , gatekeepers and champions of BIM technology mentioned above can be identified as individuals (with or without a formal BIM title) who have BIM skills, perform BIM related tasks or are responsible for BIM related outcomes. Given the high importance placed on individuals for a successful adoption of technology, it follows that these individuals' positive perceptions contribute to positive experiences in organizational adoption and their negative perceptions need to be addressed for a smoother organizational transition into a new way of business (using newly adopted technology). In this regard, perceptions of Work life balance, Career advancement and Workplace experience are studied. Perceptions are not absolute; therefore in the scope of this research, perceptions of

BIM employees are studied *in relation to* the perceptions of Non-BIM employees. The key lies in the differences in these perceptions, as these differences throw a spotlight on issues unique to BIM employees (and not just the issues related to the construction industry overall)

2.3.2 Organizational changes

Little research exists about the effect of BIM on organizations. Research by Grilo and Jardim-Goncalves (2010), Sebastian (2011) and Dossick and Neff (2010) discuss the role of Building Information Modeling on project teams and organizations, particularly in increasing collaboration between individuals and groups.

One of the areas of focus for this study is the study of self-perception of soft skills (expanded in a following section). The idea is to study skills and open up the line of enquiry of cause and effect –if soft skills (including collaborative skills) BIM employees are different than those of non-BIM employees, whether it inherent to an individual or is it due to the application/use of BIM while performing job duties. That this area is in immediate need for further research is affirmed by Merschbrock and Munkvold (2012).

2.4 WORK LIFE BALANCE

Anecdotally, it is a commonly known fact that the construction industry is particularly hard on the work-life balance of its employees. Apart from the long work hours, due to the temporary and shifting nature of construction jobsites, commute times change with jobsites and employees are often made to relocate to where construction work occurs. Focused research on the specific aspect of work life balance in the construction industry can be found mostly in studies relating to the UK and Australian construction industries. According to Lingard and Francis (2009), work life balance is one of the most pressing management issues, one of strategic importance in attracting and retaining talent in the 21st century construction industry

A good indicator of work life balance in employees is the amount of hours put in at work. In research related to the information technology industry, factors that could enhance the perception of work life balance are perceived flexibility in work schedules as well as the option to telecommute (Hill, Ferris, & Mårtinson, 2003; Hill, Hawkins, Ferris, & Weitzman, 2001; Hill, Miller, Weiner, & Colihan, 1998). In the construction industry, Lingard (2000) also mentions the possibility for increased options for telecommuting due to the increasing availability and use of IT tools for performing certain tasks.

Existing research related to the telecommuting/flexible work schedule opportunities that BIM/VDC could present is limited; extensive search results yielded no formal publications. However, some aspects of BIM-based tasks at the workplace could present such opportunities. The following five comparison points between BIM and Non-BIM workforce are studied:

1. Work Hours
2. Commute and travel time
3. Flexibility
4. Telecommuting
5. Relocation

2.5 CAREER ADVANCEMENT

The introduction of new technology in any industry presents a world of opportunity in terms of the creation of new job roles, new paths of career advancement and recognition of new skills. However, all new technology presents some growing pains – the formal recognition of new roles related to new technologies is an ongoing process. Effective organizational deployment of BIM depends on the formal inclusion of BIM professionals in organizations (Barison & Santos, 2011). When organizations recognize the necessity of adoption of a new technology, they are more likely to be willing to recognize and promote individuals who are an

integral part of this adoption and work towards active retention. (Hansen & Tatum, 1989; P. Mitropoulos & Tatum, 1999; Panagiotis Mitropoulos & Tatum, 2000; Tatum, 1988, 1989).

General Contractors vary in their organizational approach to BIM. Some have dedicated BIM departments and employees and some have employees who have additional BIM skills operating within traditional construction organizational hierarchies, either as a part of construction operations or IT departments. These employees often have both BIM and Non-BIM duties together. In research that focuses on BIM talent acquisition, Wu and Issa (2014) describe two kinds of BIM employees “Dedicated BIM talent”, usually associated with BIM prefixed job titles and “Converted BIM talent” where traditional positions are converted/redefined to become BIM capable. In a survey conducted in New Zealand by Davies, McMeel, and Wilkinson (2014), the respondents report that there are limited career paths for BIM professionals, and that a lateral move would involve taking a step back in their careers,

We can increasingly see new BIM based formal job roles in the construction industry. Based on a cursory search in a job-seeking website, BIM related roles vary from BIM-specialist, BIM-coordinator, BIM manager, etc. to Integrated Construction Coordinator, VDC engineer etc. Attempts have been made to preemptively describe the job duties required of the personnel in these roles by various BIM guides. However, clear BIM based organizational hierarchies are yet to be widespread and BIM career paths are often ill-defined.(Wu & Issa, 2014)

2.6 WORKPLACE EXPERIENCE

Studying Workplace experience, particularly with respect to individual job satisfaction is critical in understanding the success or failure of technology adoption. In general, according to Sweis, Sweis, Attar, and Abu Hammad (2011) , the individual success and positive perceptions of employees directly affect employee turnover and subsequently the success of an organization.

Early studies related to job satisfaction in organizational behavioral were conducted by researchers such as Locke (1969), Hulin and Smith (1965) and Kahn (1960) in the 60's. Such theories were applied to the construction industry in the 80's by Tatum (1989).

Relatively limited research exists on job satisfaction specifically related to the adoption BIM in the construction industry. In a study conducted by Lee, Yu, and Jeong (2013), the authors emphasize that the utilization of BIM on a continuous basis directly depends on the motivation of individuals that use it. Existing research in other industries shows that employees value individual benefits, such as career advancement, over management goals such as employee technology adoption. (Francik, Rudman, Cooper, & Levine, 1991). Based on the author's own experiences as a female BIM employee in a general contractor and on anecdotal evidence, a list of commonly perceived individual benefits that influence BIM employees was generated and levels of job satisfaction were measured.

1. Access to technology
2. Opportunity to pioneer change
3. Compensation/Incentives
4. Time spent at a desk
5. Time spent on an active construction jobsite
6. Opportunity to travel
7. Ability to telecommute
8. Work hours
9. Work culture
10. Visibility/Interaction with decision makers
11. Continuing Education Opportunities
12. Teaching/Mentoring/Outreach

The study of workplace experience also has another dimension: the perception of barriers to career advancement. Much research on barriers to career advancement in construction was done with the perspective of women and minorities. (Bagilhole, Dainty, and Neale (2000); Dainty, Bagilhole, Ansari, and Jackson (2004); Dainty, Bagilhole, and Neale (2001)). For

example, Work/life balance, Male Dominance, Unfair perception of women's capabilities, Slow career progression, Socio- cultural factors etc. were studied as barriers (Azhar & Griffin, 2014). Many such lists were cross referenced against each other. The final list of barriers used in the survey, adapted from research work by Fielden, Davidson, Gale, and Davey (2000) and Worrall, Harris, Stewart, Thomas, and McDermott (2010) , with all gender specific items adjusted for the applicability to all BIM employees is shown below :

1. Lack of work life balance
2. Lack of clear career path
3. Shortage of mentors
4. Glass ceiling
5. Lack of career advancement opportunities
6. Lack of networking opportunities
7. Your gender
8. Your race
9. Your nationality

2.7 SKILLS

Apart from the technical skills required by employees performing BIM related tasks, the collaborative aspect of BIM oriented process workflows require that employees are also equipped with the soft skills necessary for the successful practice of BIM in the construction industry. Industry-oriented research about this aspect of BIM is limited; however, there is a growing body of research in the realm of Construction Management education. For example, Pikas, Sacks, and Hazzan (2013) and Solnosky, Parfitt, and Holland (2013) emphasize that along with BIM skills, students need soft skills to be able to successfully practice BIM in their professional careers. Though many researchers emphasize the importance of soft skills in BIM education, research on defining the specific skills that are required by BIM employees is limited. To address this, a list of skills required by construction employees in general is generated and self-perceived levels of these skills for BIM and Non-BIM employees are compared to

understand the differences. The aim is to investigate whether the requirement of soft skills is only related to BIM/VDC careers or whether it applies to all construction careers regardless of BIM/VDC; to see what patterns, if any, might emerge in these differences.

Limited but important research exists to help define soft-skills applicable to construction management in the transitioning industry. Leicht, Lewis, Riley, Messner, and Darnell (2009) used the following categories to assess the potential of individual and team performance in an engineering course: interpersonal, intrapersonal, stress management, adaptability and general mood. Gunderson and Gloeckner (2011) identified a total of 42 skills and competencies required for success as a construction superintendent. Finally, Ahn, Annie, and Kwon (2012) identified four classes of competencies critical for construction graduates: (1) general competency, (2) affective competency, (3) cognitive competency, and (4) technical competency. From such research, general patterns regarding skills applicable to construction management emerge. For this research, the authors built upon and synthesized such patterns to generate a list of potential skills related to today's evolving construction workforce, including skills related to BIM/VDC.

To generate the specific list of soft skills relevant to the construction industry, first, four broad categories of skills required by construction employees were adopted from research by Ahn et al. (2012). Lists of skills required for construction employees proposed by Leicht et al. (2009), Gunderson and Gloeckner (2011), and Ahn et al. (2012) , along with the list of skills required by minorities in the general workforce proposed by Conrad (1999) were mapped to four categories proposed by Ahn et al. (2012) to generate the final list of Thirty Six skills to be used in the survey, shown in Table 2.

Table 2-List of skills relevant to employees in the construction industry

General Competency
01-Ability to communicate with varied audiences
02-Ability to understand and give instructions
03-Ability to obtain information from various sources
04-Stress Management - Ability to Keep Your Cool
05-Time management- ability to plan and prioritize deliverables
06-Awareness of Sustainability concepts
Cognitive Competency
07-Awareness of ethical issues
08-Ability to identify and solve problems and implement effective solutions
09-Adaptability - Being able to respond to a wide range of situations
10-Understanding and integration of interdisciplinary knowledge , including work not self-performed
11-Decision making skills
12-Willingness and ability to learn from others
Technical Competency
13-BIM design/modeling software skills
14-BIM model viewing/analysis/integration software skills
15-Additional scheduling, estimating, project management software skills
16-Construction field process knowledge (materials and methods, MEP systems etc.)
Affective Competency
Leadership skills
17-Ability to model the way
18-Ability to inspire a shared vision
19-Ability to challenge the process
20-Ability to enable others to act
21-Ability to encourage the heart
Collaborative skills
22-Ability to fit in and move with a larger (team/organizational)vision than one's own
23-Accountable for own skill set
24-Ability to recognize and respect others' skills and positions within a team
25-Ability to place trust in other team members
26-Ability to recognize problems within a team early and address them
27-Empathy - Ability to demonstrate respect for opinions, customs and individual differences of others
28-Ability to contribute to a team through cooperation
29-Ability to coach/train/teach

30-Ability to mentor
31-Networking - Ability to establish and maintain relationships through trust
32-Ability to listen
33-Ability to negotiate
34-Ability to resolve conflicts
35-Ability to build and manage interdisciplinary teams
36-Ability to manage people at all hierarchical levels

2.8 SUMMARY

Much of prior BIM/VDC research focuses on the technology itself – its limitations and possibilities, application in various contexts, case studies, legal issues, educational and research concerns etc. Limited research exists related to organizational/culture changes caused by the use/adoption of BIM in the construction industry or organizational factors that enable successful BIM/VDC adoption. However, prior research on technology adoption in construction indicates that individual employees form a key part in technology adoption and that individuals are more likely to adopt new technologies when they perceive individual benefits, such as career advancement. Therefore, one of the key factors in understanding organizational adoption of BIM/VDC is to understand the perceptions of BIM/VDC employees that drive it. Existing studies of employee perceptions related to BIM focus on the perceived usefulness of BIM in the contexts of construction productivity, or the ease of ease of learning, adaptability etc.

This exploratory study attempts to address the gap in organizational research into BIM/VDC and open up lines of further inquiry into the effects of BIM/VDC on individual employees' careers by studying their perceptions in comparison to Non-BIM employees on four aspects of their career experience: Work life balance, Career advancement, Workplace experience and Skills.

CHAPTER 3 – METHODOLOGY

The research is centered on studying individual employees' perceptions. The most suited tools for studying individual perceptions are ones that allow us to interact with individuals directly, such as interviews or surveys. To facilitate the ease of summarizing and comparing responses using statistical tools, survey methodology is used. A single survey was created based partly on prior relevant research and partly on the researcher's own career experience as a BIM/VDC employee. The following sections detail the organization of the survey, data collection and data analysis methods.

3.1 SURVEY ORGANIZATION

The detailed survey is provided in Appendix A – Complete Survey. It consists of six sections, as detailed in Table 3.

Table 3- Detailed descriptions of survey sections

#	Section name	Description and Goals
1	About your company and BIM/VDC	Questions in this section addressed the nature of the implementation of BIM/VDC at a respondent's company.
2	BIM/VDC Specific section	Questions in this section (answered only by BIM respondents) addressed BIM respondents' (1) perceptions on the nature of BIM work and (2) level of training and involvement in BIM related tasks.
3	Work Life balance	Questions in this section (answered by all survey respondents) addressed the extent of work life balance using indicators such as commute times, flexibility in schedule, travel for work etc.
4	Career Advancement	Questions in this section (answered by all survey respondents) addressed respondents' record of advancement, current level of advancement and perceptions of their future path of advancement and flexibility/ability to change career paths within their organizations.
5	Workplace experience	Questions in this section (answered by all survey respondents) addressed respondents' likes and dislikes regarding construction work, job satisfaction, barriers to career advancement, and availability of mentors.

6	Skills	Questions in this section (answered by all survey respondents) addressed respondents' self-perceived skill level for a list of skills
7	Demographics	Questions in this section (answered by all survey respondents) collected information related to demographics such as age, location etc.

3.2 TARGET POPULATION AND SAMPLING METHOD

For the purposes of this exploratory study, employees who work in general contracting companies in the construction industry were chosen as the main focus. To facilitate comparison, both employees with BIM/VDC related job duties and those without were studied. A combination of convenience and snowball sampling (Biernacki & Waldorf, 1981) were used to solicit responses using the researchers' extended network as well as Colorado State University's Construction Management Department's alumni mailing lists.

3.3 DATA COLLECTION

The survey was approved by CSU's Institutional Review Board (IRB). A copy of the approval can be seen in Appendix B – IRB approval. The survey was executed using SurveyMonkey, an online survey tool. To minimize the risk of identifying the participants, the survey was sent out using a universal link that could be used by any number of participants. The survey was first sent out to a convenience sample of qualified respondents who were then asked to share the survey with additional qualified respondents facilitating the snowball sampling method.

3.4 DATA ANALYSIS

All items in survey sections 1, 2 and 7 are analyzed and reported using common descriptive statistical methods such as percentage distribution and average values. From these

sections, Question 3 (BIM or Non-BIM), Question 40 (Male or Female) and Question 1 (BIM Department) are used as the primary independent variables for this study.

Responses to items in sections 3 – Work life balance, 4 – Career advancement, 5 - Workplace experience and 6- Skills are analyzed using a combination of Pearson’s Chi-Square coefficient and Fisher’s exact probability test. Where needed, responses were also binned into appropriate categories for facilitating this analysis method. The mean response value is also used, only to the extent of reporting what the overall response trend is and not for further statistical analysis.

3.5 DATA PARSING

Four survey sections, “Work life balance”, “Career Advancement”, “Workplace experience” and “Skills” were analyzed by comparing the responses of BIM employees with the responses of Non-BIM employees. When BIM and Non-BIM populations are compared, care was taken to see if other factors could affect the results, particularly gender and age.

Given two independent variables A & B that could affect results of a dependent variable C, tests for statistical significance (Pearson’s χ^2 or Fisher’s exact probability test) are for the distribution of cell counts between A/Non-A and B/Non-B. The result of this test informs us of the probability or the likelihood of this distribution being due to random chance. If the probability of the distribution is high (close to 1), that means that the distribution is random, that A and B are not statistically related. If the probability of the distribution is very low (below 0.05), then there is a statistical relationship between A and B. The result does not measure the strength of this relationship or its causality. However, it does indicate a relationship between A and B. In such a case, the populations must be compared separately, A to B and Non-A to Non-B to account for the effect of the potential relationship between A&B. In the course of the analysis

of this research, gender, age and BIM/Non-BIM are the three independent variables and are compared to each other for possible effect on each other.

3.5.1 BIM/Non-BIM

Age

The difference in distribution of male BIM and Non-BIM populations across age shown in Table 4 and Figure 1 was found to be *statistically significant*. The distribution follows a clear trend, with BIM respondents mean age higher than the Non-BIM respondents. The statistical significance only occurred when the outermost age groups (“20-25” and “Above 40”) were included in the analysis. Though the other age groups follow a similar trend, the difference in distribution is not statistically significant. To address this, respondents of these two age groups are excluded specifically when analyzing male BIM and Non-BIM populations throughout the analysis. Table 5 shows the age distribution of female respondents across BIM and Non-BIM categories. The number of respondents was too small to run a statistical test. However, for consistency’s sake, the same age categories are excluded when analyzing female respondents.

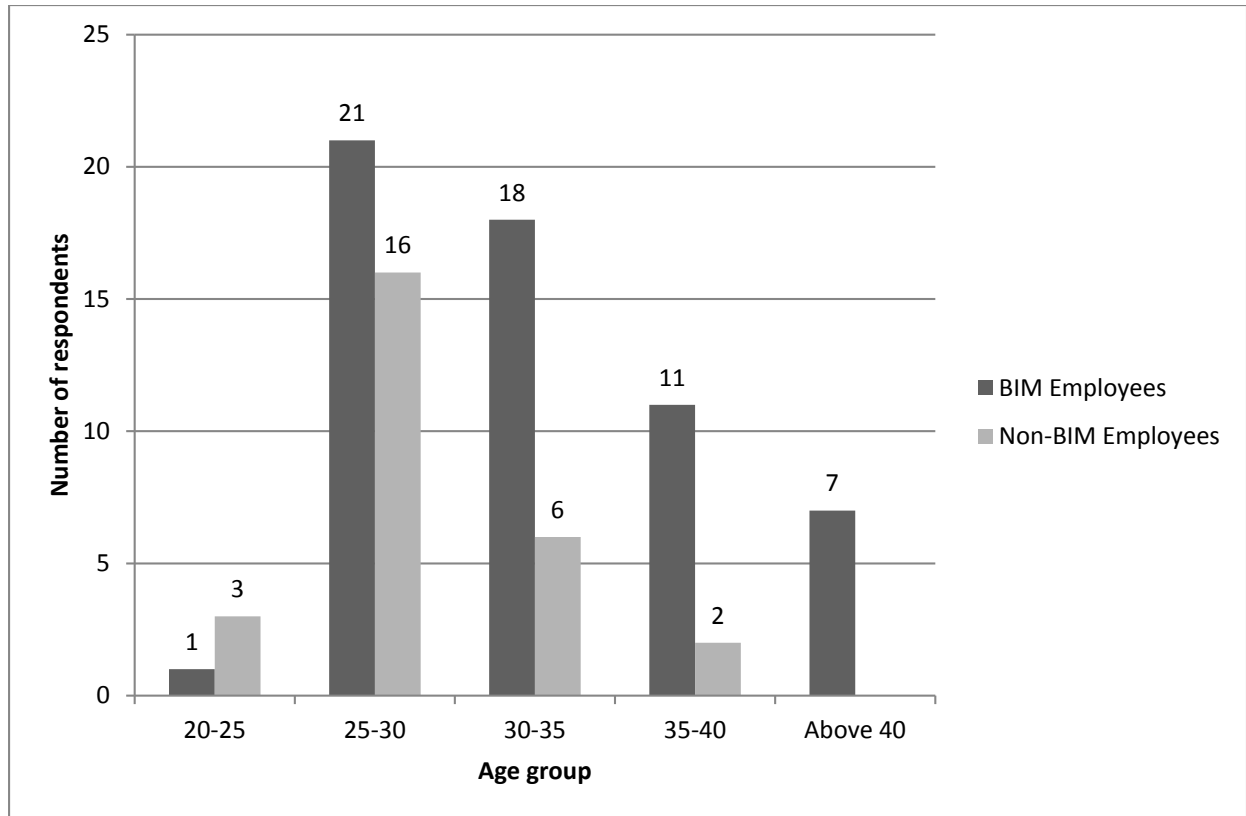


Figure 1-Age distribution of Male BIM and Non-BIM employees

Table 4 – Age distribution of Male BIM and Non-BIM respondents

Age group	Male BIM Employees	Male Non-BIM Employees
20-25	1 (25.00%)	3 (75.00%)
25-30	21 (56.76%)	16 (43.24%)
30-35	18 (75.00%)	6 (25.00%)
35-40	11 (84.62%)	2 (15.38%)
Above 40	7 (100.00%)	0 (0.00%)
Grand Total	68.24%	31.76%

Table 5 – Age distribution of Female BIM and Non-BIM respondents

Age group	Female BIM Employees	Female Non-BIM Employees
20-25	1 (50.00%)	3 (50.00%)
25-30	6 (46.15%)	7(53.85%)
30-35	2(50.00%)	2(50.00%)
35-40	3(100%)	0(0%)
Above 40	0(0%)	1(100%)
Grand Total	12(48%)	13(52%)

Gender

The difference in distribution of BIM and Non-BIM populations , shown in Table 6 across male or female populations was found to be *statistically significant*, with a significantly higher percentage of Non-BIM employees identifying themselves as female.

Table 6 – Gender distribution of BIM and Non-BIM respondents

Gender	BIM Employees	Non-BIM Employees	Grand Total
Female	12	12	24
Male	58	27	85
Grand Total	70	39	109

$\chi^2=2.708$; $DF=1$; $p=0.0998461$; $>90\%$

Due to this unequal distribution, when comparing BIM to non-BIM populations, male and female respondents were compared separately. It must be noted that due to the low number of female respondents, the reliability of Pearson's chi square tests for female population is lowered. In lieu of Pearson's Chi square test, Fisher's test of independence was used. Statistically significant results are presented.

3.5.2 Female vs. Male

A secondary focus of the study was gender. The respondents of female respondents were compared against the responses of male respondents in both BIM and Non-BIM separately. To see if age might be a factor that could influence the results, a Chi Square analysis test is done. The distribution of men and women across the various age groups, as shown in Table 7 is sufficiently random (not statistically significant). Therefore men and women of all age groups are compared against each other for analysis without the need for adjusting for age.

Table 7 – Age distribution of male and female respondents

Age group	Female	Male
20-25	2 (33.33%)	4 (66.67%)
25-30	13 (26.00%)	37 (74.00%)
30-35	4 (14.29%)	24 (85.71%)
35-40	3 (18.75%)	13 (81.25%)

Above 40	1 (12.50%)	7 (87.50%)
Grand Total	23 (21.30%)	85 (78.70%)

3.5.3 BIM Department (BIM respondents only)

Within BIM populations, respondents from organizations with separate BIM departments were compared with respondents from organizations without a separate BIM department. Chi Square analysis is used to see if age is a factor that could influence the results. The difference in age distribution for BIM respondents from organizations with or without separate BIM departments, shown in Table 8 is sufficiently random. i.e., not *statistically significant*.

Table 8 – Age distribution of BIM and Non BIM respondents

Age group	No BIM Dept.	BIM Dept.
20-25	0 (0%)	2(100%)
25-30	12(42.86%)	16(57.14%)
30-35	7(33.33%)	14(66.67%)
35-40	5(35.71%)	9(64.29%)
Above 40	2(28.57%)	5(71.43%)
Grand Total	26(36.11%)	46(71.43%)

3.5.4 Summary

To account for the factors that could influence each other, the following adjustments are made when analyzing the overall data from Work life balance, Career advancement, Workplace experience and Skills. When comparing BIM & Non BIM populations,

- Because the distribution of Men and Women in both categories is significantly different,
 - BIM Men are compared with Non-BIM men and
 - BIM Women are compared with Non BIM Women.
- Because the distribution of respondents across different age categories is significantly different, to adjust for age, respondents from age categories “20-25” and “Above 40” are omitted in the analysis.

When comparing women with men, no other factor from the survey was found to potentially influence the results, so BIM women are compared with BIM men and Non-BIM women are compared with Non-BIM men to study the differences. When comparing BIM respondents from organizations with BIM departments to BIM respondents from organizations without BIM departments, no other factor from the survey was found to potentially influence the results.

3.6 DATA ANALYSIS LIMITATIONS

Implementation of snowball sampling could introduce a source of sampling error regarding respondent qualification (employee of a general contractor). (Biernacki & Waldorf, 1981). Due to the implementation of convenience and snowball sampling methods, the resultant distribution of respondents across age groups, genders and BIM or Non-BIM categories is not representative of the overall population studied. Therefore, inferential statistics cannot be used to extrapolate the data to the larger target population set. Instead, descriptive statistics are used to summarize the data about survey respondents.

CHAPTER 4: FINDINGS

A total of One hundred and twenty nine respondents answered the survey. Response rate is unknown since distribution utilized convenience and snowball sampling.

4.1 RESPONDENT PROFILE

4.1.1 Location

65% of the respondents are from Western United States, with most respondents from Colorado and California, followed by 15% of respondents each from the South and Midwest regions. Of those who choose to answer demographic questions, 75% were 20-35 years old, 23% were female and 30% were non-Caucasians from different races.

4.1.2 Job Duties

Of the hundred and twenty nine survey respondents, 83 (64.34%) respondents' work/job duties involved BIM/VDC in varying degrees while the rest were from the operations side of construction management. Sixty nine (53.49%) respondents worked for organizations with a separate, dedicated BIM/VDC department, Sixteen (12.4%) did not have a BIM/VDC program and the rest had indicated that either select individuals throughout various departments in their company had BIM skills that their company intended to have all employees know BIM/VDC or that they outsource their BIM/VDC work to consultants. Regardless of their BIM/VDC duties, Ninety six (75%) respondents reported that their company provides support in terms of time, compensation and training materials for BIM/VDC initiatives, while twenty eight (22%) indicated that there was no organizational support for BIM/VDC initiatives.

4.2 SURVEY RESPONSES

The results below are summarized in the order of the questions asked in the survey. Results in this section are presented numerically without analysis. For the results of statistical analysis, please refer to the next section “Results of Analysis”

4.2.1 Section 1 - About your company and BIM/VDC

Question 1

What is the nature of your company’s BIM/VDC program? (Check all that apply)

- ☐ We have a separate BIM/VDC department (Coded as Category 1)
- ☐ Our goal is to have all employees know BIM/VDC (Coded as Category 2)
- ☐ Select individuals throughout various departments have BIM/VDC skills (Coded as Category 3)
- ☐ We outsource our BIM/VDC work to consultants(Coded as Category 4)
- ☐ We do not have a BIM/VDC program (Coded as Category 5)
- ☐ Other (please specify) (Open ended response, Coded under categories 1-5)

Responses

Figure 2 and Table 9 show the responses to Question 1. Respondents could check multiple boxes for this question. Respondents who checked none of the Category 1-5 boxes but checked the “Other” category were coded based on the open ended response provided. One response was disqualified since mutually exclusive answers were selected. One additional response was disqualified based on the open ended response since it did not directly answer the question:

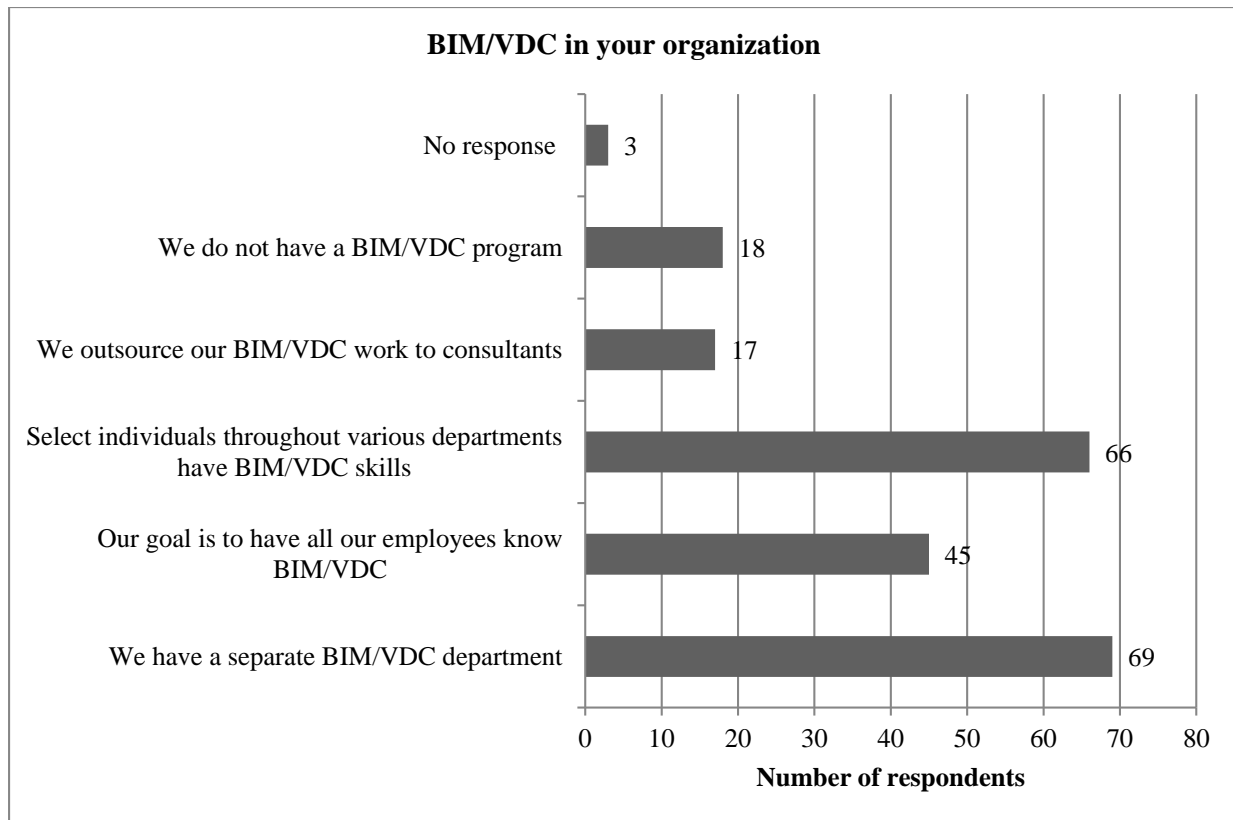


Figure 2-Responses to question 1

Table 9 - Responses to question 1

Response categories	Number of respondents
Category 1 only	21
Categories 1 and 2	11
Categories 1,2 and 3	14
Categories 1,2,3 and 4	9
Categories 1,2 and 4	2
Categories 1 and 3	10
Categories 1,3 and 4	1
Category 2 Only	6
Categories 2 and 3	2
Categories 2 and 4	1
Category 3 Only	26
Categories 3 and 4	3
Category 4 Only	1
Category 5 Only	18
“Other”, Coded as Category 3	2
Disqualified responses	2
Grand Total	129

For the purposes of the scope of this study, the researcher chose to focus on Category 1 “We have a separate BIM/VDC department”. Sixty nine respondents out of one hundred and twenty nine checked this box. This result was used as an independent variable / qualifier in the survey. The results of this summation can be seen in Figure 3.

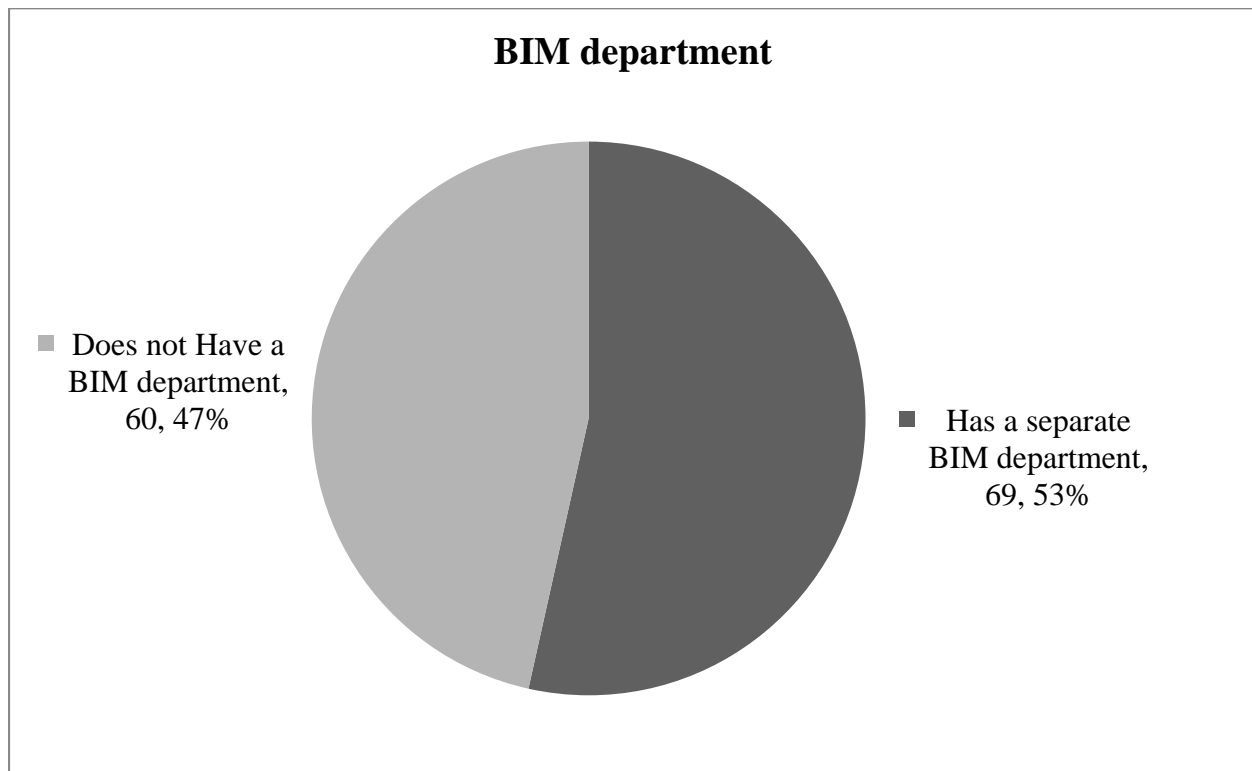


Figure 3-Respondents from organizations with BIM departments

Survey recommendations/Lessons learnt

Apart from category 5, responses overlapped between the various categories. It would be beneficial for future research to modify this question to contain only mutually exclusive categories. Based on the disqualified open ended response, it is inferred that the question, particularly the word “program” has a potential to be misunderstood by a limited number of respondents.

Question 2

What kind of support does your company provide to support the implementation of BIM/VDC?

Please answer even if your company does not provide formal support.

Responses

For this question, respondents could provide an open ended answer. For a complete list of responses, please refer to Appendix D – Detailed responses and comments.

Question 3

Does your work directly involve BIM/VDC in any way? (i.e., Do you perform any BIM/VDC related tasks as a part of your work?) (Yes/No)

Responses

This question was used as an independent variable / qualifier in the survey. All respondents who answered “Yes” were coded as “BIM employees” and were directed to survey section 2 – BIM only section. Respondents who answered “No” were coded as “Non-BIM Employees” and were directed to section 3 while skipping section 2. These results are summarized and shown in Figure 4.

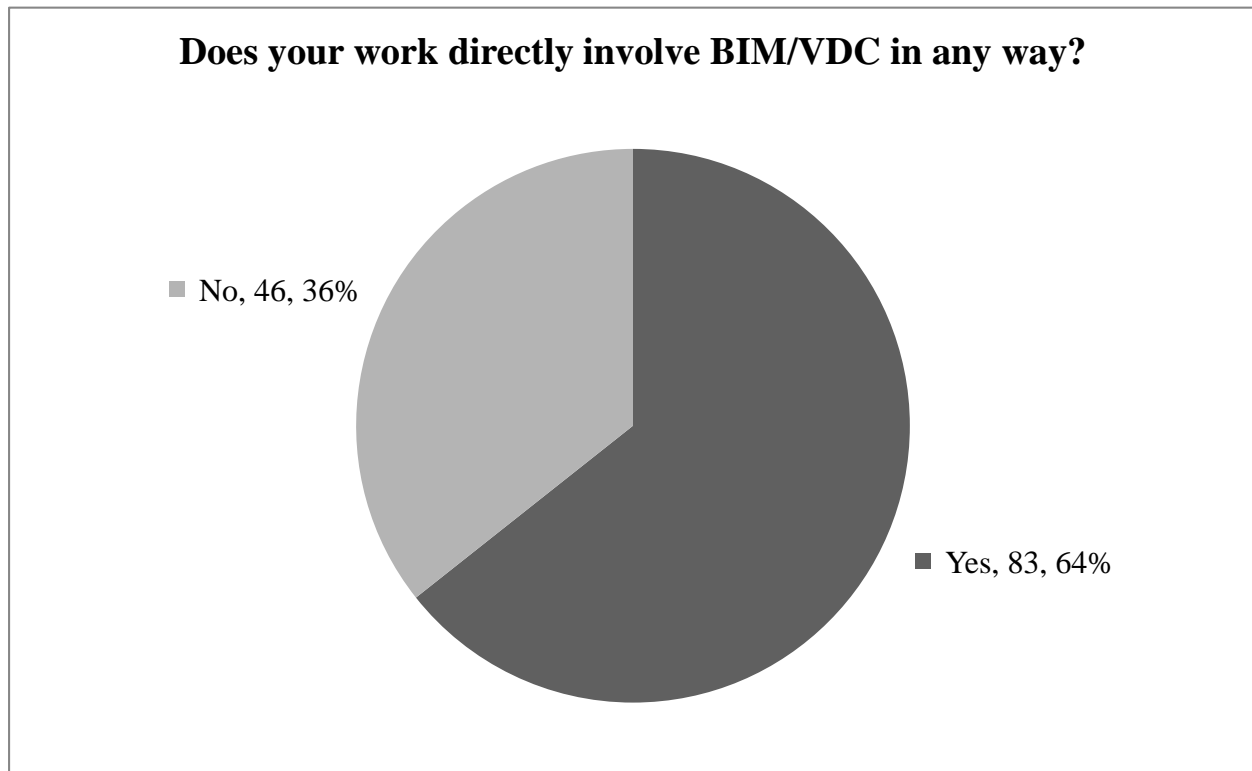


Figure 4-BIM or Non BIM respondents

A disproportionately high number of survey respondents responded that they used BIM/VDC. This was due to the survey sampling methods implemented.

4.2.2 Section 2 – BIM Only Section

Question 4

What do you like best about working with BIM/VDC at your company?

Responses

For this question, respondents could provide an open ended answer. For a complete list of responses, please refer to Appendix D – Detailed responses and comments. Networking with people from varied backgrounds, being in the frontlines of emerging technologies and continuous education opportunities were mentioned the most. Other lesser factors like increased visibility, gaining an edge over colleagues without BIM skills, opportunities to work on multiple

projects and participate in business development and being able to understand a project better due to BIM software were also identified.

Question 5

Is there anything you would like to change about working with BIM/VDC at your company?

Responses

For this question, respondents could provide an open ended answer. For a complete list of responses, please refer to Appendix D – Detailed responses and comments. The following themes recurred often in the responses to this question.

1. Need for a clear career path that includes an option to move laterally to other CM roles to avoid being pigeonholed (ten responses)
2. Need for colleagues and upper management to understand and appreciate the value of BIM employees more and
3. Need for basic BIM/VDC training (ten responses)
4. Need for hiring more BIM/VDC employees to share workload, more field/on-site exposure and training and more ways to integrate BIM personnel into the mainstream CM/Project Management teams instead of siloing them were also mentioned.

Question 6

Please review the following statements (shown here in Table 10)

Table 10 - Question 6 statements

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
6A. My BIM/VDC skills have enabled me to work at a higher pay grade than my Peers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

6B. My BIM/VDC skills have given me the opportunity to get promoted faster than my peers	○	○	○	○	○
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Responses

All five response categories were treated as ordinal (but not interval) categories and the number of respondents in each category was counted to see the location distribution of the data, summarized in Table 11.

Table 11 - Responses to question 6

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Total	Skipped	Average
6A	1.30%	18.18%	45.45%	24.68%	10.39%	100%	6	3.25
	1	14	35	19	8	77		
6B	6.58%	22.37%	43.42%	15.79%	11.84%	100%	7	3.04
	5	17	33	12	9	76		

Question 7

Have you had training in BIM/VDC? Check all that apply.

- ☐ None/Self-taught (Category 1)
- ☐ Industry led training (e.g. BIMForum, Autodesk University etc.) (Category 2)
- ☐ In-house training (Category 3)
- ☐ College courses (Category 4)
- ☐ Other – Please explain (Not coded, this space was provided to the respondents in case they needed to clarify their responses)

Responses

Respondents could check multiple boxes for this question. Respondents who did not check any of the boxes but wrote an explanation in the “other” category were coded under categories 1-4 per their response. Results are summarized in Table 12. Respondents who did not check any of the boxes or write in the other category were categorized as “skipped”. This question was analyzed as a standalone question that was not tested for its effect on or the effect of any of the other variables.

Table 12 - Responses to question 7

Response category	Number of respondents
All 4 categories	2
Categories 1, 2 and 3	10
Categories 1 and 2	7
Categories 1 and 3	7
Categories 1 and 4	5
Categories 1, 2 and 4	2
Categories 1, 3 and 4	4
Categories 2 and 3	5
Categories 2 and 4	1
Categories 2,3 and 4	5
Categories 3 and 4	3
Category 1 only	16
Category 2 only	1
Category 3 only	9
Category 4 only	1
Skipped	5
Grand Total	83

Survey recommendations/Lessons learnt

Category 1 was meant to be a mutually exclusive category. i.e., respondents who have had training in the industry, in-house or a college, in theory, should not check the “none/self-taught” box which implies that they had no formal training whatsoever and only taught themselves in the course of their career. However, one could be mostly self-taught with some mix of the other types of training. The researcher recommends to split category 1 into “No training” and “Self-Taught”. Another recommendation would be to track the mix of training in terms of approximate percentages.

Question 8

What best describes the relationship between your primary job duties and job title? (*Pick one*)

- My job duties include BIM/VDC but my title does not (Coded as Category 1)
 - My title includes BIM/VDC or a variant but I also have other job duties (Coded as Category 2)
 - My job duties and my title include BIM/VDC (Coded as Category 3)
- Comments (Optional)

Responses

The categories are mutually exclusive. The question is analyzed by all categories for its own sake for an idea about how the respondents' job title relates to their job functions. For the sake of simplified data analysis/parsing for other questions in the survey, Categories 2 and 3 are binned together as "Has a BIM title" and Category 1 is considered as "Does not have a BIM title" and summarized in Table 13 and Figure 5.

Table 13 - Responses to question 8

	Number of respondents
Category 1	26 (39%)
Category 2	13 (20%)
Category 3	27 (41%)
Total	66 (100%)
Skipped	17

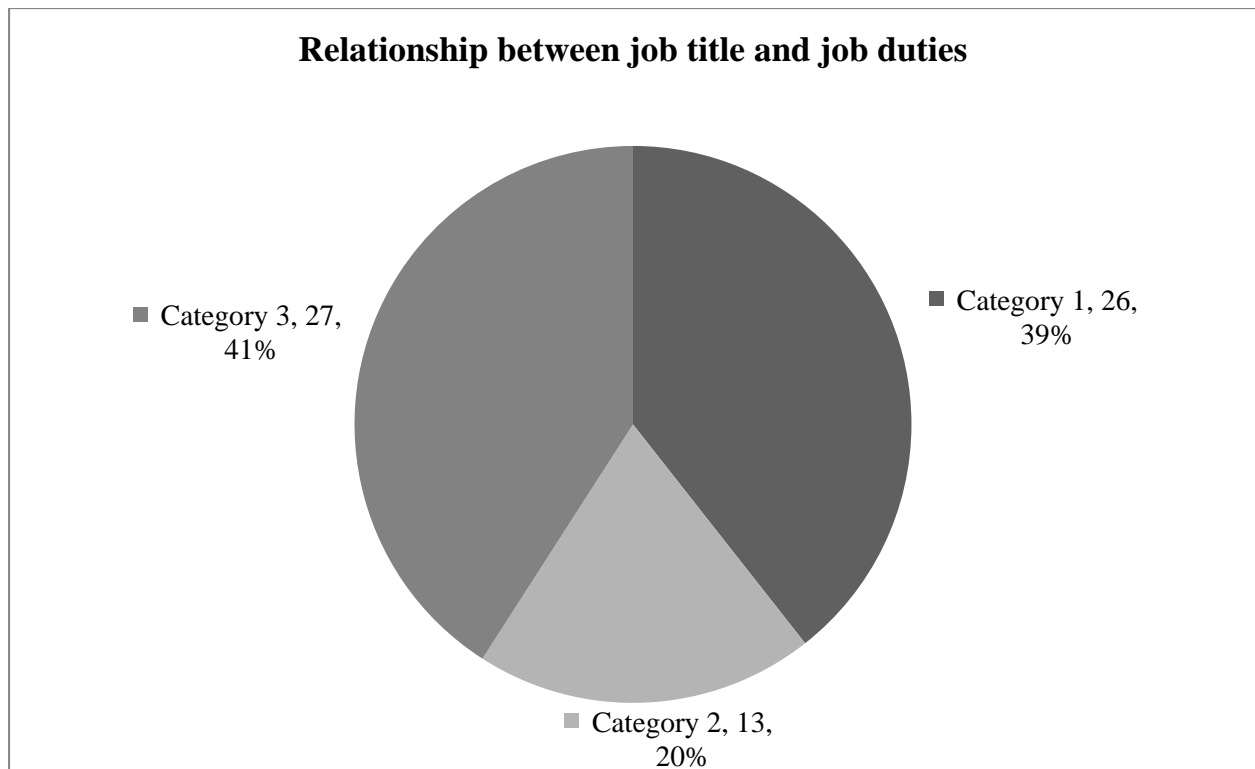


Figure 5-Responses to question 8

The comments section of this question yielded interesting observations about the nuances of working with BIM. Respondents could have worked with BIM/VDC in their past on the same project but not at the moment. They could also be managing BIM personnel, or they could be BIM engineers who have picked up field duties during low BIM workload times. For a complete list of comments, please refer to Appendix D – Detailed responses and comments.

Survey recommendations/Lessons learnt

The definition of BIM/VDC related job duties and Non-BIM Operations job duties needs to be clarified to get more accurate responses. There would still be some job duties that can be categorized equally as BIM or Non-BIM roles. E.g. managing BIM/VDC personnel.

Question 9

What is the percentage of time you spend on BIM/VDC duties?

- ☐ 0-15%
- ☐ 15%-30%
- ☐ 30-60%
- ☐ 60-90%
- ☐ 100%

Responses

Responses to question 9 are summarized in Table 14 and Figure 6.

Table 14 - Responses to question 9

Time	Number of respondents
0-15%	34 (43%)
15%-30%	3 (4%)
30%-60%	7 (9%)
60%-90%	17 (21%)
100%	18 (23%)
Total	79 (100%)
Skipped	4

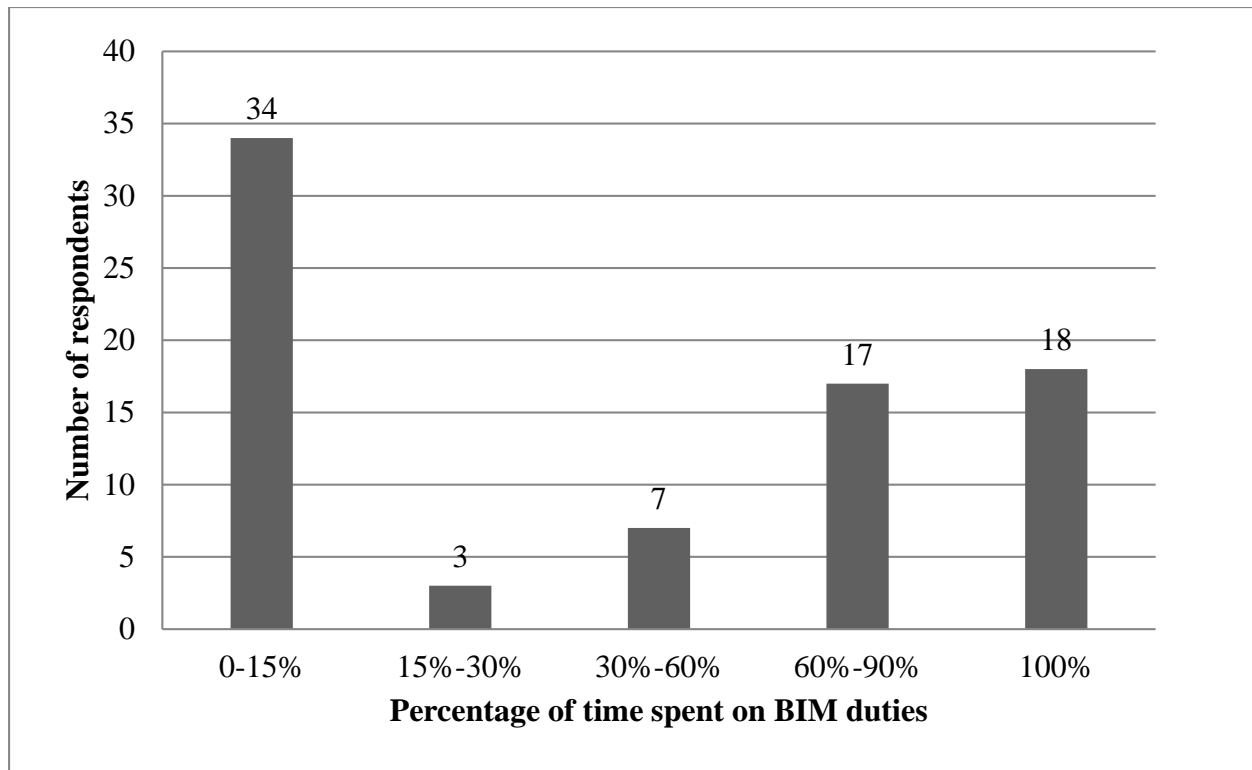


Figure 6-Responses to question 9
Question 10

Please describe any barriers/challenges to your career advancement, in both BIM/VDC as well as in Construction in general

Responses

For a complete list of responses, please refer to Appendix D – Detailed responses and comments. Table 15 shows a summary of the responses to question 10, after a rough qualitative analysis was performed. The most mentioned barrier was a lack of understanding of the value of BIM and the subsequent worth of a BIM/VDC employee by their company's general management (12 responses). The second most important one was found to be the lack of a clear career advancement path (8 responses). Lack of formal allocation of time and resources towards training for an employee to keep up with the fast paced changes of the BIM world ranked third (5 responses). 7 respondents felt that pigeonholing into a BIM role or lack of exposure to the construction field would impede their career advancement. Lack of mentors, clear personnel

evaluation systems and formal qualifications in BIM were also mentioned. In the open ended section, there were no significant differences in the perceptions between men, women or minorities.

Table 15 - Responses to question 10

Theme	Times mentioned
Lack of mentoring	1
Lack of formal qualifications	1
Lack of opportunities for lateral movement	1
Lack of practices to evaluate BIM roles	1
Trailblazing/Lack of prior processes or lessons learnt or standardization	2
Lack of training in Non-BIM/Construction related tasks	3
Lack of (available) promotions	4
I do not see any challenges	4
Pigeonholing/Siloing	4
Keeping up with rapid changes in industry/Lack of (time to) train in additional BIM tools	5
Lack of clear career advancement path	8
Lack of recognition/understanding by others/upper management	12

Question 11

Your BIM/VDC job duties/functions include to... *(Check all that apply)*

Responses

A list of commonly performed BIM/VDC duties was given. Respondents could check multiple responses. Additionally, an “Other” field was provided for duties not listed. Results are reported as the number of times a box was checked and summarized in Table 16.

Table 16 - Responses to question 11

Job Duty	Number of times checked
Analyze models for coordination or clash detection	57
Create site logistics plans or models	50
Create marketing materials related to BIM (includes visuals, animations, written responses to RFPs etc.)	49
Document lessons learned or create best practices	46
Train others in BIM/VDC usage (colleagues, subordinates, subcontractors, owners etc.)	45
Create 3D models	43
Overlay models from different sources	43

Create 4D schedule simulations	39
Manage other BIM/VDC personnel	38
Test new software	36
Assist in making/Make decisions about new hardware, software or processes	36
Set up jobsites with BIM/VDC (Hardware & Software)	34
Represent your company at technical conferences - Outreach and learning	32
Extract estimates from BIM/VDC models	29
Create 2D plans using CAD – Drafting	26
Prepare a facilities management ready model	26
Analyze models for safety	25
Manipulate databases underlying model	21
Analyze models for environmental concerns (energy, daylighting etc.)	8

4.2.3 Section 3 – Work Life Balance

Question 12

How long is your average commute time? (*numeric response, number of hours*)

Responses

Table 17 shows the responses question 12, categorized as number of hours.

Table 17 - Responses to question 12

Number of hours	Number of respondents
0	10
1	76
2	23
3	3
Disqualified Responses	5
Skipped	12
Grand Total	129

Average commute time for all respondents: 1.17 hours

Survey recommendations/Lessons learned

Respondents could provide a numeric response as an answer to this question. The premise/intention was to understand how many hours workers spend commuting and its subsequent impact on work-life balance. There were many issues to this question

- If one commutes a fraction of an hour (0.5 or 0.25 hrs.) , they could enter 0 or 1 depending on how they would round it off
- The commute time changes with office/jobsite locality (Downtown/suburbs), location (city) etc.
- The commute time also changes if there are multiple jobsites one commutes to, where the respondents chose to live etc.

Due to the related challenges, the question was eliminated from the overall analysis.

Question 13

Are your work hours flexible? (Yes/No)

Responses

Table 18 and Figure 7 show the responses to question 13.

Table 18 - Responses to question 13

Response	Respondents (%)
Yes	71 (59%)
No	49 (41%)
Total	120(100%)
Skipped (unanswered)	9

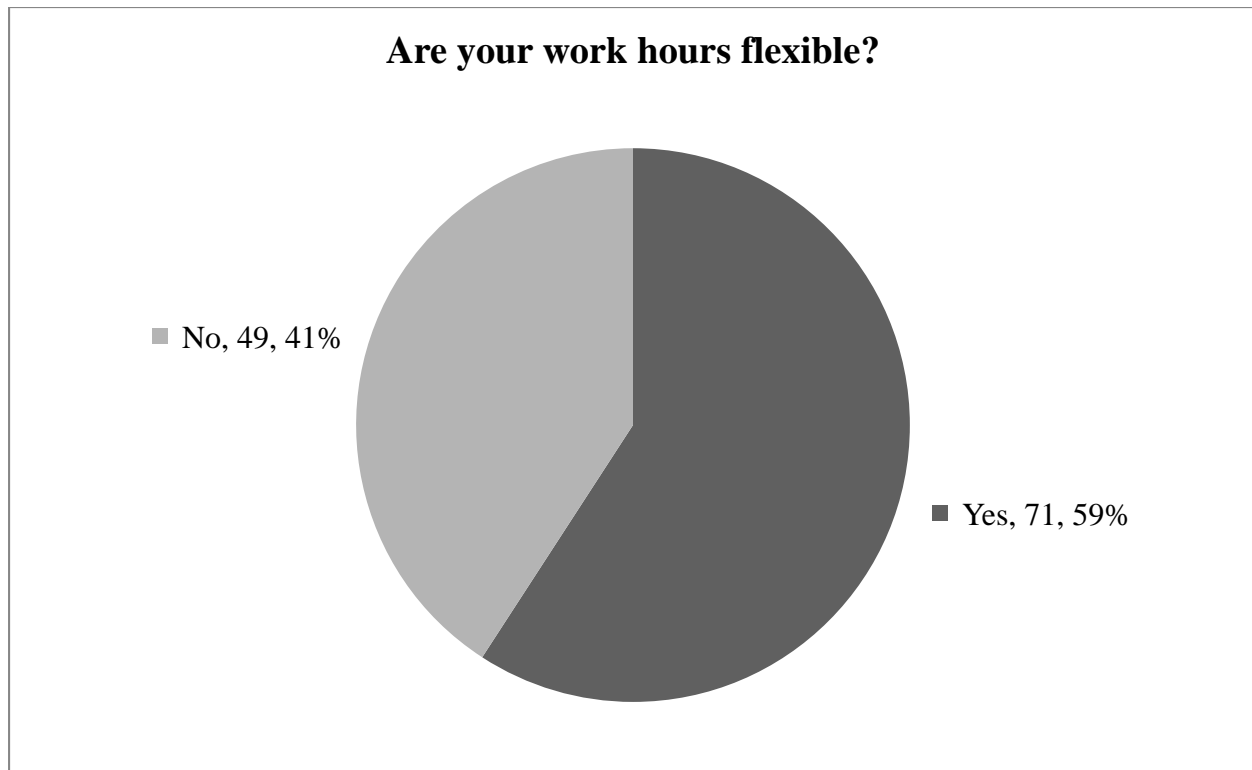


Figure 7-Responses to question 13

Question 14

Does your organization allow you to telecommute? (Yes/No)

Responses

Table 19 and Figure 8 show the responses to question 14.

Table 19 - Responses to question 14

Response	Respondents (%)
Yes (Allowed)	37 (30%)
No (Not allowed)	85 (70%)
Total	122
Skipped (unanswered)	7

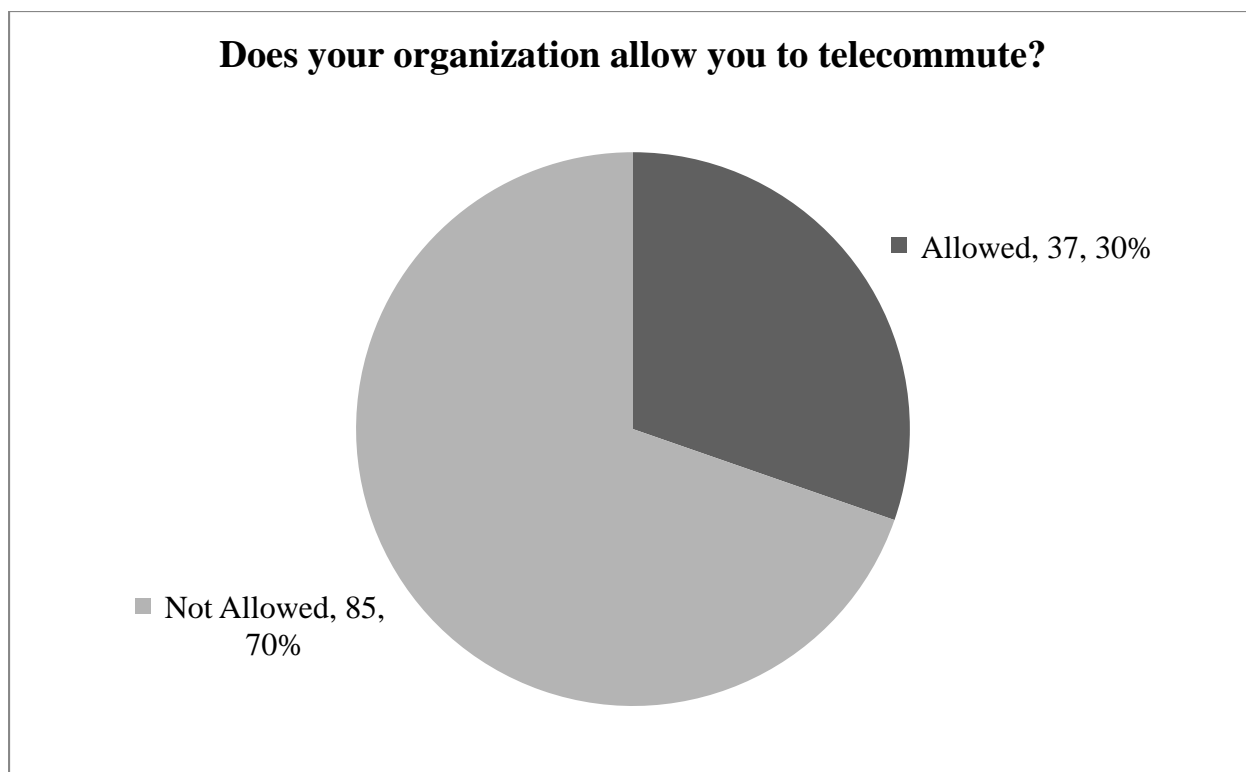


Figure 8-Responses to question 14

Question 15

Do you telecommute? (Yes/No)

Responses

Table 20 and Figure 9 show the responses to question 15.

Table 20 - Response to question 15

Response	Respondents (%)
Yes	24 (20%)
No	97 (80%)
Total	121 (100%)
Skipped (unanswered)	8

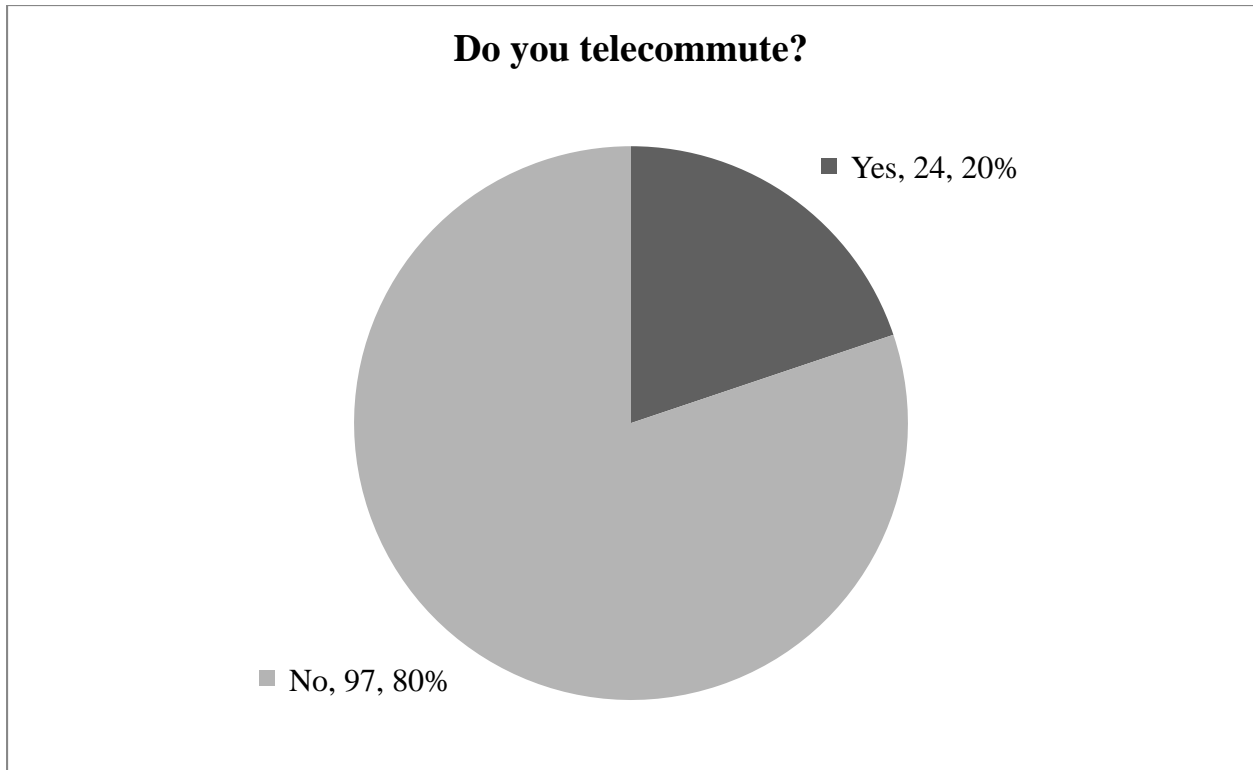


Figure 9-Responses to question 15

Question 16

Over the course of a month, on an average, how many days do you work from home? (*numeric response, whole numbers*)

Responses

Table 21 and Figure 10 show the responses to question 16.

Table 21 - Responses to question 16

Response - Number of days per month	Number of respondents
0	81 (68.64%)
1	18 (15.25%)
2	8 (6.78%)
3	2 (1.69%)
4	3 (2.54%)
5	4 (3.39%)
15	1 (0.85%)
20	1(0.85%)
Total Responses	118 (100%)
Skipped	11

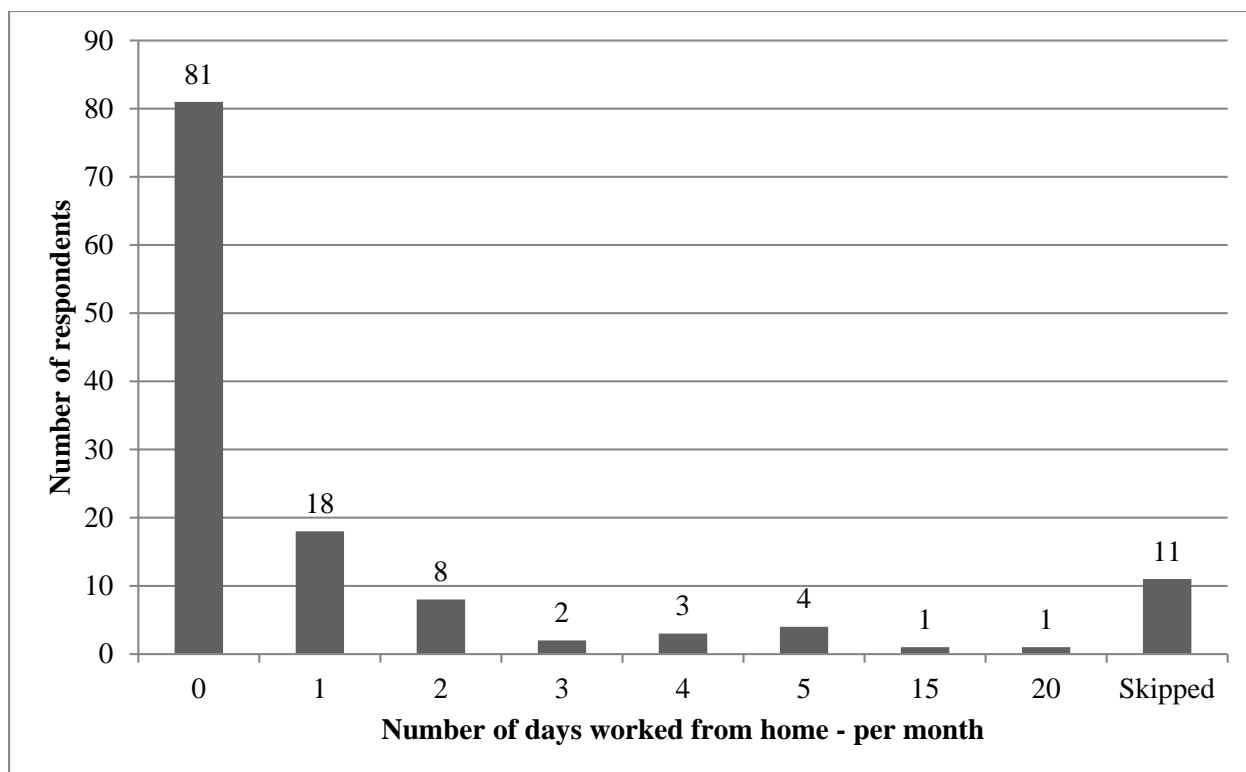


Figure 10-Responses to question 16

Question 17

Over the course of a month, on an average,

- A. How many hours do you work a day? (Numeric response , whole number)
- B. How many days do you travel out of town for work? (Numeric response , whole number)
- C. How many days do you spend on an active construction site? (Numeric response , whole number)

Responses

Table 22 and Figure 11 summarize the responses for statement 17A; Table 23 and Figure 12 summarize the responses for statement 17B; Table 24 shows the responses for statement 17C.

Table 22 - Responses to question 17 A

17A. Number of work hours a day	Number of respondents
8	13
9	22
10	52

11	16
12	11
13	3
Total	117
Disqualified	4
Skipped	8
Grand Total	129

Average number of hours worked by all respondents except disqualified or skipped : 9.99 hrs.

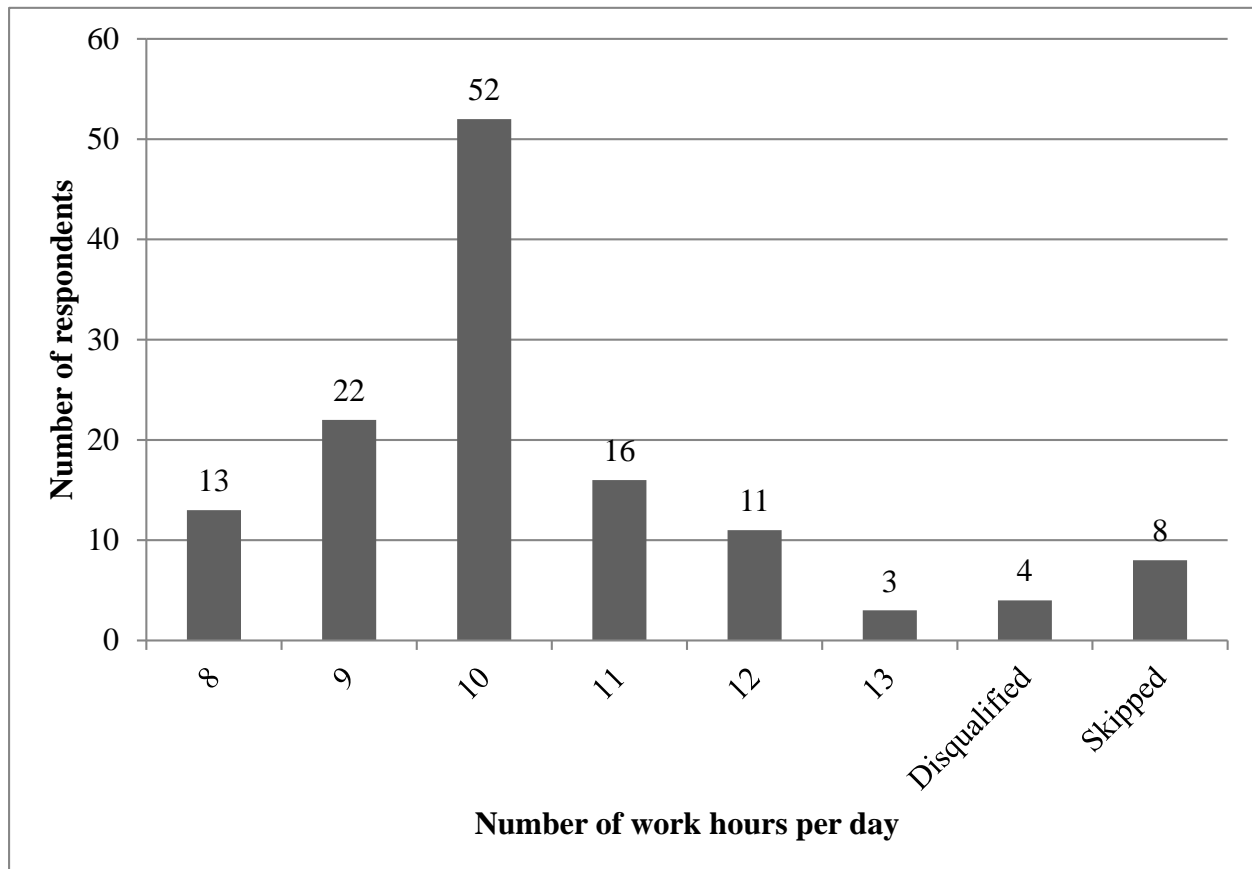


Figure 11-Responses to question 17 A

Table 23 - Responses to question 17 B

17B. Number of travel days per month	Number of respondents
0	59
1	23
2	14
3	6
4	2

5	2
7	1
8	3
10	3
12	1
16	1
20	1
26	1
28	1
Total	118
Disqualified	1
Skipped	10
Grand Total	129

Average number of travel days per month, for all respondents except disqualified or skipped:

2.11 days

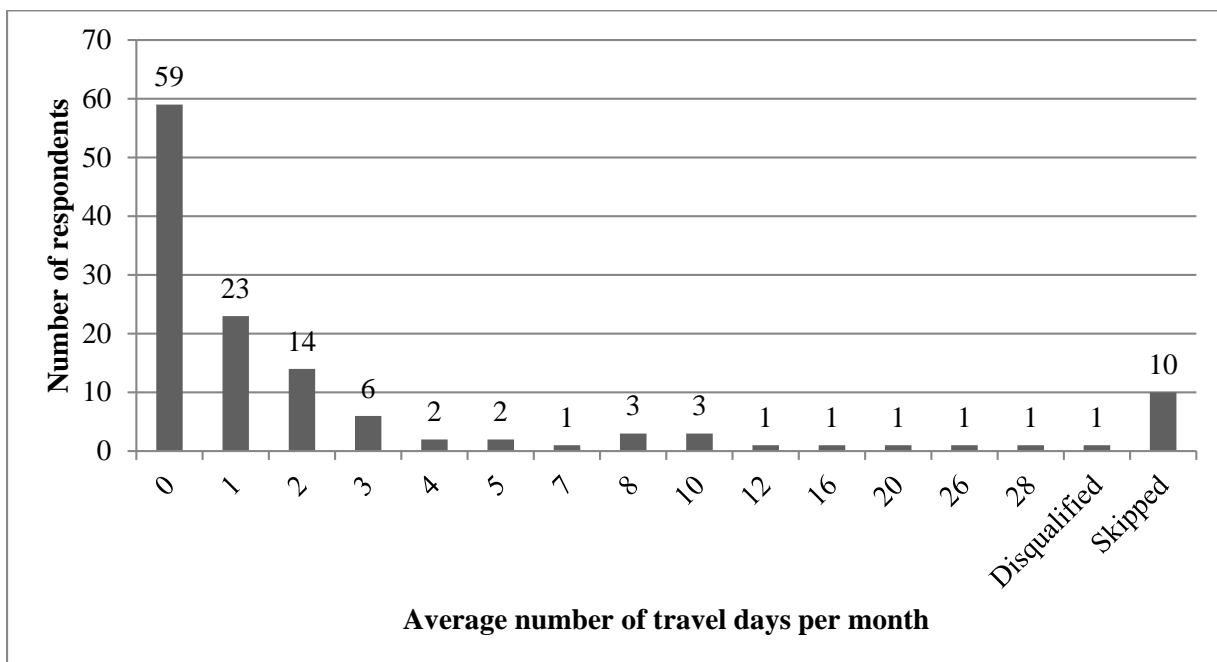


Figure 12-Responses to question 17 B

Table 24 - Responses to question 17 C

17C. Days on active construction site	Number of respondents
0	13
1	7

2	6
3	7
4	4
5	11
6	1
7	1
8	1
10	4
12	2
15	2
16	1
18	2
19	1
20	20
21	2
22	7
23	4
24	2
25	7
27	1
28	2
29	1
30	6
31	2
40	1
Total	118
Disqualified	3
Skipped	8
Grand Total	129

Average number of days spent on an active construction site, per month, for all respondents
except disqualified and skipped: 13.57 days

Question 18

How many times have you relocated for work for your current job? (*Numeric response*)

Responses

Table 25 and Figure 13 summarize the responses to question 18. The average number of times relocated for all respondents who answered the question was 1.37 times

Table 25 - Responses to question 18

Number of times relocated	Number of respondents
0	58
1	25
2	12
3	6
4	9
5	5
6	1
7	2
15	1
Total	119
Skipped	10
Grand Total	129

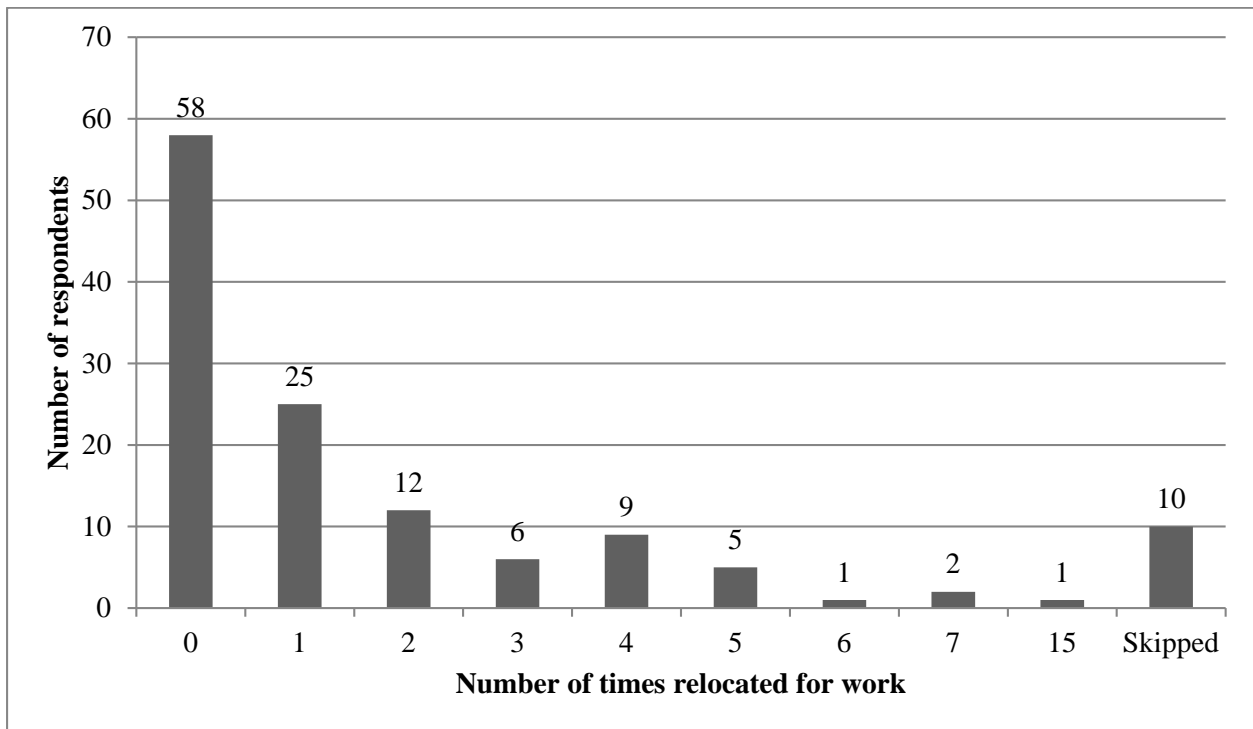


Figure 13-Responses to question 18

4.2.4 Section 4 - Career advancement

Question 19

Do you manage employees of your own company? (Yes/No)

Responses

Table 26 shows the responses to question 19.

Table 26 - Responses to question 19

Response	Number of respondents
Yes	62 (51%)
No	59 (49%)
Total	121 (100%)
Skipped	8
Grand Total	129

Question 20

Do you manage subcontractors or external consultants? (Yes/No)

Responses

Table 27 shows the responses to question 20.

Table 27 - Responses to question 20

Response	Number of respondents
Yes	105
No	16
Total	121
Skipped	8
Grand Total	129

Question 21

How many employees/subcontractors/consultants/others do you manage? (*text response, comment*)

Responses

Respondents of this question gave varied answers. “How many” was interpreted by respondents as referring to companies, trades, crew, employees or organizations. Data could not be summarized meaningfully or parsed. Due to the related challenges, the question was eliminated from the overall analysis. For a list of all responses, please refer to Appendix D – Detailed responses and comments

Question 22

How many times have you been promoted (change in title and pay) in your career in construction management (including company changes)? (*Choose one*)

- ☐ 1 time
- ☐ 2 times
- ☐ 3 times
- ☐ 4-5 times
- ☐ More than 5 times

Responses

Table 28 shows the responses to question 22.

Table 28 - Responses to question 22

Times promoted	Number of respondents
1 time	30 (26%)
2 times	29 (25%)
3 times	27 (24%)
4-5 times	19 (17%)
More than 5 times	9 (8%)
Total	114
Skipped	15
Grand Total	129

Question 23

Do you have yearly performance evaluations? (Yes/No)

Responses

Table 29 shows a summary of the responses to question 23. One hundred and twenty one respondents answered this question, Eight skipped it. Of those one hundred and twenty one respondents, only five respondents answered “No”. All five who answered “no” to the question were either men or preferred not to answer the question about their gender. Seven respondents commented on the question. All comments indicated that the respondents did have performance evaluations, but the evaluations were bi annual or more frequent. For a list of all comments, please refer to Appendix D – Detailed responses and comments.

Table 29 - Responses to question 23

Response	Number of respondents
Yes	116 (96%)
No	5 (4%)
Skipped	8
Grand Total	129

Question 24

Does this evaluation include a section for measuring performance in BIM/VDC? (Yes/No/In Part)

Responses

Table 30 shows a summary of responses to question 24.

Table 30 - Responses to question 24

Response	Number of respondents
Yes	42 (35%)
No	61 (51%)
In Part	16 (14%)
Skipped	10
Grand Total	129

Question 25

Does your pay or promotion depend on this evaluation? (Yes/No/In Part)

Responses

Table 31 shows a summary of the responses to question 25.

Table 31 - Responses to question 25

Response	Number of respondents
Yes	66 (56%)
No	31 (27%)
In Part	20 (17%)
Skipped	12
Grand Total	129

Question 26

Does your organization have a clearly defined hierarchy/ path of advancement for BIM/VDC employees? (Yes/No)

Responses

Table 32 shows a summary of responses to question 26.

Table 32 - Responses to question 26

Response	Number of respondents
Yes	34 (29%)
No	84 (71%)
Skipped	11
Grand Total	129

Question 27

Does your company support lateral moves to switch between career tracks or job functions? (Yes/No)

Responses

Table 33 shows a summary of responses to question 27.

Table 33 - Responses to question 27

Response	Number of respondents
Yes	103
No	17
Skipped	9
Grand Total	129

4.2.5 Section 5 - Workplace experience

Question 28

What do you like best about working in construction at your company?

Responses

Twenty two respondents out of One hundred and twenty nine skipped the question. Responses have been summarized for the sake of simplicity. The most commonly occurring themes in the responses are presented in Table 34 along with the number of times they appeared in the overall responses. For a complete list of responses, please refer to Appendix D – Detailed responses and comments.

Table 34 - Responses to question 28

Themes	Times mentioned
People/Teamwork/Camaraderie	32
Projects (Different types, challenges, experience)	19
Challenging work	15
Tangible product that can be showed off	10
The process of building/being on site	10
Compensation/benefits	8
Flexibility	7
No supervision/autonomy at work	6
Learning opportunities	6
Problem solving/Creative solutions	6
Career opportunities	5
Work culture	5
Work environment	4
Ability to work on multiple projects	2
Changing situations	2
Company support	2
Ability to be on site	1

Ability to travel	1
Company's passion for technology	1
Improving the industry, effecting change	1
Innovation	1
Professionalism	1
Quality of work	1
Responsibility	1
Stability	1
Technology	1

Question 29

What is the biggest thing you would like to change about working in construction at your company?

Responses

Thirty respondents out of one hundred and twenty nine skipped the question. Responses have been summarized for the sake of simplicity. The most commonly occurring themes in the responses are presented in Table 35 along with the number of times they appeared in the overall responses. For a complete list of responses, please refer to Appendix D – Detailed responses and comments.

Table 35 - Responses to question 29

Theme	Times mentioned
Industry/Company needs change (rate of change, technology adoption, processes, efficiency etc.)	23
Excessive work Hours	13
Work culture	9
Lack of work life balance	9
Commute/Multiple locations (travel to sites)	8
Compensation	4
Lack of Flexibility	4
Need more time on site	4
Lack of recognition of efforts	4
Need additional help/manpower	3
Organizational Structure	3
Stress	3

Need more feedback/communication	2
Need more training/Continuous Education	2
Need a clearer career path	1
Market volatility	1
Need more diversity	1
Politics	1

Question 30

Please rate your satisfaction level for the following aspects of your job (*five point Likert scale, Very low(1) to Very high (5)*)

Responses:

Table 36 shows the distribution of respondents across the Likert response scale for question 30.

Table 36 - Responses to question 30

Job Satisfaction items	Very Low	Low	Neutral	High	Very high	N/A	Skipped	Grand Total
01 - Access to technology	1	7	17	39	52		13	129
02 - Opportunity to pioneer change	1	12	21	44	35		16	129
03 - Compensation/Incentives	2	17	36	37	24		13	129
04 - Time spent at a desk	5	27	46	19	19		13	129
05 - Time spent on an active construction jobsite	4	22	32	31	24	3	13	129
06 - Opportunity to travel	4	24	38	34	14	2	13	129
07 - Ability to telecommute	29	35	33	6	6	6	14	129
08 - Work hours	5	37	37	21	15		14	129
09 - Work culture	1	17	17	45	36		13	129
10 - Visibility/Interaction with decision makers	1	15	18	40	41	1	13	129
11 - Continuing Education Opportunities	5	17	25	32	36	1	13	129
12 - Teaching/Mentoring/Outreach	4	16	31	35	30		13	129

Cell values are number of respondents.

Question 31

Do you have a mentor? (Check all that apply)

- ☐ No (Category 1)
- ☐ Yes, unrelated work function (Category 2)
- ☐ Yes, same work function (Category 3)
- ☐ Yes, Same gender (Category 4)
- ☐ Yes, same race/ethnicity (Category 5)

Responses

Table 37 shows the distribution of respondents across the four response categories. Out of One hundred and twenty nine total survey respondents, thirteen respondents skipped the question. Two responses were disqualified. Of the remaining one hundred and fourteen respondents, thirty nine did not have a mentor at all and seventy five did.

Table 37 - Responses to question 31

Responses	Number of respondents
Category 1 only	36
Category 2 only	9
Categories 2 & 4	3
Categories 2 & 5	2
Categories 2, 3 & 4	2
Categories 2, 3, 4 & 5	4
Categories 2, 4 & 5	5
Category 3 only	12
Categories 3 & 4	7
Categories 3 & 5	1
Categories 3, 4 and 5	16
Category 4 only	1
Categories 4 and 5	3
Disqualified	6
Skipped	22
Grand Total	129

Question 32

Please rank the following challenges/barriers you might face in your career on a five point scale
(five point Likert scale, Extremely irrelevant (1) to Highly relevant (5))

Responses

Table 38 shows the distribution of all respondents across the Likert response scale for question 32.

Table 38 - Responses to question 32

Barriers	Extremely irrelevant	Irrelevant	Neutral	Relevant	Extremely Relevant	N/A	Skip	Grand Total
01-Lack of Work-life balance	5	9	7	51	43	1	13	129
02-Lack of a clear career path	5	26	31	37	16	1	13	129
03-Shortage of mentors	9	26	39	30	11	1	13	129
04-Glass ceiling	10	30	33	25	12	6	13	129
05-Lack of career advancement opportunities	5	43	26	30	11	1	13	129
06-Lack of networking opportunities	18	45	36	8	7	1	14	129
07-Your gender	41	22	12	8	6	3	37	129
08-Your race/ethnicity	46	27	11	3	1	3	38	129
09-Your nationality	47	25	12	3	2	3	37	129

Cell values are number of respondents.

4.2.6 Section 6 - Skills

Question 33-38 – Skills

Please rate yourself on the following skills (*Five point Likert type response 1- Very weak to 5- Very strong*)

Responses

Table 39 shows the distribution of all respondents across the Likert response scale for question 32.

Table 39 - Responses to questions 33-38 (Skills)

Skills	Very weak	Weak	Neutral	Strong	Very strong	Skip	Grand Total
General Competency							
01-Ability to communicate with varied audiences		1	9	73	31	15	129
02-Ability to understand and give instructions			8	74	32	15	129

03-Ability to obtain information from various sources		1	8	73	32	15	129
04-Stress Management - Ability to Keep Your Cool	1	8	32	51	22	15	129
05-Time management- ability to plan and prioritize deliverables		6	25	74	9	15	129
06-Awareness of Sustainability concepts		14	38	47	15	15	129
Cognitive Competency							
07-Awareness of ethical issues		5	15	59	35	15	129
08-Ability to identify and solve problems and implement effective solutions			8	76	30	15	129
09-Adaptability - Being able to respond to a wide range of situations		2	9	71	32	15	129
10-Understanding and integration of interdisciplinary knowledge , including work not self-performed		4	14	67	28	16	129
11-Decision making skills		3	16	73	22	15	129
12-Willingness and ability to learn from others		2	11	52	49	15	129
Technical Competency							
13-BIM design/modeling software skills	26	27	16	22	22	16	129
14-BIM model viewing/analysis/integration software skills	22	22	14	30	25	16	129
15-Additional scheduling, estimating, project management software skills	2	11	36	44	21	15	129
16-Construction field process knowledge (materials and methods, MEP systems etc.)	1	4	24	55	29	16	129
Affective Competency							
17-Ability to model the way	1	4	24	66	17	17	129
18-Ability to inspire a shared vision		3	39	59	11	17	129
19-Ability to challenge the process		5	25	63	19	17	129
20-Ability to enable others to act	1	2	36	58	15	17	129
21-Ability to encourage the heart	1	2	44	52	13	17	129
22-Ability to fit in and move with a larger (team/organizational)vision than one's own			11	70	31	17	129
23-Accountable for own skill set		1	6	68	36	18	129
24-Ability to recognize and respect others' skills and positions within a team			12	72	28	17	129
25-Ability to place trust in other team members	2	8	19	62	21	17	129
26-Ability to recognize problems within a team early and address them		8	26	63	15	17	129
27-Empathy - Ability to demonstrate respect for opinions, customs and individual differences of others		3	14	65	30	17	129

28-Ability to contribute to a team through cooperation			7	71	34	17	129
29-Ability to coach/train/teach			14	75	23	17	129
30-Ability to mentor		2	32	58	19	18	129
31-Networking - Ability to establish and maintain relationships through trust	1	2	22	65	22	17	129
32-Ability to listen		3	17	69	23	17	129
33-Ability to negotiate	1	8	28	60	15	17	129
34-Ability to resolve conflicts		3	19	66	24	17	129
35-Ability to build and manage interdisciplinary teams		3	32	56	21	17	129
36-Ability to manage people at all hierarchical levels		7	33	53	19	17	129

4.2.7 Section 7 - Demographics

Question 39

Where is your office located? (*Select State*)

Responses

Table 40 shows the distribution of respondents across different states in USA.

Table 40 - Responses to question 39

Location (State)	Count of Respondent
AZ	1
CA	27
CO	34
FL	1
GU	1
IL	1
KY	1
LA	1
MD	1
MN	5
NC	2
ND	2
NE	6
NY	2
OH	1
OK	1
PA	1

SC	1
TN	1
TX	1
VA	5
WA	3
WI	1
Skipped	29
Grand Total	129

Question 40

Are you male or female? (Male/Female/Prefer not to answer)

Responses

Table 41 shows the distribution of respondents across genders.

Table 41 - Responses to question 40

Gender	Number of respondents
Female	24
Male	85
Prefer not to answer	3
Skipped	17
Grand Total	129

Question 41

How old are you?

- ☐ 20-25
- ☐ 25-30
- ☐ 30-35
- ☐ 35-40
- ☐ Above 40
- ☐ Prefer not to answer

Responses

Table 42 and Figure 14 show the distribution of all respondents across various age categories.

Table 42 - Responses to question 41

Age category	Number of respondents
20-25	7
25-30	51
30-35	29
35-40	16
Above 40	8
Prefer not to answer	1
Skipped	17
Grand Total	129

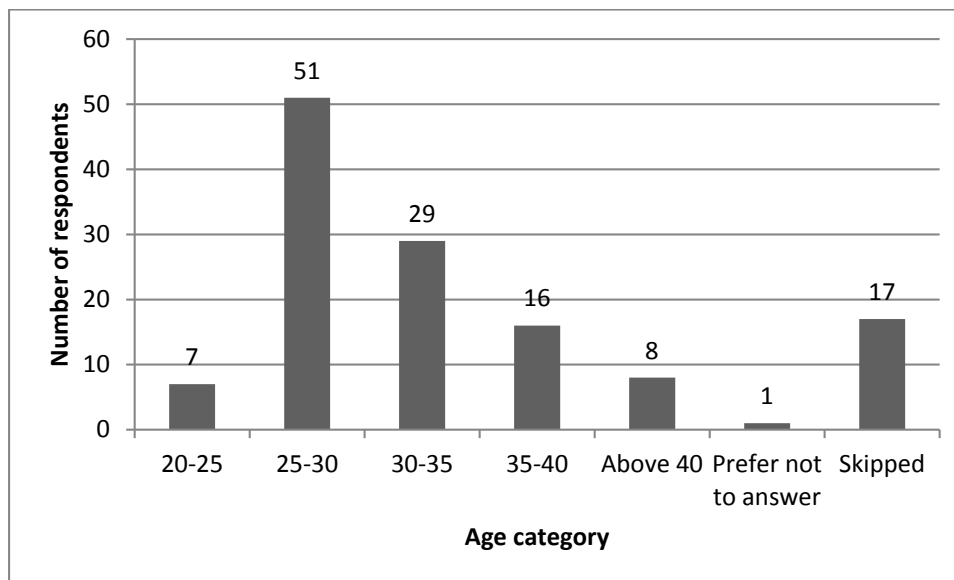


Figure 14-Responses to question 41

Question 42

Are you a U.S Citizen? (Yes/No/Prefer not to answer)

Responses

Table 43 shows the responses to question 42.

Table 43 - Responses to question 42

US Citizen?	Number of respondents
Yes	102 (91%)
No	10 (9%)
Total	112 (100%)

Prefer not to answer	0
Skipped	17
Grand Total	129

Question 43

What is your race? (*Please choose one or more*)

- ☐ White (Category 1)
- ☐ Black or African American (Category 2)
- ☐ Asian (Category 3)
- ☐ Native Hawaiian or other Pacific Islander (Category 4)
- ☐ American Indian or Alaska native (Category 5)
- ☐ Other (Category 6)
- ☐ Prefer not to answer

Responses

Table 44 shows the distribution of respondents across different response categories in question 43.

Table 44 - Responses to question 43

Race categories	Number of respondents
Category 1 only	86
Categories 1 & 2	1
Categories 1, 5 & 6	1
Categories 1,3 & 6	1
Category 2 only	1
Category 3 only	8
Categories 3 & 4	1
Categories 3 & 6	1
Category 6 only	6
Prefer not to answer	6
Skipped	17
Grand Total	129

Question 44

What is your current marital status?

- ☐ Single
- ☐ Partnered
- ☐ Prefer not to answer
- ☐ Other (Please specify)

Responses

Table 45 shows the summary of responses to question 44.

Table 45 - Responses to question 44

Marital Status	Number of respondents
Single	37
Partnered	74
Prefer not to answer	1
Skipped	17
Grand Total	129

Question 45

Do you have any children under 18? (Yes/No/Prefer not to answer)

Responses

Table 46 shows the summary of responses to question 45

Table 46 - Responses to question 45

Children under 18?	Number of respondents
Yes	44
No	67
Prefer not to answer	1
Skipped	17
Grand Total	129

Question 46

What is the highest level of school you have completed or the highest degree you have received?

- ☐ Less than high school degree
- ☐ Prefer not to answer
- ☐ High school degree or equivalent (e.g., GED)
- ☐ Some college but no degree
- ☐ Associate degree
- ☐ Bachelor degree
- ☐ Graduate degree

Responses

Table 47 shows the summary of responses to question 46.

Table 47 - Responses to question 46

Level of education	Number of respondents
Less than high school degree	0 (0%)
Prefer not to answer	0 (0%)
High school degree or equivalent (e.g., GED)	0 (0%)
Associate degree	1 (0.89%)
Bachelor degree	83 (74.11%)
Graduate degree	23 (20.54%)
Total	112 (100%)
Skipped	17
Grand Total	129

Question 47

What was your undergraduate major? (*Text response*)

Responses

Table 48 shows the summary of responses to question 47.

Table 48 - Responses to question 47

Undergraduate Major(s)	Number of respondents
BS Building Construction/Construction Management	53
Architecture/Architectural Engineering/Architectural Studies	20
Civil /Environmental Engineering	11
Business/Economics	5
Engineering(Other)	3
Graphic Design	2
Technology Management	2
Philosophy	2
Technical Writing - Emphasis in Civil Engineering/Math	1
Skipped	30
Grand Total	129

Question 48

What was your graduate major? (*Text response*)

Responses

Table 49 shows the summary of responses to question 48.

Table 49 - Responses to question 48

Graduate Major	Number of respondents
Architecture/Architectural Engineering	10
Business Administration	4
Civil engineering	1
Construction Management	9
Diesel Technology	1
Historic Preservation	1
Master of Engineering	1
Mechanical Eng.	1
MS of PM	1
Grand Total	29

Question 49

What category best describes your annual compensation (including bonuses)?

Responses

Table 50 and Figure 15 shows the summary of responses to question 49.

Table 50 - Responses to question 49

Compensation	Number of respondents
Less than \$40,000	1
\$50,000-\$60,000	19
\$60,000-\$70,000	14
\$70,000-\$80,000	24
\$80,000-\$90,000	14
\$90,000-\$100,000	7
Greater than \$100,000	29
Prefer not to answer	4
Skipped	17
Grand Total	129

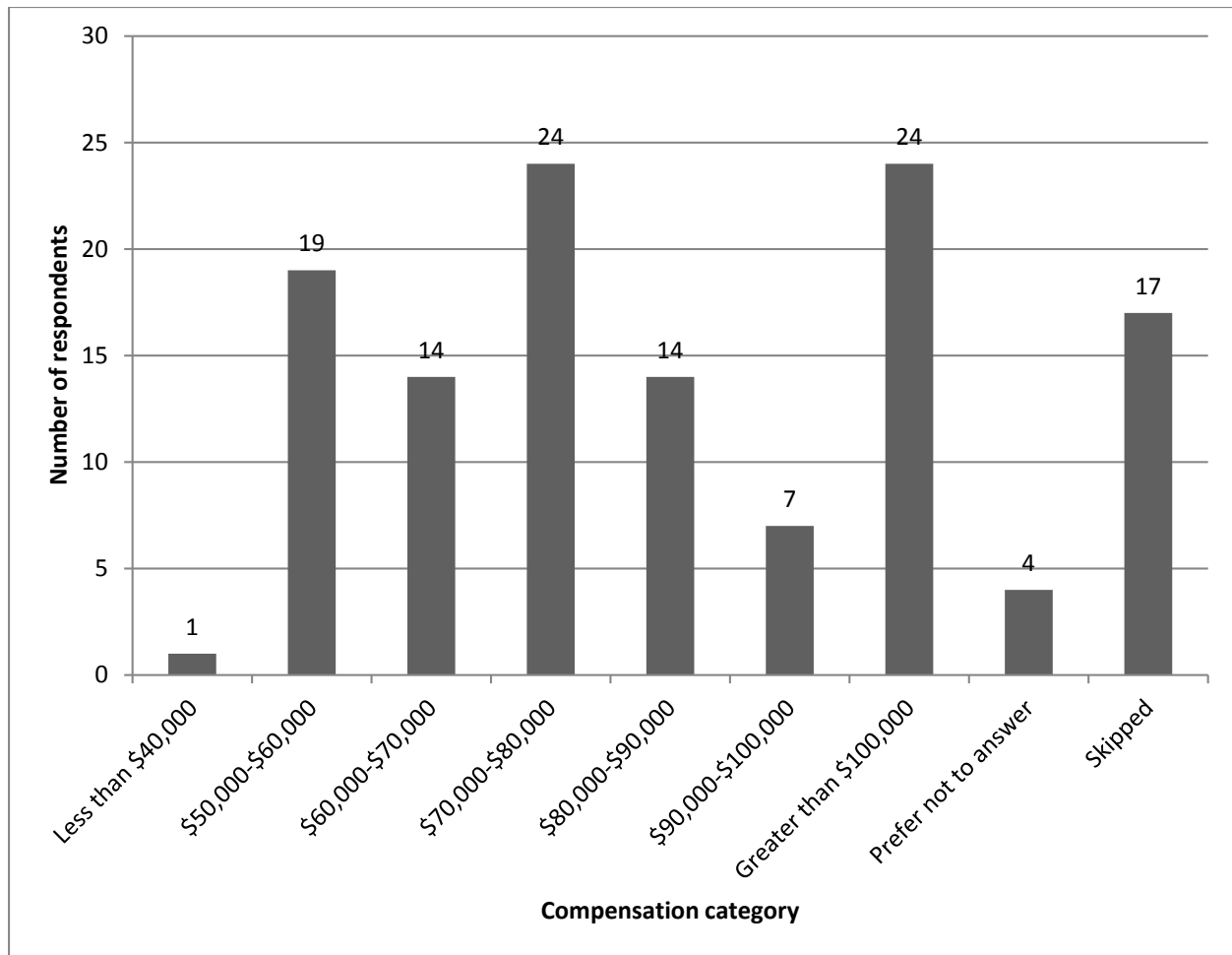


Figure 15-Responses to question 49

4.3 RESULTS OF ANALYSIS

4.3.1 BIM Only Section

Table 51 shows a summary of the comparison for the two statements in question 6, which is the only question in this section that lends itself to statistical analysis. All other questions sought open ended responses, which are presented in Appendix D – Detailed responses and comments.

Women

The average response values show that male BIM employees agree that their BIM VDC skills give them access to faster promotions and a higher pay grade whereas surprisingly, female

BIM employees disagree with both the statements. This difference is statistically significant as well.

BIM Department

While the averages for employees who work for organizations with a dedicated BIM department show a higher level of agreeability to both the statements than employees who work for organizations without a dedicated BIM Department, the differences are not statistically significant.

Table 51-Responses to question 6

Statements		BIM Employees			
		Female	Male	BIM-Dept.	No BIM-Dept.
Responses (Avg. values)					
6A	My BIM/VDC skills have enabled me to work at a higher pay grade than my Peers	2.91	3.24	3.26	3.23
6B	My BIM/VDC skills have given me the opportunity to get promoted faster than my peers	2.54	3.11	3.06	3.00

5 Point Likert scale - 1=Strongly disagree 5=strongly agree

4.3.2 Work Life Balance

BIM and Non-BIM

Table 52 shows the average numeric value responses for work life balance related questions across various groups in the study. Due to the wide disparity in sample size for male versus female, the authors averaged the responses of both populations. Findings across these combined averages suggest that BIM survey respondents commute times are slightly longer, work from home more days per month, work more hours a day, travel out of town more days per

month and are on an active construction site more than the Non-BIM survey respondents. They've also relocated fewer times than Non-BIM survey respondents.

Upon further analysis of the data for male and female respondents separately, the same trends are seen for the female respondents. This is true for all male respondents as well, with the exception of the average daily commute time, where male BIM respondents commuted less than the male Non-BIM respondents.

Table 53 shows a summary of the percentages of groups who answered “yes” to the “yes/no” type questions in this section. Due to the wide disparity in sample size for male versus female, the authors averaged the percentages of both populations to arrive at a combined value. The percentage of BIM survey respondents who report that their organization allows them to telecommute is higher than the percentage of Non-BIM respondents. However, the percentage of BIM survey respondents that report that their work hours are flexible and that they telecommute to work is actually lower than the percentage of Non-BIM respondents who believed so.

Upon further analysis of the data for male and female respondents separately, slight differences emerge. Though a higher percentage of both male and female BIM respondents report that their organization allows them to telecommute, only a higher percentage of BIM male respondents seem to actually telecommute than Non-BIM male respondents. None of the female BIM respondents report telecommuting for work. The trend for both male and female populations follows the same direction as the overall trend for perception of flexible work hours.

Women

When the averages of the responses of female survey respondents are compared with the averages of responses of male survey respondents in Table 52, we see that across the board the values reported are less from female than male respondents, with the exception of BIM female

respondents whose average daily commute time in hours is slightly more than that of BIM male respondents. Barring this exception, overall, female respondents reported that they commuted less, worked less days from home, worked less hours per day, travelled less days per month and spent less time on a construction site than their male counterparts. However, the average scores reported by BIM female respondents are higher than Non-BIM female respondents across the board. Their commute times are higher, they worked more days from home, worked more hours per day and traveled a lot more than their Non-BIM counterparts and spent more time on an active construction jobsite than their Non-BIM counterparts.

A comparison of the percentages of respondents in Table 53 between female and male respondents shows different trends for Non-BIM and BIM populations. Within Non-BIM respondents, higher percentages of female respondents are allowed to telecommunicate and do telecommunicate than their male counterparts. A lower percentage of Non-BIM female respondents report that their work hours are flexible than Non-BIM male respondents. For BIM respondents, however, across the board, lower percentages of BIM female respondents report flexibility in work hours and permissions to telecommute than not just BIM male respondents, but also Non-BIM female respondents. None of the BIM female respondents report telecommuting.

BIM department

The averages in Table 52 show that within BIM respondents, those that work with organizations that have a dedicated BIM department work more days from home, travel a lot more for work and have relocated more times for their career than respondents from organizations without a dedicated BIM department. They also report working less hours a day

and being on an active construction site for lesser days per month than respondents from organizations without dedicated BIM departments.

The percentages in Table 53 show that greater percentages of BIM respondents from organizations with dedicated BIM Departments report flexibility in their work hours and that their organization allows them to telecommute than the BIM respondents from organizations without dedicated BIM departments. However, a lower percentage of the respondents from BIM departments report actually telecommuting for work than the respondents from organizations without BIM departments.

Table 52 - Work life balance – Summary of responses to questions that require numeric input

<div style="display: flex; align-items: center;"> <div style="flex: 1;">Questions</div> <div style="flex: 1; border-left: 1px solid black; border-bottom: 1px solid black; position: relative;"> <div style="position: absolute; top: 0; right: 0; transform: rotate(45deg); width: 50%; height: 50%;"></div> <div style="position: absolute; bottom: 0; left: 0; transform: rotate(-45deg); width: 50%; height: 50%;"></div> <div style="position: absolute; top: 50%; left: 50%; transform: translate(-50%, -50%);">Responses (Avg values)</div> </div> </div>		Non-BIM			BIM				
		Female	Male	Combined M/F Avg	Female	Male	Combined M/F Avg	BIM-Dept.	No BIM-Dept.
Q12	Average daily commute time in hours	0.88	1.39	1.14	1.20	1.15	1.18	1.18	1.03
Q16	Average days per month - work from home	0.22	0.83	0.53	0.30	1.15	0.73	1.36	0.63
Q17a	Average hours worked per day	9.50	10.08	9.79	9.54	10.19	9.87	9.92	10.41
Q17b	Average travel days per month	0.55	2.48	1.52	1.44	2.90	2.17	3.06	1.46
Q17c	Average days on construction site per month	7.67	12.08	9.88	9.60	15.50	12.55	13.14	14.92
Q18	Average times relocated in career	1.91	2.08	2.00	0.70	1.22	0.96	1.35	0.95

Table 53 - Work life balance – Summary of responses in percentages for yes/no type questions

Questions Respondent % (Ans: Yes)		Non-BIM			BIM				
		Female	Male	Combined M/F Avg %	Female	Male	Combined M/F Avg %	BIM-Dept.	No BIM-Dept.
Q13	Are your work hours flexible?	62.50 %	70.83 %	66.67 %	54.55 %	63.27 %	58.91 %	66.00 %	48.15 %
Q14	Does your organization allow you to telecommute ?	33.33 %	20.83 %	27.08 %	27.27 %	34.00 %	30.64 %	36.00 %	35.71 %
Q15	Do you Telecommute ?	22.22 %	16.67 %	19.45 %	0%	22.00 %	11.00 %	20.41 %	21.43 %

Statistically significant differences

For all questions, the distribution of respondents across different response categories has been tested for independence using Pearson's chi square test or Fisher's exact test. In the work life balance category, only the following distributions were found to be statistically significant

- A significantly higher percentage of BIM respondents from organizations with a dedicated BIM department report that their work hours are flexible than BIM respondents from organizations without a dedicated BIM department
- BIM respondents from organizations with a dedicated BIM department travel a significantly higher number of days per month for work than BIM respondents from organizations without a dedicated BIM department
- A significantly lower percentage of BIM female respondents (none at all) report telecommuting than BIM male respondents

4.3.3 Career Advancement

All questions in this section are “Yes/No” type questions and the percentage of respondents in each group who said “Yes” to the questions listed below are reported in Table 54. Due to the wide disparity in sample size for male versus female, the authors averaged the percentages of both populations to arrive at a combined value.

BIM and Non-BIM

When the combined percentage values for BIM and Non-BIM respondents are compared, we see that slightly lower percentages of BIM respondents manage other people, whether the people in question are employees of their own organization or subcontractors or external consultants. Almost all respondents equally have performance evaluations, but a higher percentage of BIM respondents believe that their pay or promotion depends on these performance evaluations. This is true even when male and female percentage values are compared separately. Of note, only 54.72% of BIM respondents believe that their evaluations include a section for BIM/VDC. An almost equal percentage of both BIM and Non-BIM respondents believe that their organization supports lateral moves between jobs.

When data is further analyzed separately for male and female populations, higher percentages of female BIM respondents manage subcontractors and external consultants than their Non-BIM counterparts. This is reversed for male respondents - lower percentages of male BIM respondents manage employees of their own organizations, subcontractors or external consultants than their Non-BIM counterparts.

Women

Across the board, for both BIM and Non-BIM, lower percentages of women respondents believed that their organization supported lateral career moves and that their pay or promotions

depend on their performance evaluations than their male counterparts. Lower percentages of women, both BIM and Non-BIM also reported that they do not manage employees of their own organization. However, a higher percentage of BIM female respondents managed subcontractors/consultants than BIM male respondents. This is true even compared with Non-BIM female respondents.

BIM department

Within BIM respondents, lower percentages of those that belonged to organizations with dedicated BIM departments managed people, both employees of own organization and subcontractors/external consultants. A lower percentage of the same group also believes that their organization allows lateral moves than the percentage of BIM respondents from organizations with no BIM departments. However, a higher percentage of BIM respondents from organizations with a separate BIM department believe that their pay or promotions depend on their performance evaluations.

Table 54 - Career advancement - Summary of responses in percentages for yes/no type questions

<div> <div>Questions</div> <div>Respondent % (Ans: Yes)</div> </div>		Non-BIM			BIM				
		Female	Male	Combined M/F Avg %	Female	Male	Combined M/F Avg %	BIM-Dept.	No BIM-Dept.
Q19	Do you manage employees of your own company?	33.33 %	66.67 %	50.00 %	36.36 %	58.00 %	47.18 %	38.78 %	75.00 %
Q20	Do you manage subcontractors or	77.78 %	100%	88.89 %	90.91 %	82.00 %	86.46 %	81.63 %	85.71 %

	external consultant s?								
Q23	Do you have yearly performance evaluations?	100%	95.83 %	97.92 %	100%	96.00 %	98.00 %	100%	92.86 %
Q24	Does this evaluation include a section for measuring performance in BIM/VDC?	25.00 %	14.29 %	19.65 %	44.44 %	65.00 %	54.72 %	66.67 %	45.83 %
Q25	Does your pay or promotion depend on this evaluation?	37.50 %	50.00 %	43.75 %	62.50 %	76.32 %	69.41 %	84.21 %	57.89 %
Q26	Does your organization have a clearly defined hierarchy/path of advancement for BIM/VDC employees?	12.50 %	29.17 %	20.84 %	18.18 %	34.00 %	26.09 %	38.78 %	19.23 %

Q27	Does your company support lateral moves to switch between career tracks or job functions?	77.78 %	91.67 %	84.73 %	80.00 %	90.00 %	85.00 %	87.50 %	92.86 %
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Statistically significant differences

For all questions, the distribution of respondents across different response categories has been tested for independence using Pearson's chi square test or Fisher's exact test. In the career advancement category, only the following distributions were found to be statistically significant.

- A significantly lower percentage of Non-BIM female respondents manage subcontractors/external consultants than their Non-BIM male respondents
- A significantly lower percentage of BIM male respondents manage subcontractors/external consultants than Non-BIM male respondents
- A significantly higher percentage of BIM male respondents report that their performance evaluations have sections for measuring BIM/VDC performance than Non-BIM male respondents.
- A significantly higher percentage of BIM male respondents believe that their pay or promotions depend on their performance evaluations than Non-BIM male respondents.
- Compared to the percentage of BIM respondents from organizations without a separate BIM department,
 - A significantly lower percentage of BIM respondents from organizations with dedicated BIM departments manages employees of their own organization

- A significantly higher percentage of BIM respondents from organizations with dedicated BIM departments report that their performance evaluations contain a section for measuring BIM/VDC performance
- A significantly higher percentage of BIM respondents from organizations with dedicated BIM departments believe that their pay or promotions depend on their performance evaluations
- A significantly higher percentage of BIM respondents from organizations with dedicated BIM departments report that their organization provides a clearly defined hierarchy/path of career advancement for BIM/VDC employees

4.3.4 Workplace Experience

All questions in this section have Likert type responses coded from 1-5 and the average response values for each group are reported in Table 55 for Job satisfaction indicators and Table 56 for Barriers. Due to the wide disparity in sample size for male versus female, the authors averaged the average values of both populations to arrive at combined values for BIM and Non-BIM categories.

Table 55 - Work place experience – Job Satisfaction

<div>Questions</div> <div>Responses (Avg values)</div>		Non-BIM			BIM				
		Female	Male	Combined M/F Avg	Female	Male	Combined M/F Avg	BIM-Dept.	No BIM-Dept.
01	Access to technology	3.78	3.79	3.79	4.00	4.44	4.22	4.60	4.04
02	Opportunity to pioneer change	2.78	3.58	3.18	3.78	4.20	3.99	4.36	3.96
03	Compensation/Incentives	3.33	3.25	3.29	2.73	3.90	3.32	3.69	3.74
04	Time spent at a desk	3.22	3.13	3.18	2.64	3.24	2.94	3.04	3.48

05	Time spent on an active construction jobsite	2.71	3.63	3.17	2.91	3.50	3.21	3.31	3.73
06	Opportunity to travel	2.88	3.29	3.09	3.00	3.46	3.23	3.32	3.41
07	Ability to telecommute	2.00	2.33	2.17	1.91	2.48	2.20	2.41	2.42
08	Work hours	3.22	2.75	2.99	3.40	3.04	3.22	3.09	3.15
09	Work culture	3.44	3.75	3.60	3.64	4.02	3.83	3.94	4.11
10	Visibility/Interaction with decision makers	3.13	4.17	3.65	3.73	3.90	3.82	3.92	4.11
11	Continuing Education Opportunities	3.00	3.42	3.21	3.82	3.88	3.85	3.81	4.07
12	Teaching/Mentoring/Outreach	3.11	3.38	3.25	3.09	3.84	3.47	3.77	3.89

Likert response scale 1-5, “Very Low” =1 – “Very High=5”

Table 56 - Work place experience - Barriers to career advancement

Questions Responses (Avg values)		Non-BIM			BIM				
		Female	Male	Combined M/F Avg	Female	Male	Combined M/F Avg	BIM-Dept.	No BIM-Dept.
01	Lack of Work-life balance	4.00	4.33	4.17	3.33	4.02	3.68	3.85	4.07
02	Lack of a clear career path	3.20	3.11	3.16	4.00	3.14	3.57	3.36	3.19
03	Shortage of mentors	3.00	3.26	3.13	3.08	2.90	2.99	3.09	2.74
04	Glass ceiling	3.80	2.85	3.33	3.73	2.71	3.22	2.89	2.81
05	Lack of career advancement opportunities	3.00	2.85	2.93	3.17	2.90	3.04	3.13	2.63
06	Lack of networking opportunities	2.80	2.54	2.67	2.50	2.34	2.42	2.32	2.41
07	Your gender	4.30	1.83	3.07	2.50	1.51	2.01	1.62	1.67
08	Your race/ethnicity	1.67	1.88	1.78	1.83	1.46	1.65	1.46	1.67
09	Your nationality	2.00	1.88	1.94	1.83	1.49	1.66	1.49	1.60

Likert response scale 1-5, “Extremely irrelevant” =1 – “Extremely relevant=5”

BIM and Non-BIM

When average Likert response values are compared between BIM and Non-BIM respondents, we see that BIM respondents report higher values of job satisfaction in all

indicators except “time spent on a desk”. BIM respondents also report that the barriers listed are of lower relevance to their careers with the exception of “lack of clear career path” and “lack of career advancement opportunities”. The results for barriers hold true even when male and female populations are compared separately.

When data is further analyzed separately for male and female populations, we see that overall, male BIM respondents report higher job satisfaction scores than their Non-BIM counterparts, with the exception of “time spent on an active construction jobsite” and “visibility/interaction with decision makers”. Female BIM respondents score higher than female Non-BIM respondents for 8 out of the 12 indicators listed. Female Non-BIM respondents report higher values for “Compensation/incentives”, “Time spent at a desk”, “Ability to telecommute” and “Teaching/mentoring/outreach”. For barriers, the general trend using combined averages holds true for all but one exception – female BIM respondents report that a shortage of mentors is of higher relevance as a barrier to their career than female Non-BIM respondents.

Women

Across the board, for both Non-BIM and BIM populations, overall, female respondents report lower scores of job satisfaction than their male counterparts with the exception of “work hours” where both Non-BIM and BIM female respondents report higher levels of job satisfaction than male respondents. Another exception that only applies to Non-BIM population is that Non-BIM female respondents report higher level of job satisfaction for “compensation” than Non-BIM male respondents.

For barriers, a general trend for both Non-BIM and BIM populations shows that female respondents assign higher values for relevance of all barriers to their careers than their male counterparts, with the exception of “work life balance” to which all female respondents assigned

lower values of relevance than male respondents. Another exception that only applies to Non-BIM population is that Non-BIM female respondents assigned a lower value of relevance to “shortage of mentors” than Non-BIM male respondents.

For four out of the seven barriers listed, female BIM respondents assign lower values of relevance than their Non-BIM counterparts. The three exceptions are “Lack of a clear career path”, “Shortage of mentors” and “Lack of career advancement opportunities”. The most visible result is the scoring of “gender” as a barrier to career advancement – BIM female respondents indicated that this is irrelevant as a barrier whereas Non-BIM female respondents indicated that it is highly relevant in their careers.

BIM department

With the exception of the job satisfaction indicators “access to technology” and “opportunity to pioneer change”, all BIM employees who belong to organizations with separate BIM departments report lower scores of job satisfaction for all the indicators listed. BIM respondents from organizations with separate BIM departments also assign higher values of relevance for four out of the seven barriers listed; “lack of a clear career path”, “shortage of mentors”, “glass ceiling” and “lack of career advancement opportunities”.

Statistically significant differences

For all questions, the distribution of respondents across different response categories has been tested for independence using Pearson’s chi square test or Fisher’s exact test. When respondents were too low across five Likert response categories, the five Likert response categories were binned to three categories by combining the lower two categories into one, keeping the neutral response category as it is and combining the higher two categories as one and

then running the tests for 2X3 contingency tables. In the workplace experience category, only the following distributions were found to be statistically significant.

Job Satisfaction Indicators

- BIM female respondents reported a significantly lower score for “compensation/incentives” than BIM male respondents
- BIM female respondents reported significantly higher scores for “opportunity to pioneer change”, “opportunity to travel” and “visibility/interaction with decision makers” than Non-BIM female respondents
- BIM male respondents reported significantly higher scores for “access to technology” , “opportunity to pioneer change” , “compensation/incentives” and “visibility/interaction with decision makers” than Non-BIM male respondents
- Non-BIM female respondents reported significantly lower scores for “opportunity to pioneer change”, “opportunity to travel” and “visibility/interaction with decision makers” than Non-BIM male respondents
- BIM employees from organizations with a separate BIM department reported significantly higher scores for “access to technology” and “opportunity to pioneer change” and a significantly lower score for “time spent at a desk” than BIM respondents from organizations without a separate BIM department.

Barriers

- BIM male respondents reported significantly lower score for relevance for “lack of work life balance” than Non-BIM male respondents.
- BIM female respondents reported a significantly lower score for relevance for gender as a barrier than Non-BIM female respondents

- For both BIM and Non-BIM, female respondents reported a significantly lower score for relevance for “lack of work life balance” and significantly higher scores for “glass ceiling” and “gender” than their male counterparts.
- BIM employees from organizations with a separate BIM department reported significantly higher scores for relevance for “lack of career advancement opportunities” than BIM respondents from organizations without a separate BIM department.

4.3.5 Skills

Tables 57, 58, 59, 60 & 61 show the average response scores across different categories of skills.

Table 57- Skills - General Competency

<div>Skills</div> <div>Responses (Avg. values)</div>		Non-BIM			BIM				
		Female	Male	Combined M/F Avg	Female	Male	Combined M/F Avg	BIM-Dept.	No BIM-Dept.
01	Ability to communicate with varied audiences	4.11	4.04	4.08	4.00	4.32	4.16	4.26	4.19
02	Ability to understand and give instructions	4.00	4.13	4.06	4.00	4.38	4.19	4.30	4.23
03	Ability to obtain information from various sources	4.11	4.08	4.10	4.18	4.24	4.21	4.28	4.19
04	Stress Management - Ability to Keep Your Cool	3.33	3.54	3.44	3.18	3.96	3.57	3.89	3.81
05	Time management- ability to plan and prioritize deliverables	3.78	3.79	3.78	3.45	3.84	3.65	3.79	3.81
06	Awareness of Sustainability concepts	3.44	3.38	3.41	3.73	3.62	3.67	3.70	3.62

Table 58- - Skills - Cognitive competency

<div>Skills</div> <div>Responses (Avg. values)</div>		Non-BIM			BIM				
		Female	Male	Combined M/F Avg	Female	Male	Combined M/F Avg	BIM-Dept.	No BIM-Dept.
07	Awareness of ethical issues	3.89	4.04	3.97	4.09	4.16	4.13	4.17	4.04
08	Ability to identify and solve problems and implement effective solutions	3.78	4.17	3.97	4.18	4.30	4.24	4.34	4.15
09	Adaptability - Being able to respond to a wide range of situations	3.56	4.25	3.90	3.91	4.22	4.06	4.28	4.12
10	Understanding and integration of interdisciplinary knowledge , including work not self-performed	3.44	4.17	3.81	3.91	4.12	4.01	4.17	4.04
11	Decision making skills	3.44	4.17	3.81	3.64	4.18	3.91	4.11	4.04
12	Willingness and Ability to learn from others	3.78	4.33	4.06	4.09	4.36	4.23	4.30	4.38

Table 59-Skills - Technical competency

<div>Skills</div> <div>Responses (Avg. values)</div>		Non-BIM			BIM				
		Female	Male	Combined M/F Avg	Female	Male	Combined M/F Avg	BIM-Dept.	No BIM-Dept.
13	BIM design/modeling software skills	1.44	2.09	1.77	3.82	3.36	3.59	3.62	3.12
14	BIM model viewing/analysis/integration software skills	1.67	2.21	1.94	3.73	3.76	3.74	3.87	3.54
15	Additional scheduling, estimating, project management software skills	3.33	3.83	3.58	3.27	3.70	3.49	3.53	3.88

16	Construction field process knowledge (materials and methods , MEP systems etc.)	3.44	4.25	3.85	3.36	4.02	3.69	3.89	3.96
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Table 60-Skills - Affective competency – Leadership

<div>Skills</div> <div>Responses (Avg values)</div>		Non-BIM			BIM				
		Female	Male	Combined M/F Avg	Female	Male	Combined M/F Avg	BIM-Dept.	No BIM-Dept.
17	Ability to model the way	3.89	3.83	3.86	3.64	3.80	3.72	4.00	3.54
18	Ability to inspire a shared vision	3.33	3.58	3.46	3.27	3.80	3.53	3.78	3.65
19	Ability to challenge the process	3.78	3.71	3.74	3.64	3.98	3.81	3.98	3.81
20	Ability to enable others to act	2.78	3.63	3.20	3.64	3.90	3.77	3.83	3.96
21	Ability to encourage the heart	3.22	3.58	3.40	3.73	3.57	3.65	3.70	3.69

Table 61 - Skills - Affective competency - Collaboration

<div>Skills</div> <div>Responses (Avg values)</div>		Non-BIM			BIM				
		Female	Male	Combined M/F Avg	Female	Male	Combined M/F Avg	BIM-Dept.	No BIM-Dept.
22	Ability to fit in and move with a larger (team/organizational)vision than one's own	3.67	4.21	3.94	4.00	4.29	4.14	4.28	4.15
23	Accountable for own skill set	4.00	4.04	4.02	4.27	4.42	4.34	4.38	4.35
24	Ability to recognize and respect others' skills and positions within a team	4.00	3.92	3.96	4.18	4.29	4.23	4.30	4.12

25	Ability to place trust in other team members	3.44	3.71	3.58	3.91	3.94	3.92	4.09	3.69
26	Ability to recognize problems within a team early and address them	3.33	3.79	3.56	3.45	3.86	3.66	3.91	3.65
27	Empathy - Ability to demonstrate respect for opinions, customs and individual differences of others	4.00	3.96	3.98	4.27	4.10	4.19	4.15	4.15
28	Ability to contribute to a team through cooperation	3.89	4.29	4.09	4.27	4.27	4.27	4.35	4.15
29	Ability to coach/train/teach	3.78	4.17	3.97	4.09	4.06	4.08	4.13	4.00
30	Ability to mentor	3.56	3.92	3.74	3.82	3.77	3.79	3.78	3.92
31	Networking - Ability to establish and maintain relationships through trust	3.89	3.75	3.82	3.82	3.96	3.89	3.96	4.00
32	Ability to listen	4.00	3.92	3.96	4.27	3.98	4.13	4.04	4.04
33	Ability to negotiate	3.00	3.79	3.40	3.55	3.88	3.71	3.78	3.77
34	Ability to resolve conflicts	3.56	3.92	3.74	4.09	4.02	4.06	4.11	3.96
35	Ability to build and manage interdisciplinary teams	3.00	3.79	3.40	3.91	3.90	3.90	4.00	3.85
36	Ability to manage people at all hierarchical levels	3.00	3.83	3.42	3.55	3.78	3.66	3.80	3.77

BIM and Non-BIM

After adjusting for age, when average Likert response values are compared between BIM and Non-BIM respondents, we see that overall, BIM respondents report higher scores for all skills with the exception of the following:

General competency

- 05 - Time management- ability to plan and prioritize deliverables

Technical competency

- 15 - Additional scheduling, estimating, project management software skills
- 16 - Construction field process knowledge (materials and methods, MEP systems etc.)

Affective competency – Leadership skills

- 17 - Ability to model the way

When data is further analyzed separately for male and female populations, the trend holds with the following exceptions, listed in Table 62

Table 62 - List of skills where Non-BIM average response value is greater than BIM average response value

Skill	Gender
General Competency	
01 - Ability to communicate with varied audiences	Women
04 - Stress Management - Ability to Keep Your Cool	Women
05 - Time management- ability to plan and prioritize deliverables	Women
Cognitive Competency	
09 - Adaptability - Being able to respond to a wide range of situations	Men
10 - Understanding and integration of interdisciplinary knowledge , including work not self-performed	Men
Technical Competency	
15 - Additional scheduling, estimating, project management software skills	Women and Men
16 - Construction field process knowledge (materials and methods, MEP systems etc.)	Women and Men
Affective competency – Leadership skills	
17 - Ability to model the way	Women and Men
18 - Ability to inspire a shared vision	Women
19 - Ability to challenge the process	Women
Affective competency – Collaborative skills	
21 - Ability to encourage the heart	Men
28 - Ability to contribute to a team through cooperation	Men
29 - Ability to coach/train/teach	Men
30 - Ability to mentor	Men
31 - Networking - Ability to establish and maintain relationships through trust	Women
36 - Ability to manage people at all hierarchical levels	Men

Women

Overall, for both BIM and Non-BIM, when compared with their male counterparts, female respondents tended to rate themselves lower for all skills. However, they rated themselves higher than male respondents for the following skills, listed in Table 63

Table 63-List of skills where female average response value is higher than male response value

Skill	BIM/Non-BIM
General Competency	
01 - Ability to communicate with varied audiences	Non-BIM

03 - Ability to obtain information from various sources	Non-BIM
06 - Awareness of Sustainability concepts	Both BIM and Non-BIM
Technical Competency	
13 - BIM design/modeling software skills	BIM
Affective competency – Leadership skills	
17 - Ability to model the way	Non-BIM
19 - Ability to challenge the process	Non-BIM
21 - Ability to encourage the heart	BIM
Affective competency – Collaborative skills	
24 - Ability to recognize and respect others' skills and positions within a team	Non-BIM
27 - Empathy - Ability to demonstrate respect for opinions, customs and individual differences of others	Both BIM and Non-BIM
28 - Ability to contribute to a team through cooperation	BIM
29 - Ability to coach/train/teach	BIM
30 - Ability to mentor	BIM
31 - Networking - Ability to establish and maintain relationships through trust	Non-BIM
32 - Ability to listen	Both BIM and Non-BIM
34 - Ability to resolve conflicts	BIM
35 - Ability to build and manage interdisciplinary teams	BIM

When compared with female Non-BIM respondents, female BIM respondents generally reported higher scores for all skills with the following exceptions:

General competency

- 01 - Ability to communicate with varied audiences
- 02 - Ability to understand and give instructions
- 04 - Stress Management - Ability to Keep Your Cool
- 05 - Time management- ability to plan and prioritize deliverables

Technical competency

- 15 - Additional scheduling, estimating, project management software skills
- 16 - Construction field process knowledge (materials and methods, MEP systems etc.)

Affective competency – Leadership skills

- 17 - Ability to model the way
- 18 - Ability to inspire a shared vision
- 19 - Ability to challenge the process

Affective competency – Collaborative skills

- 31 - Networking - Ability to establish and maintain relationships through trust

BIM Department

Overall, BIM respondents who worked for an organization with a dedicated BIM department reported higher scores for all skills, with the following exceptions.

General competency

- 05 - Time management- ability to plan and prioritize deliverables

Cognitive competency

- 12 - Willingness and Ability to learn from others

Technical competency

- 15 - Additional scheduling, estimating, project management software skills
- 16 - Construction field process knowledge (materials and methods, MEP systems etc.)

Affective competency – Leadership skills

- 20 - Ability to enable others to act

Affective competency – Collaborative skills

- 30 - Ability to mentor
- 31 - Networking - Ability to establish and maintain relationships through trust

Statistically significant differences

For all questions, the distribution of respondents across different response categories has been tested for independence using Pearson's chi square test or Fisher's exact test. When respondents were too low across five Likert response categories, the five Likert response categories were binned to three categories by combining the lower two categories into one, keeping the neutral response category as it is and combining the higher two categories as one and then running the tests for 2X3 contingency tables. In the skills category, only the following differences were found to be statistically significant.

- Both male and female BIM respondents score significantly higher than their Non-BIM counterparts for the following skills :

Technical skills

- 13 – BIM design/modeling software skills
- 14 – BIM model viewing/analysis/integration software skills

Affective competency – collaborative skills

- 23 – Accountable for own skill set
- BIM female respondents score significantly higher than Non-BIM female respondents for

- **Affective competency – Leadership skills**
 - 20 – Ability to enable others to act
 - **Affective competency – Collaborative skills**
 - 35 – Ability to build and manage interdisciplinary teams
 - 36 – Ability to manage people at all hierarchical levels.
- BIM male respondents scored significantly higher than Non-BIM male respondents for
 - **General competency**
 - 04-Stress management – Ability to keep your cool
 - **Affective competency – Leadership skills**
 - 18 – Ability to inspire a shared vision
 - **Affective competency – collaborative skills**
 - 24 – Ability to recognize and respect others’ skills and positions within a team
- BIM female respondents score significantly lower than Non-BIM female respondents for
 - 19 – Ability to challenge the process (Affective competency – Leadership skills)
- Female BIM respondents scored significantly lower than Male BIM respondents in the following skills :
 - **General competency**
 - 04-Stress Management – Ability to keep your cool (general competency),
 - **Affective competency – leadership skills**
 - 18 – Ability to inspire a shared vision (affective competency – leadership skills)
 - 19 – Ability to challenge the process (affective competency – leadership skills)
- Female Non-BIM respondents scored significantly lower than Male Non-BIM respondents in the following skills :
 - **Cognitive competency**
 - 08 - Ability to identify and solve problems and implement effective solutions
 - 09 - Adaptability - Being able to respond to a wide range of situations
 - 10 - Understanding and integration of interdisciplinary knowledge , including work not self-performed
 - 11 - Decision making skills
 - 12 - Willingness and Ability to learn from others
 - **Technical competency**
 - 16 - Construction field process knowledge (materials and methods, MEP systems etc.)
 - **Affective competency – collaborative skills**
 - 28 - Ability to contribute to a team through cooperation
 - 33 - Ability to negotiate
 - 35 - Ability to build and manage interdisciplinary teams
 - 36 - Ability to manage people at all hierarchical levels

- BIM respondents from organizations with a dedicated BIM department scored significantly higher than BIM respondents from organizations without a separate BIM department for 13 – BIM design/modeling software skills (technical competency), 17 – Ability to model the way(affective competency – leadership skills) and 25 – Ability to place trust in other team members (affective competency – collaborative skills)

CHAPTER 5 – DISCUSSION

Data from one hundred and twenty nine survey respondents was collected and analyzed to compare the overall differences between BIM and Non-BIM respondents. Data is further analyzed separately for male and female populations because the distribution of male and female respondents across different categories was unequal //and non-representative. BIM male respondents were compared with Non-BIM male respondents and BIM female respondents were compared with Non-BIM female respondents. The distribution of respondents varied across different age groups as well, with a number of BIM respondents indicating higher age categories than Non-BIM respondents. To address this, age categories where the distributions were unequal were omitted from analysis. To analyze the data, average values where applicable were simply compared against each other. For Yes/No type of questions, the percentages of respondents were compared instead of averages.

A secondary research aim is to explore how women perceive the various aspects studied in the research and to see whether having BIM skills makes any difference in women's perceptions. This is done by comparing BIM female respondents to BIM male respondents and Non-BIM female respondents to Non-BIM male respondents to see if both BIM and Non-BIM females are similarly placed in relation to their male counterparts. Further, the results from comparing BIM female respondents to Non-BIM female respondents (in the context of BIM vs. Non-BIM) are also reviewed in the gender context.

Within BIM respondents, an additional comparison point of interest to the authors was whether the BIM respondents belonging to organizations with a separate BIM department makes any difference in their perceptions. This is studied by comparing BIM respondents from

organizations with separate BIM departments to BIM respondents from organizations without separate BIM departments.

5.1 SUMMARY OF RESULTS

Overall, within our survey respondents, we see that BIM respondents' perceptions of the various aspects of their careers are generally different than Non-BIM respondents' perceptions; they report higher values of job satisfaction indicators and lower levels of perceived relevance for barriers to their careers. BIM respondents consistently indicate the lack of a career path / hierarchy to be an issue in their careers.

Women's perceptions of the various aspects of their careers are generally more negative than that of men but BIM female respondents' perceptions are more positive than that of Non-BIM females. Within BIM respondents, the perceptions of those that belonged to organizations without separate BIM departments were more positive than those that belonged to organizations with a separate BIM department. During the comparisons between various respondent groups, some exceptions are seen along with some differences that are statistically significant. These will be discussed by sections below.

5.1.1 Work life balance

BIM and Non-BIM

For male BIM respondents, the one statistically significant indicator was the number of days worked from home. BIM/VDC personnel work more days from home (1.14 days) than their Non-BIM counterparts (0.83 days). This is expected as the kind of job functions and job culture fostered among the BIM/VDC community in construction enables employees to telecommute to some extent. The fact that the difference in averages is relatively minor suggests that the industry is still slow to change in terms of allowing employees to work from home. The nature of

construction work is such that working from home is not only not possible in many cases, but also not encouraged even when it *is* possible.

Women

Overall, there were no statistically significant differences between BIM male and female employees, whereas in Non-BIM (construction), there are differences in commute times and the number of days worked from home. On average, Non-BIM males worked more days from home per month (0.74 days) than females (0.25 days). They also commuted more for work (1.35 hrs.) than women (1 hr.). The lack of differences between BIM males and females suggest a sense of equal/similar perceptions by both genders. When women of BIM and Non-BIM categories were compared, there were no statistically significant differences in work life balance indicators for women, regardless of their job functions. This suggests that BIM/VDC may not have a significant impact on women's Work life balance.

BIM Department

Within BIM respondents, those who are from organizations with separate BIM/VDC departments or organizational divisions tend to travel out of town more for work (2.94 days) than employees from companies without a separate BIM department (2.14 days). This could suggest that organizations with separate BIM departments groom their BIM employees to be specialists, ones who can travel and set up BIM/VDC infrastructure and practices across their jobsites in different locations, whereas companies without a separate department assign their BIM employees to specific jobsites for the duration of the project.

5.1.2 Career advancement

BIM and Non-BIM

For male BIM respondents, the one statistically significant indicator was in whether they managed subcontractors. There were all Non-BIM respondents managed subcontractors, but 11 out of 58 BIM respondents (19%) did not manage subcontractors at all. i.e., they held purely technical, BIM/VDC related positions. One interesting difference is that a significantly larger percentage of Non-BIM personnel (46%) believe that their pay or promotion does not depend on their performance evaluations, compared to only 19% of BIM personnel who think so.

The fact that there were no other statistically significant differences suggests that BIM/VDC personnel are treated equally with their Non-BIM counterparts, and that BIM/VDC skills or job functions do not necessarily give them an advantages or disadvantages in their workplace. However, Male BIM respondents generally believe that their BIM/VDC skills give them access to faster promotions or higher pay grades than their colleagues (Ref. Chapter 4 – Results of Analysis-BIM Only Section)

Women

Overall, there were no statistically significant differences between BIM male and female employees, whereas in Non-BIM (construction), there are differences whether they manage subcontractors or not. This was due to the fact that all Non-BIM male respondents managed subcontractors, compared to only 9 out of 12 (75%) of women Non-BIM respondents. The lack of differences between BIM males and females suggest a sense of equal/similar perceptions by both genders. When women of BIM and Non-BIM categories were compared, there were no statistically significant differences in career advancement indicators for women, regardless of their job functions. This suggests that BIM/VDC may not have a significant impact on women's

careers. In fact, when asked whether BIM/VDC skills give them access to higher pay or faster promotions, women actively *disagree*. (Ref. Chapter 4 –Results of Analysis-BIM Only Section)

BIM Department

Within BIM respondents, a lesser percentage of those who are from organizations with separate BIM/VDC departments (39%) manage people, as opposed to respondents from organizations without separate BIM/VDC departments (75%). This could suggest greater opportunities for career advancement with respect to managing personnel for respondents who are from companies without separate BIM departments. This, in turn, suggests that BIM/VDC skills give employees a certain edge in career advancement in organizations without a separate BIM department.

A lesser percentage of employees from organizations with separate BIM/VDC departments (16%) believe that their pay or promotions depend on their performance evaluations than those from organizations without BIM/VDC employees (only 42%). So, if an employee has BIM/VDC skills and works in an organization without a separate BIM/VDC department, it is likely that she has been managing employees of her own organization and believes that her pay or promotion depends on her performance evaluation, where, her BIM/VDC skills are evaluated and rewarded.

5.1.3 Workplace experience

BIM and Non-BIM

After adjusting for differences due to age for male respondents, when BIM and Non-BIM populations are compared using averages, BIM respondents score higher on all job satisfaction indicators except “visibility/interaction with decision makers”- this difference is statistically significant as well, with Non-BIM respondents scoring higher for this item.

When we look at only the statistically significant items, we see BIM respondents scoring higher for “access to technology”, “opportunity to pioneer change” and “compensation/incentives”. While items 1 and 2 are self-explanatory, the fact that BIM employees are happier with their compensation/incentives could be indicative of the fact that employees with BIM/VDC skills are compensated adequately for their skills.

In terms of barriers, after accounting for differences due to age distribution, the overall trend for averages suggests that male BIM employees perceive that the list of barriers is irrelevant, more than their Non-BIM counterparts.

Women

In terms of job satisfaction indicators, when we look at overall averages, in both BIM and Non-BIM categories, generally, women indicate lesser values for job satisfaction than their male counterparts. When we look at only the statistically significant differences, in construction, women are more dissatisfied than men about opportunities to pioneer change, the time spent at a jobsite and their visibility/interaction with decision makers. In BIM/VDC, women are more dissatisfied than men about their compensation/incentives and exposure to teaching/mentoring/outreach opportunities.

In terms of barriers to their career advancement, both Non-BIM and BIM women follow the same trend in the statistically significant differences when compared to their male counterparts. Women perceive that a glass ceiling and their gender are more relevant as barriers to their career advancement than men do. The most significant finding in this section is that women in BIM feel that their gender is irrelevant as a barrier to their career (avg. score 2.50) when compared to Non-BIM women who feel that their gender is highly relevant to their career (avg. score 4.36). This difference is statistically significant. Because women with BIM/VDC

career do not perceive that gender is of any relevance to their careers as a barrier, this suggests a sense of equal treatment and a healthy work environment.

BIM Department

Within BIM respondents, the general trend is that those who are from organizations without a separate BIM/VDC department are more satisfied with their jobs, with “Access to Technology” and “Opportunity to pioneer change” as exceptions. The difference in these items is also statistically significant. Those from organizations without a separate BIM/VDC department are unhappier with the time they spend at a desk, which could be indicative of their desire to spend more time on a construction jobsite.

For barriers, the overall average trend shows that employees from organizations without a separate BIM department feel that the common barriers to career advancement are less relevant to their careers. This could suggest that for this particular group, BIM/VDC skills or job functions provide advantages in their careers. The one statistically significant difference was for “Lack of career advancement opportunities” – where the group’s score was 2.63 (slightly irrelevant) as opposed to the employees from organizations with separate BIM departments, who scored 3.13 (slightly relevant)

5.1.4 Skills

BIM and Non-BIM

Several important findings are observable from analyzing the differences between skills of BIM and Non-BIM personnel. In comparing overall average scores, BIM respondents self-reported higher skill level than Non-BIM respondents for thirty three out of thirty six skills, suggesting an overall higher level of confidence; Nine of these skills showed statistically significant differences for BIM respondents, in all of which BIM respondents scored higher;

Not surprisingly the strongest differences occurred for two technical skills related to BIM/VDC. The next biggest differences occurred for four Collaborative skills: *Accountability for own skill set*, *Ability to build and manage interdisciplinary teams*, *Ability to manage people of all hierarchical levels* and *Ability to recognize and respect other's skills and positions within a team* suggesting a greater level of connectivity of BIM/VDC users to their colleagues. A potential implication of this finding is to support other research findings that suggest that BIM/VDC is a platform that supports a more collaborative work environment among construction professionals. The differences in two Leadership skills *Ability to enable others to act* and *Ability to inspire a shared vision* suggest that some leadership skills are correlated to the demands of performing BIM related tasks at the jobsite. The last significantly different skill, General competency – *Stress management – Ability to keep your cool* suggests that BIM employees are required to be cool under pressure, perhaps even more than their Non-BIM counterparts when performing their job duties.

Of the nine skills identified as significantly different for BIM/VDC users: three were higher for both men and women, while an additional three skills were higher for women, and an additional three were higher for men. The gender specific skills for both men and women tended to be associated with leadership and collaborative skills as well as the ability to manage stress.

In general, the fact that in thirty three out of thirty six skills where differences existed in averages, BIM respondents perceived themselves to have higher levels of skill suggests opportunities for future research regarding changes in skill levels over time, and/or studies focused on pre-disposition of individuals towards careers in BIM/VDC. Certainly, as more construction employees are sought to perform computer-based, 3-dimensional BIM/VDC

analyses, additional research is needed identify and assess which soft-skills are the most effective in such a new work environment.

Women

Average response scores show that female respondents rate themselves higher than male respondents in sixteen out of thirty six skills. Of these, female BIM respondents rated themselves higher than male BIM respondents in one out of four General competency skills, one out of four Technical skills, one out of four Leadership skills and five out of fifteen collaborative skills; female Non-BIM respondents rated themselves higher than male Non-BIM respondents in three out of six General competency skills, two out of four Leadership skills and three out of fifteen collaborative skills. In *Awareness of sustainability concepts*, *Empathy – Ability to demonstrate respect for opinions, customs and individual differences of others* and *Ability to listen*, both BIM and Non-BIM female respondents rated themselves higher than their male counterparts. The pattern in difference shows that being while BIM female respondents tend to rate themselves higher in collaborative skills and Non-BIM female respondents tend to rate themselves higher in leadership and general competency skills. The fact that different patterns of skill differences exist for BIM female respondents and Non-BIM female respondents highlights opportunities for future research regarding how BIM/VDC could be used to recruit and potentially retain more women in the construction industry.

BIM department

Overall, BIM respondents who worked for an organization with a dedicated BIM department reported higher average scores for twenty nine out of thirty six skills. Of these, the differences in three skills were found to be statistically significant - BIM design/modeling software skills (technical competency), Ability to model the way (affective competency –

leadership skills) and Ability to place trust in other team members (affective competency – collaborative skills). This could suggest that working for an organization that has a separate BIM department fosters the growth in the overall self-perceived skill levels for BIM employees.

5.2 RECOMMENDATIONS FOR FUTURE RESEARCH

This research focused on studying the impact of BIM/VDC on construction employees through the use of a survey answered by various construction employees of the general contracting industry. The survey itself was designed to be exploratory and contain a sample of questions under six broad sections, of which one was demographics, one pertained only to BIM/VDC employees and four used for comparison between BIM and Non-BIM respondents. Each of the categories used for comparison could be further explored in detail for future research. In review, these were:

1. Work Life Balance – Includes commute times, telecommuting, work hours etc.
2. Workplace Experience – Includes work culture, job satisfaction, perceived barriers etc.
3. Career Advancement – Includes promotions, pay, career paths etc.
4. Skills – Includes thirty six skills in four categories to assess self-perceived levels.

The scope of the survey was delimited to general contracting companies in United States, due to the fact that rate of BIM/VDC adoption among contractors is currently the highest in the AEC industry (Bernstein & Jones, 2012). However, BIM/VDC is a technology that is rapidly changing other parts of the AEC industry as well. The scope of the study could be broadened to include Architecture (design), Engineering and Consulting sectors. A comparative study between these industries could also be performed. Within the Construction industry, the subcontracting community, particularly the ones focused on MEP (Mechanical, Electrical and Plumbing trades) could also be included.

The study also focused on studying only the perceptions of respondents about various items, and did not delve into establishing statistical causality. i.e. – The study focused on studying *what* a respondent thinks about an item but does not explore *why* these perceptions differ in some cases. This could be an area of interest for future researchers.

5.2.1 Minorities

A secondary research aim was to study whether the differences between BIM and Non-BIM employees pertain specifically to women. Future research could also focus on minorities. One of the demographic questions asked was about the respondent's race. There were relatively few minority respondents - those who identified themselves as anything other than Caucasian – twenty in total, as seen in Figure 16 and Table 64

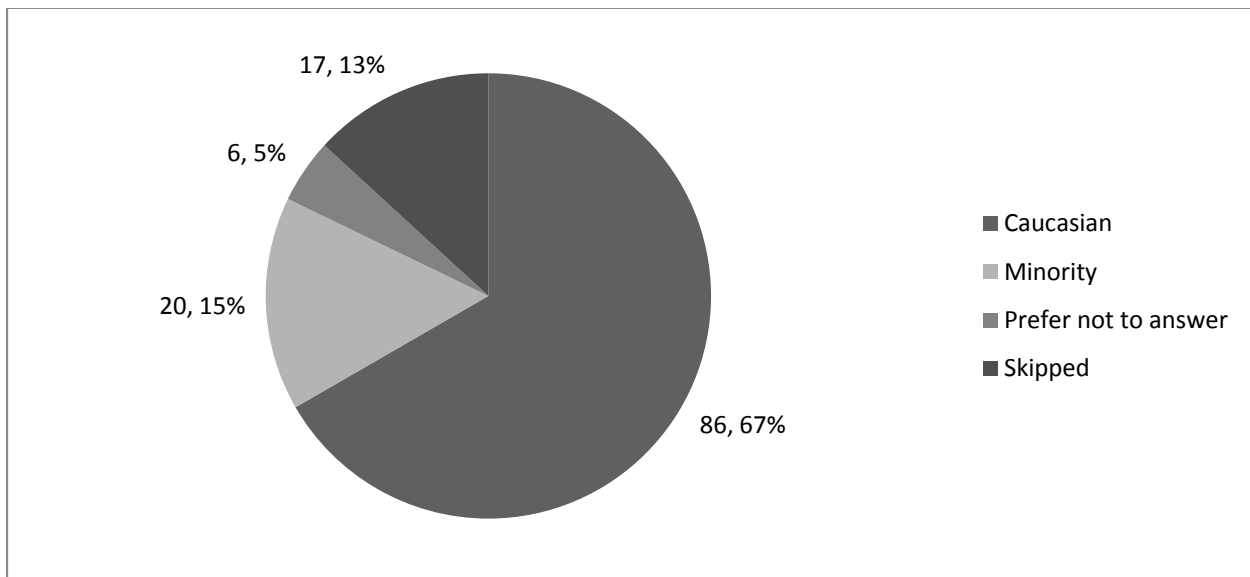
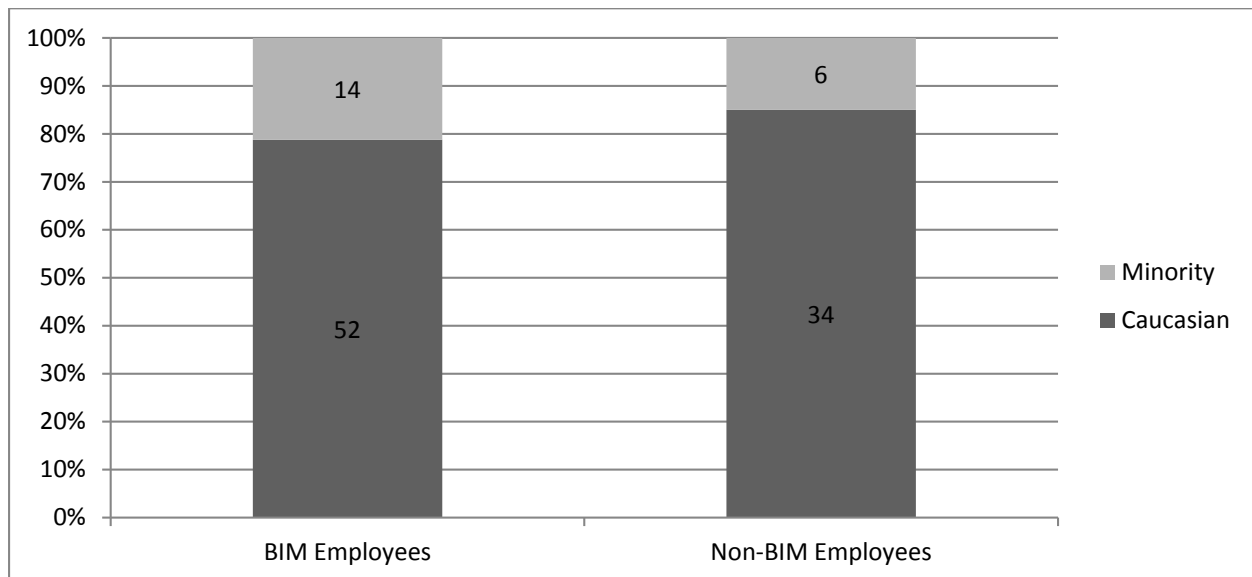


Figure 16-Demographics - Minority respondents

Table 64- Demographics - Minority respondents

Race	Count of Respondents
Caucasian	86 (67%)
Minority	20 (15%)
Prefer not to answer	6 (5%)
Skipped	17 (13%)
Grand Total	129 (100%)

Figure 17 and Table 65 show the distribution of minorities (non-Caucasians) across BIM and Non-BIM categories.

**Figure 17-BIM and Non-BIM minority respondents****Table 65 - BIM and Non-BIM minority respondents**

	Race		
BIM/Non-BIM	Caucasian	Minority	Grand Total
BIM Employees	52	14	66
Non-BIM Employees	34	6	40
Grand Total	86	20	106

Within BIM respondents, the differences between Caucasians and Minorities are statistically significant only in the responses to the questions shown in Table 66.

Table 66 - Statistically significant differences for minority respondents

SECTION 3 - WORK LIFE BALANCE	Caucasian	Minority
	Mean	
Q17b - Travel days per month	3.9	1.79
Q17c - Days on active site	15.44	9.64
Q18 - Times relocated	1.28	0.57
SECTION 5 - WORKPLACE EXPERIENCE		
Q 30 - Job Satisfaction (<i>1 – Very Low to 5 – Very High</i>)		
04 - Time spent at a desk	3.15	3.21
08 - Work hours	2.98	3.91
Q 32 - Barriers (<i>1 – Extremely Relevant to 5 – Extremely irrelevant</i>)		
01-Lack of Work-life balance	1.94	2.71

Overall, the respondents who identified themselves as only Caucasian are on site more, relocate more, travel more, are less satisfied with their work hours or time spent at a desk and perceive that a lack of work life balance is more relevant as a barrier to their career advancement than the respondents who identified themselves as anything other than Caucasian. This suggests a need for further exploration, to test possible causes.

5.3 LESSONS LEARNED

Overall, the survey was very intensive and contained forty nine questions grouped by different categories and an additional skills survey that consisted of thirty six skills. The survey was designed to be broad and exploratory. However, this also made the survey long (taking participants, on average twenty minutes to complete). This led to survey respondents skipping the questions in the end (survey fatigue) and consequently less data to parse for the questions in the end.

Considering the length of the survey, the number of responses whose differences are statistically significant was relatively small. The low number of significant differences could be due to multiple reasons, the first of which would be the ambiguous definition of a BIM/VDC

employee within the industry itself. Such an emerging role is yet to be standardized in the construction industry, and varies from employees whose primary focus is BIM/VDC to employees that have BIM duties but not a job title to those who may or may not have BIM/VDC duties depending on the current project, or project phase. Many employees also “Double up” on BIM and Non-BIM duties depending on various factors, thus leading to some ambiguity in responses, as seen in comments for some questions, under “notes – optional” or “please explain” response fields.

The secondary aim for this research included studying if significant differences exist for women who use BIM. However, the low number of female respondents for both Non-BIM and BIM categories (twelve each) made it difficult in many cases to identify significant differences. Specifically, even though the more inclusive Fisher’s exact test was used for calculating the difference in distribution, the particularly low number of respondents reduced the confidence in the validity of the results, including averages. For future research, perhaps a targeted, quota sampling approach could be used to gain enough respondents in each subcategory such as gender.

5.4 CONCLUSIONS

The increased use of BIM/VDC in construction is changing the culture and nature of work performed. The general trends observed in terms of averages indicate that BIM/VDC personnel are more satisfied with their jobs and consider common barriers to career advancement to be of lesser relevance than their Non-BIM counterparts. Qualitative responses suggest that both BIM and Non-BIM personnel are equally passionate about their work and enjoy it, but for completely different reasons. The fact that most differences are not statistically different also

suggests that BIM/VDC employees may not be treated that differently from Non-BIM employees.

The way the industry is evolving, one can speculate about two possible outcomes or a combination of both for the futures of BIM/VDC employees. One scenario involves them evolving into a highly specialized functional group of people that provides a value added service to the construction industry (much like SAP consultants to the business world). In this scenario, the observed differences would be absorbed into the creation of a new services based sub-industry in AEC. This is already occurring. The results for employees from organizations with separate BIM/VDC departments indicate how this specialized industry could look like. Results indicate that they are comparable with construction employees in terms of their employee experience. Their biggest concerns are the lack of a viable career advancement path or a lack of exposure to construction activities (siloeing).

The other involves BIM/VDC employees as an integral part of the construction industry, particularly when all construction employees are empowered to use BIM/VDC in their day to day construction operations activities. The technical tools available for BIM/VDC and the industry culture itself are evolving and this transformation is occurring right now. In this scenario, the fact that BIM/VDC employees have a better work experience than Non-BIM employees could drive organizational change across the construction industry, for example, by giving construction employees more opportunities for telecommuting or enabling gender equality in the construction workplace. In our research, the best average scores for employees in all sections came from male BIM respondents from organizations without separate BIM/VDC departments, who enjoy the best of both worlds, and for whom BIM/VDC skills provide many advantages over their Non-BIM counterparts.

If future research can inform us regarding the causes of the observed differences between BIM and Non-BIM populations, this could hold the key to transforming the construction industry by modernizing it in terms of not just technology, but also employee experience. This research, therefore, provides a next step in research investigating similar lines of thought.

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APPENDICES

APPENDIX A – COMPLETE SURVEY

Welcome to the survey!

Your responses will help us further our understanding of the topic, "Impact of BIM/VDC on construction workforce". Your responses are anonymous and should you choose to, you may elect not to answer certain questions or exit the survey at any given point during the survey. At the end of the survey, you will be given an opportunity to enter a chance to win one of ten \$10 online gift cards.

Thank you for your participation!

SECTION 1 – ABOUT YOUR COMPANY AND BIM/VDC

1. What is the nature of your company's BIM/VDC program? (Check all that apply)
 - ☐ We have a separate BIM/VDC department
 - ☐ Our goal is to have all employees know BIM/VDC
 - ☐ Select individuals throughout various departments have BIM/VDC skills
 - ☐ We outsource our BIM/VDC work to consultants
 - ☐ We do not have a BIM/VDC program
 - ☐ Other (please specify) _____

2. What kind of support does your company provide to support the implementation of BIM/VDC? Please answer even if your company does not provide formal support. (For example, "Our company encourages employees to learn BIM by providing onsite training facilities and time and sends us to technology forums" or "We have to learn BIM on our own time" etc.)

3. Does your work directly involve BIM/VDC in any way? (i.e., Do you perform any BIM/VD related tasks as a part of your work?)
 - ☐ Yes
 - ☐ No

SECTION 2 - BIM ONLY SECTION

4. What do you like best about working with BIM/VDC at your company? (For example, "it gives me great visibility and helps my career" or "it gives me an outlook of the overall project and keeps me on the forefront of technology trends")

5. Is there anything you would like to change about working with BIM/VDC at your company? (For example, "It would be nice if BIM employees could move laterally to onsite roles" or "Instead of one project, I wish I could work on multiple projects at a time" etc.)

6. Please review the following statements

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
My BIM/VDC skills have enabled me to work at a higher pay grade than my Peers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My BIM/VDC skills have given me the opportunity to get promoted faster than my peers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

7. Have you had training in BIM/VDC? Check all that apply.
- ☐ None/Self-taught
 - ☐ Industry led training(e.g. BIMForum, Autodesk University etc.)
 - ☐ In-house training
 - ☐ College courses
 - ☐ Other (please describe) _____
8. What best describes the relationship between your primary job duties and job title?

- My job duties include BIM/VDC but my title does not
 - My title includes BIM/VDC or a variant but I also have other job duties
 - My job duties and my title include BIM/VDC
 - Other (please describe) _____
9. What is the percentage of time you spend on BIM/VDC duties?
- 0-15%
 - 15-30%
 - 30-60%
 - 60-90%
 - 100%
10. Please describe any barriers/challenges to your career advancement , in both BIM/VDC as well as in Construction in general

11. Your BIM/VDC job duties/functions include to...(Check all that apply)

- ☐ Create 2D plans using CAD – Drafting
- ☐ Create 3D models
- ☐ Overlay models from different sources
- ☐ Analyze models for coordination or clash detection
- ☐ Analyze models for environmental concerns (energy, daylighting etc.)
- ☐ Analyze models for safety
- ☐ Manipulate databases underlying model
- ☐ Prepare a facilities management ready model
- ☐ Create site logistics plans or models
- ☐ Create marketing materials related to BIM (includes visuals, animations, written responses to RFPs etc.)
- ☐ Represent your company at technical conferences Outreach and learning
- ☐ Test new software

- ☐ Assist in making/Make decisions about new hardware, software or processes
- ☐ Train others in BIM/VDC usage (colleagues, subordinates, subcontractors, owners etc.)
- ☐ Document lessons learned or create best practices
- ☐ Extract estimates from BIM/VDC models
- ☐ Create 4D schedule simulations
- ☐ Manage other BIM/VDC personnel
- ☐ Set up jobsites with BIM/VDC (Hardware & Software)
- ☐ Other (please specify)

SECTION 3 - WORK LIFE BALANCE

12. How long is your average daily commute time?

Number of Hours : _____

13. Are your work hours flexible?

- ☐ Yes
- ☐ No

Please comment (optional) : _____

14. Does your organization allow you telecommute ?

- ☐ Yes
- ☐ No

Please comment (optional) : _____

15. Do you telecommute?

- ☐ Yes
- ☐ No

Please comment (optional) : _____

16. Over the course of a month, on an average, how many days do you work from home?

Number of days : _____

17. Over the course of a month, on an average...

- a. How many hours do you work a day? _____
- b. How many days do you travel out of town for work? _____
- c. How many days do you spend on an active construction site? _____

18. How many times have you relocated for work for your current job?

Enter number of times here : _____

SECTION 4 - CAREER ADVANCEMENT

19. Do you manage employees of your own company?

- a. Yes
- b. No

20. Do you manage subcontractors or external consultants?

- a. Yes
- b. No

21. How many employees/subcontractors/consultants/others do you manage?

22. How many times have you been promoted (change in title and pay) in your career in construction management (including company changes)?

- ☐ 1 Time
- ☐ 2 Times
- ☐ 3 Times
- ☐ 4-5 Times
- ☐ More than 5 times

23. Do you have yearly performance evaluations?

- ☐ Yes
- ☐ No

Please comment (optional) : _____

24. Does this evaluation include a section for measuring performance in BIM/VDC?

- ☐ Yes
- ☐ No
- ☐ In part (Please comment): _____

25. Does your pay or promotion depend on this evaluation?

- ☐ Yes
- ☐ No
- ☐ In part (Please comment): _____

26. Does your organization have a clearly defined hierarchy/ path of advancement for BIM/VDC employees?

- ☐ Yes
- ☐ No

Optional Notes: _____

27. Does your company support lateral moves to switch between career tracks or job functions?

- ☐ Yes
- ☐ No

Optional Notes: _____

SECTION 5 - WORKPLACE EXPERIENCE

28. What do you like best about working in construction at your company?

29. What is the biggest thing you would like to change about working in construction at your company?

30. Please rate your satisfaction level for the following aspects of your job

	Very Low	Low	Neutral	High	Very High	NA
Job Satisfaction Indicator						
01 - Access to technology	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
02 - Opportunity to pioneer change	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
03 - Compensation/Incentives	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
04 - Time spent at a desk	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
05 - Time spent on an active construction jobsite	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
06 - Opportunity to travel	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
07 - Ability to telecommute	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
08 - Work hours	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
09 - Work culture	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
10 - Visibility/Interaction with decision makers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
11-Continuing Education Opportunities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
12 - Teaching/Mentoring/Outreach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

31. Do you have a mentor? (Check all that apply)

- ☐ Yes, unrelated work function
- ☐ Yes, same work function
- ☐ Yes, Same gender
- ☐ Yes, same race/ethnicity

32. Please rank the following challenges/barriers you might face in your career on a five point scale

Barriers	Extremely Irrelevant	Irrelevant	Neutral	Relevant	Extremely Relevant	NA
01 – Lack of work life balance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
02 – Lack of clear career path	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
03 – Shortage of mentors	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
04 – Glass ceiling	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
05 – Lack of career advancement opportunities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
06 - Lack of networking opportunities	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
07 – Your gender	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
08 – Your race	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
09 – Your nationality	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other (Please specify) : _____

SECTION 6 - SKILLS

Please assess your skill level on a five point scale for the following categories of skills

33. Skills - General Competency

	Very Weak	Weak	Neutral	Strong	Very Strong
Ability to communicate with varied audiences	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to understand and give instructions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to obtain information from various sources	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Stress Management – Ability to keep your cool	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time management – Ability to plan and prioritize deliverables	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Awareness of Sustainability concepts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

34. Skills - Cognitive Competency

	Very Weak	Weak	Neutral	Strong	Very Strong
Awareness of ethical issues	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to identify and solve problems and implement effective solutions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Adaptability - Being able to respond to a wide range of situations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Understanding and integration of interdisciplinary knowledge , including work not self-performed	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Decision making skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Willingness and Ability to learn from others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

35. Skills –Technical Competency

	Very Weak	Weak	Neutral	Strong	Very Strong
BIM design/modeling software skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
BIM model viewing/analysis/integration software skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Additional scheduling, estimating, project management software skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Construction field process knowledge (materials and methods, MEP systems etc.)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Skills – Affective Competency

36. Leadership skills

	Very Weak	Weak	Neutral	Strong	Very Strong
Ability to model the way	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to inspire a shared vision	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Ability to challenge the process	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to enable others to act	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

37. Ability to collaborate (split into questions 37 and 38)

	Very Weak	Weak	Neutral	Strong	Very Strong
Ability to fit in and move with a larger (team/organizational) vision than one's own	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Accountable for own skill set	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to recognize and respect others' skills and positions within a team\	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to place trust in other team members	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to recognize problems within a team early and address them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Empathy – Ability to demonstrate respect for opinions, customs and individual differences of others	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to contribute to a team through cooperation	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to coach/train/teach	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to mentor	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Networking – Ability to establish and maintain relationships through trust	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to listen	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to negotiate	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to resolve conflicts	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to build and manage interdisciplinary teams	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to manage people at all hierarchical levels	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

SECTION 7 - DEMOGRAPHICS

39. Where is your office located?

U.S States (dropdown)

40. Are you male or female?

- ☐ Male
- ☐ Female
- ☐ Prefer not to answer

41. How old are you?

- 20-25
 - 25-30
 - 30-35
 - 35-40
 - Above 40
 - Prefer not to answer
- 42. Are you a U.S Citizen?
 - Yes
 - No
 - Prefer not to answer
- 43. What is your race? Please choose one or more.
 - ☐ White
 - ☐ Black or African American
 - ☐ Asian
 - ☐ Native Hawaiian or other Pacific Islander
 - ☐ American Indian or Alaska Native
 - ☐ Other
 - ☐ Prefer not to answer
- 44. What is your current marital status?
 - Single
 - Partnered
 - Prefer not to answer
 - Other (please specify) _____
- 45. Do you have any children under 18?
 - a. Yes
 - b. No
 - c. Prefer not to answer
- 46. What is the highest level of school you have completed or the highest degree you have received?
 - Less than high school degree
 - High school degree or equivalent (e.g., GED)
 - Some college but no degree
 - Associate degree
 - Bachelor degree
 - Graduate degree
 - Prefer not to answer
- 47. What was your undergraduate major?

- 48. What was your graduate major?


49. What category best describes your annual compensation (including bonuses)?

- ☐ Less than \$40,000
- ☐ \$50,000-\$60,000
- ☐ \$60,000-\$70,000
- ☐ \$70,000-\$80,000
- ☐ \$80,000-\$90,000
- ☐ \$90,000-\$100,000
- ☐ Greater than \$100,000
- ☐ \$100,000-\$120,000 (Category added later)
- ☐ \$120,000-\$140,000 (Category added later)
- ☐ Greater than \$140,000 (Category added later)
- ☐ Prefer not to answer

Thank you so much for participating in our survey!!


END OF SURVEY REWARD

APPENDIX B – IRB APPROVAL


Research Integrity & Compliance Review Office
Office of Vice President for Research
Fort Collins, CO 80523-2011
(970) 491-1553
FAX (970) 491-2293

Date: April 8, 2013

To: Dr. Caroline Clevenger, Construction Management
Girija Inguva, Construction Management



From: Janell Barker, IRB Coordinator

Re: Influence of Virtual Design & Construction on Construction Workforce

IRB ID: 053-14H Review Date: April 8, 2013

The Institutional Review Board (IRB) Coordinator has reviewed this project and has declared the study exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b)(2): Research involving the use of educational tests,....survey procedures, interview procedures or observation of public behavior, unless: a) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects.

The IRB determination of exemption means that:

- You do not need to submit an application for annual continuing review.
- You must carry out the research as proposed in the Exempt application, including obtaining and documenting (signed) informed consent if stated in your application.
- Any modification of this research should be submitted to the IRB Coordinator through an email prior to implementing any changes, to determine if the project still meets the Federal criteria for exemption. If it is determined that exemption is no longer warranted, then an IRB protocol will need to be submitted and approved before proceeding with data collection.
- Please notify the IRB Coordinator if any problems or complaints of the research occur.

Please note that you must submit all research involving human participants for review by the IRB. **Only the IRB may make the determination of exemption**, even if you conduct a similar study in the future.

Figure 18-IRB approval (image)

APPENDIX C – LIKERT ITEMS IN SURVEY

A total of 59 Likert type response items exist in the survey, grouped under four subcategories (see Appendix A – Complete Survey). However, technically, they do not constitute a true Likert scale. A Likert scale *emerges* from responses to a set of questions designed to measure a single construct. The response format for these questions may or may not be in a five point/seven point scale. (Carifio & Perla, 2007). A Likert item, on the other hand is a word commonly used to describe a question whose response format consist of a five or seven point response ordered with extreme opposite responses located on either end of the “scale”. Per Clason and Dormody (1994), the responses to a group of Likert like items cannot be summarized together and need to be analyzed separately. The distribution of respondents across the Likert *response scale* needs to be analyzed as being from discrete categories. The best known statistic the analysis of distribution of cell counts is Pearson’s X².

APPENDIX D – DETAILED RESPONSES AND COMMENTS

QUESTION 2

What kind of support does your company provide to support the implementation of BIM/VDC?

Please answer even if your company does not provide formal support.

1. Each jobsite's MEP manager will train the Superintendents on how to navigate thru the BIM but that is all.
2. My company does not provide any support
3. It is a mix of learning BIM (we use Revit) at work and then at home on our own. I would say 40% at work, 60% at home.
4. Very strong support at the highest levels. Budget is provided to advance, use, and educate.
5. On site professionals dedicated to BIM, teaching the rest of the team how to leverage the tools in the future.
6. Currently BIM education is provided on individual as-needed basis to others in the company by our VDC Manager. Our company [sic] also supports our VDC staff by providing membership to local user groups and sending us to technology conferences.
7. Learn on own time
8. Our VDC department offers training workshops for non VDC folks. Members of the VDC department also take the time to train any individual that wants to learn something specific to what "we" do, although usually the basics and short due to time constraints on both ends with current daily tasks

9. Minimal training docs and reference materials. Official, full 'training' or tutorials does not exist. Very brief rotation in VDC could be helpful.
10. Everyone is encouraged and empowered to learn BIM/VDC.
11. BIM/VDC is part of our company strategy for innovation and improving efficiency. We have a formal Community of Practice made up of over 60 people with leadership support. There are multiple levels of training, but mostly one on one training on projects.
12. BIM is learned on a case by case basis. Depending on the employees interest in the subject they can look into outside training.
13. We use Smart Plant.
14. If we want to learn BIM we must do so on our own time.
15. Our company supports VDC efforts on a majority of the projects throughout the country. The only exception are the lower budget projects. As a VDC department, we are relatively close nit and train each other on an as needed basis.
16. Our company encourages employees to learn BIM by providing on-site training facilities and time and sends us to technology forums
17. We have a dedicated staff devoted to providing VDC services on every job. Support for VDC is comprehensive, from top to bottom. A new initiative is focused on educating staff in other positions: PMS, superintendents, engineers, etc.
18. Our designated BIM Modelers (2ea) are current on all things BIM
19. Our company has training for non-bim[sic] people to understand benifits[sic] and what are the possiblities[sic]

20. Encouragement for our [group name omitted] (those directly involved with BIM) to help spread knowledge to others. We [group name omitted] have training documents and are improving databases to share with and learn from [sic] each other
21. We have individuals that work on VDC activities, but the goal is to get all project team members well versed in aspects of VDC so they can utilize the by products [sic] of the model and the information stored within to work more effectively.
22. Our company provides training for Superintendents, Engineers, Safety Managers, Managers, and Senior Management. We have online resource groups.
23. BIM specialists train their project teams as needed.
24. If we require BIM on a project, it is outsourced to consultants.
25. No support for BIM systems. CAD is available and PDF viewing editing programs are provided.
26. We only do BIM when required by the job.
27. We have to learn BIM on our own time
28. no support
29. Our company encourages employees to learn BIM, however only a select few get fully trained to build models. Most others are shown how to navigate models but rely on a select few to edit and change the model.
30. We have a qualified BIM department. Seminars have been held to increase knowledge of individuals but the real skills come through on the job training if BIM is used.
31. Our company provides continuing education at local colleges to gain experience in BIM/VDC. Also sends the BIM/VDC employees to various seminars and local workshops.

32. Our company provides training to all new and young employees. BI, has become part of the entry level position and our department handles the more sizable projects.
33. If an employee wishes to learn BIM, it must be on their own time and with their own resources.
34. We have one person designated to do our Vdc [sic] whom provides basic knowledge to the remainder of the mgmt [sic] staff
35. As a subcontractor, we are trying to see how we can implement BIM.
36. None
37. Curently [sic], our support and execution of VDC/BIM primarily by specialists. A part of our vision for growth is with expanded capabilities and expertise in VDC/BIM across our business, including estimating, superintendents, office/field engineers, and project management
38. I work for a smaller company without a BIM/VDC program but have previous BIM/VDC experience. Our company has not yet seen the need to pursue BIM/VDC.
39. We are a heavy civil construction company. All BIM type design work is outsourced to design firms.
40. Our company invests in classed and training seminars offsite to learn, and keep up to date with the current technology.
41. My company does not offer BIM training to its employees at this time. We have only a couple of people that know what BIM is and how to use it effectively on projects.
42. We have "Cad Techs/Engineers" who model all work in solidworks [sic] and our own proprietary software to ensure validity of modification designs before the go into fabrication.

43. Minimal if any - and I'm in the BIM department of my company. I might be a bit disgruntled too :)
44. We have a BIM manager that controls BIM efforts when applicable.
45. The ND based company I work for is slow to learn about VDC. They don't provide any information or training on it. I believe this will cause problems for them in the future with it comes to winning projects.
46. Our company provides training so that employees can be comfortable navigating models, however there is no requirement for each employee to learn BIM/VDC.
47. There is no BIM training.
48. N/a
49. We have a small department (4 people) who lead the BIM efforts, however most PE's are expected to be able to run clash detection and coordinate through the BIM model in the field.
50. We utilize BIM, but have to learn it on our own time. Those that assist with BIM were hired with the experience.
51. Our company has yet to use BIM on a project. We do use AGtech [sic] on some projects. I am the only one who has completed the AGC BIM course
52. We just view the models for construbility[sic] and scheduling
53. Within the Engineering Sector of [organization name omitted], projects can be supported by BIM profesionels[sic].
54. We have Subject Matter Experts who support our projects worldwide with BIM/VDC. We are an Owner's Agency Firm [organization name omitted] so we set requirements for contractors and design-builders in contract language to utilize this software.

55. My company provides no support for BIM
56. Our company encourages employees to learn BIM by providing OJT.
57. Our company has a self-guided training that is available [sic] to the employees.
58. Both hands on training on-site as well as off-site trainings are available to any personnel who are interested or have the need to develop their BIM skills.
59. Many employees within the company are provided on-the-job, peer to peer training in order to complete specific tasks. The company has also provided reimbursement to and paid time off for employees who personally request to attend training seminars offered outside the company. These employees are typically the ones who have more full time BIM responsibilities.
60. Occasionally special trainings will be offered, but majority of the time it's self-taught with company produced training videos
61. Our Company provides on-site training for construction projects utilizing BIM.
62. Our company encourages the use of BIM and provides the opportunity to employees to learn, on company time, how to use BIM. Our company also provides direct access to other employees within the company that have BIM knowledge. This ensures the employee learning BIM receives adequate support and guidance.
63. Our company encourages us to use BIM, however there is no formal training. Resources are readily available.
64. We have an online self-guided Revit [sic] training
65. Our VDC department is involved in several technology groups outside of the company, and provides training for both VDC and non-VDC team members.

66. companywide training for all employees; profesional [sic] training, conferences, forums, etc. for BIM professionals
67. Support has evolved to be primarily through social networking (Chatter) and comittee [sic] meetings.
68. My company provides limited training for the BIM/VDC employees. The BIM/VDC employees are responsible for training the feild [sic] team on BIM/VDC uses.
69. We have plenty of training opportunities on-site to learn BIM.
70. Highly supportive. I am sent to training and technology conferences throughout the year. Then I relay the newly learned information back to our VDC team members through internal training.
71. Online resources, onsite training,
72. We do many things to support the implementation of BIM/VDC throughout the organization:
- Corporate innovation team focused on BIM/VDC
 - Corporate knowledge sharing portal
 - Corporate process improvement teams focused on BIM/VDC
 - High degree of training, both formalized at the corpoarate [sic] level and one on one training at the project level.
 - We attend most of the BIM related conferences around the country, and try to get as many people invovled [sic] here as possible.
 - On line company tutorials/training
73. Our company encourages employees to learn BIM by providing on-site training facilities and time and sends us to technology forums
74. [Organization name omitted] has a dedicated VDC manager who advises and supports BIM efforts on projects. Select Engineers in our offices are trained to work with BIM

Software like "Glue". Training is provided for those who are interested in learning more about BIM and implementing on their [sic] projects.

75. BIM training is typically offered when someone presents interest.

76. Our company provides basic VDC (e.g. sketchup [sic]) training to all interested employees. For those employees whose functional responsibility or assignment requires robust utilization of BIM, our company sends those individuals to both internal and external training.

77. Intense training and direct involvement for select employees; overview for others

78. We provide several week long course called BIM University to select people.

79. Our company encourages employees to learn BIM. Most training is peer to peer, and base don [sic] interest.

80. We have dedicated BIM Engineers on larger projects, a regional BIM/VDC Manager, then a National BIM/VDC/Lean Manager. We have various MEP coordinators that know Navisworks and our Estimating Department has varied experience in Revit and VICO.

81. Our company provides online training for our BIM/VDC group to help keep their skills current. For the company as a whole, project teams receive some training from the VDC group to enable them to capitalize on the VDC deliverables provided to them.

82. We have district VDC Managers that monitor the VDC Projects. Then we gather the information and report to Corporate. We also have a corporate training program.

83. WE have at least one BIM-proficient individual on each project, primarily for MEP coordination.

84. in-house training, training by software vendors

85. The BIM/VDC group provides classes throughout the year to teach BIM.

86. Our company strives to incorporate BIM into the way all of our projects are run. We have two employees focused on BIM Training, along with a subset of our full-time BIM resources helping to focus on BIM training within a focused group. Training is offered both online, in a formal class room setting, along with just-in-time training on projects.
87. The company encourages everyone to learn BIM, however does not provide training to everyone.
88. Our company is very involved on cross training departments to get involved with VDC/BIM. We are encouraging anyone who is wanting [sic] to learn about the new processes that we are using.
89. We have a dedicated SharePoint site with resources for VDC/BIM. The site includes CAD/BIM license ordering, Great Practice examples, Webinar recordings, Tutorial videos, vendor/consultant contacts and metrics.
90. Our company provides webinars and select training courses for employees who will be using BIM/VDC the most. There are plans in the future for all employees to be trained.
91. Encourages to learn [sic] BIM and tries to see if the Owners lean towards implementing BIM in their projects.
92. We have provided training workshops to all our employees. Our company encourages to attend [sic] BIM workshops and local BIM meetings.
93. Broad knowledge and general capability with a seperate [sic] dedicated group with deeper technical skills
94. Learn BIM on our own time.
95. We provide support through the project level and at administration level. The project level support is focused on making sure the operations staff is knowledgeable of all the

BIM features of the project and able to perform all the necessary functions of basic model navigation, coordination, layout, etc. At the administration level, there are varying degrees of aptitude that range from simple basic understanding of BIM to very advanced fabrication level modeling skills. At any degree, BIM activities are supported from our Management Committee down to the Regional Managers and down to the Project Managers.

96. All employees are encouraged to understand BIM, at least in the most basic form (terminology). Our company has everyone from the most novice user to a full-time BIM manager. We use BIM in almost every project.
97. Our company provides everything which is needed from Pre-Construction till close-out and beyond. When I say beyond, we also provide services to the facilities team in such a way that all maintenance information is linked to the BIM model. This is just an example. We even link schedule, costs, etc. to the BIM model and make sure it is feasible in all aspects in the industry.
98. a lot of just in time training opportunities [sic] such as on demand videos and on the job trainings.
99. Our BIM support is sorely lacking. Within our entire region and our \$1 billion plus portfolio, I can only name one person who is proficient in the use of BIM.
100. Our company encourages all employees to be able to navigate a 3D model as a minimum. Creating actual models is more specific to the BIM department.
101. Some on-site training is provided. Mostly on our own time and through "trial and error".

102. Master license setup for all users to access the necessary software Ongoing training for all levels of BIM knowledge
103. We have a corporate initiative to get all employees knowledgeable in BIM. There are also discussions about making this a topic on our yearly performance review.
104. Classes that company will compensate employee for costs.
105. We support all employees that want to learn new software. From purchasing the software to trainings.
106. Our company encourages employees to learn BIM by providing training sessions for BIM engineers and encouraging employees who are not BIM engineers to be familiar with the software.
107. Our company provides some in-house BIM training and also encourages employees to take outside courses or workshops to learn the latest in BIM.
108. We have a company-wide BIM specific training initiative through which we create and provide class room training, onsite training, video tutorials, training & troubleshooting write-ups, etc. In addition, our regional BIM managers support our field staff as-needed.
109. We have a BIM training task force
110. Our company encourages employees to learn BIM by providing on-site training facilities and time and sends us to technology forums
111. We have on-site and online training.
112. [Organization name omitted] buys modeling in with our subcontracts by making BIM Execution Plans Contract Appendixes. We also dedicate over \$1 million annually to developing innovations (many of which are BIM focused.) Heavy BIM users provide

regular training (there are typically 2-3 sessions that occur each week (some informal, some formal.) We have also developed a system for ranking the BIM skills of all [Organization name omitted] employees and have related this database to opportunities for promotion. Lastly, BIM software network licenses are network based and [Organization name omitted] retains over 150 seats for standard Builders Suite software and a similar number for non-Autodesk software.

- 113. Our company has a national IT department that has a BIM/VDC subdivision. We have BIM team members across the company at various jobsites.
- 114. Our company encourages employees to learn BIM by providing on-site training facilities and time and sends us to technology forums
- 115. We have BIM coordinators however all management is encouraged to learn BIM. Not learning it as far as how to load files, but learn to walk through the drawings.
- 116. We try to train all the project engineers on all job to be able to perform basic BIM related duties.
- 117. We have corporate and local BIM and VDC managers who oversee and provide support from an operational standpoint and we have select project specific individuals who actually perform the modeling and coordinating.
- 118. Our company will support on the job training but will rarely invest in formal training. Typically BIM Managers are hired with the expected level of knowledge / experience.
- 119. Autodesk or consultant training Peer training
- 120. Training

QUESTION 4

What do you like best about working with BIM/VDC at your company

1. I love that BIM can detect conflicts within a building and make the construction part go smoother. Though, on design-build it can be a hindrance.
2. A project is completed cheaper, more timely, and more efficiency. The challenges of complex projects are more likely to be completed with the use of BIM.
3. Gives me the opportunity to get into a lot of different areas and work on improving our business and customer experience.
4. It is a critical component of working in a more integrated fashion with project teams. Overall there is a lot of possibility to better coordinate work and improve quality, shorten schedules, and reduce risk.
5. It's the reward you get for being able to look at something differently than most (3D vs. 2D) and then solving problems b/c of that. Also it is an exciting time in the industry and so many new products are and will be coming out to help our industry, and we get to be exposed to them.
6. the benefit it brings to the project
7. VDC is part of how we plan and execute our projects. We don't just sell it we live it. We have the metrics and case studies to prove it.
8. I enjoy working with new technology and developing/utilizing new and improved strategies to improve efficiency within construction.
9. Direct connection to the work that's being done in the field. Ability to problem solve. Exposure to new technologies.

10. Allows me the ability to really understand a project and help through the whole process from begining [sic] to end. Allows me to work with A/E, owners, subcontractors and facilites [sic] teams
11. Encourages me to embrace technology at a greater level and involves me in the construction of our projects in unique ways
12. It gave me the opportunity to show field staff what the trouble spots of the job look like before they occur in the field.
13. I'm directly involved with BIM/VDC processes and I just like what I do.
14. Reduces indirect costs, allows leaner construction
15. It helps us identify potential design / schedule issues early so adjustments can be made and the proper plan can be put in place.
16. It developed early on a BIM model can be a useful tool in determining clashes between trades, mainly MEP. However, the model is a tool so importing all the information is crucial.
17. It helps us be a successful mechanical contractor through planning. We limit rework, are more efficient, work safer and it fosters a team environment.
18. By using the software it directly impacts field operations for the better. Underground assemblies are streamlined during install.
19. It provides visuals for everyone to use for discussions and planning. It provides clash detection so we can correct problems before they are found in the field.
20. Gives good insight as to what is needed in order to successfully complete the project
21. [Organization name omitted] is great because our company is committed to continuing to improve how we deliver value from applying VDC. We have a large team representing

all of our markets that is focused on exactly that- full time dedication [sic] to improving design and construction with VDC.

22. It is fun opportunity to impact the project from the role of a contractor, at the same time as the design teams

23. I don't work with it. It's an additional service my company offers, only if the client wants to pay for it.

24. I definitely like utilizing this type of software because it helps you work out many construction problems before they start costing a lot of money. I do feel it is important to work with new technologies like this to help stay on the forefront of the industry.

25. It allows the building to become real much faster than traditional construction. I can literally see superintendents switch when we get into the model and show them exactly what will happen.

26. It has helped set me apart from my peers and decreased the time to estimate projects when performing QTO

27. Can help plan project and foresee issues months before they happen. Can also hinder you if you make changes without having all trades coordinated in BIM model.

28. Models are one additional tool for construction

29. Clash detection, 4D, 5D, take-off ease, 3D walkthorughts [sic]

30. I provides me with a vehicle that can communicate to groups through the use of graphics rather than written communication and/or schedules

31. It assists with the visualization of the project and helps to eliminate many issues.

32. The engineering side of problem solving and the enormous communication aid it provides.

33. It decreases mistakes in the field and is a great coordination tool.
34. We have the opportunity to implement various aspects of VDC on nearly all projects.
35. highly technical and specialized that touches all aspects of a project
36. The vlaue [sic] that it provides to projects.
37. It provides a great way to communicate complicated designs. It helps to minimize rework in the field.
38. I like the technology/using computers. I enjoy helping those visualize the 2D world in 3D & work out problems before work starts in the field.
39. We are involved in all aspects of the projects we support. From early Design Phase management, thru construction and into Facilities turnover.
40. It is the new up can coming segment of the construction industry, and thus gets a lot of attention. We can bring skills, expertise and work products to the table that others cannot. I like that it is so impactful on our bottom line on self-performed work in the field. I like to be invovled [sic] in business development pursuits, and VDC is a large part of that most often. It challenges me technically so I don't stagnate in my learning.
41. it gives me an outlook of the overall project and keeps me on the forefront of technology trends
42. It is the latest tech that helps projects be sucessful [sic] Helps to mitigate problems. The technology and use of BIM is getting easier, you can view models on you iPad for example.
43. It allows us to build the project in the computer prior to actual construction. Cost savings.
44. Visibility mostly. It gets me put in front of clients.

45. I enjoy working with the jobsite teams to identify & resolved issues well before they might normally.
46. It is always evolving.
47. it helps us deliver our projects in smarter way
48. I get to work on many projects and meet many people. I have many tasks and many responsibilities.
49. I've had the opportunity to meet a huge cross section of our company through my BIM work, and have made many industry contacts that I probably wouldn't have had the opportunity to in a more traditional role.
50. It is at the forefront of cutting edge for the construction industry. It is a huge step to what the industry will be using as standards in the near future. This 3D, 4D, and 5D side of construction allows you to be more intimate with project more than 2D plans. This also truly reduced was if done right i.e. work hours/resources. Google "model progression specification"
51. It helps us spend less time communicating the context of issues being addressed and more time getting team members to contribute to solutions.
52. I am one of the 2 people that can work with BIM. So any opportunity to work with BIM/Revit would be my cup of tea.
53. This is something that I love to do and I feel great to be helping the company move forward technologically.
54. Better buildings; helps understand the process, problems, and solutions. Generates a common understanding for all team members.

55. BIM is not "just coordination" and it's a great way to see many different sides of BIM.

It's also a changing environment and every day is different.

56. It keeps our company on the leading edge of technology. It also helps control the project

57. Visibility is great because everybody understands when we're looking at a 3D model. It

also has a great 'wow' factor when reviewing a model with a client or owner.

58. Greatly increases the effectiveness of MEP coordination during design. Facilitates [sic]

communication of issues between teams by allowing graphical depiction of 3 dimensions

59. It helps me to see the whole project inside and out at the beginning which helps me to

understand what is going on during construction. It also helps to keep me on the cutting edge of new tech.

60. Ease of construction.

61. I am able to see the new technology and determine what works for our company and what does not.

62. It gives me satisfaction that work is coordinated, so when installation begins, I know things will run smoothly and I will get good production.

63. I like seeing project before it gets built

64. I like the mixture of building, technology, and creativity that working in BIM provides.

65. I love the ability to create in 3D, I love being on the cutting edge of virtual design technologies

66. I use it in estimating. I like that by seeing the building in 3D you can much more quickly assess what the details are showing on a complex project.

67. It gives me a different perspective, and really allows me to see the whole process from design to building of the different systems in the building.

68. I have a project management background, but I also use modern construction technology on a regular basis. BIM is an excellent tool & process for a number of things, and I enjoy working on the cutting edge to encourage communication across teams and to provide added value for our clients by networking the team within a federated model. BIM methods are simply the best way for me to perform my job as a Project Manager, and I want to be the best builder that I possibly can be.
69. Primarily it forecasts the potential issues we could face in construction and minimizes unnecessary expenses.
70. it gives me an outlook of the overall project
71. I am a Superintendent and it helps me to visualize the work before we put it in place.
72. It keeps me on the edge with new technology.
73. While I'm at a new company it appears that they are willing to invest in the program based on how much the owner requirements specify the level of BIM and how much they are willing to invest. The good thing about the job I own [sic] is we were able to experiment with a lot of new technologies such as: digital wallboards digital plan tables and qwerty codes for equipment identification and model hyperlinks in the field
74. BIM is an excellent tool. I enjoy having the ability to collaborate / communicate with a 3D model; there are typically far less mis-communications [sic] when a model is utilized for coordination / collaboration.
75. It allows me to assist the field in coordination and sequencing
76. Problem solving

QUESTION 5

Is there anything you would like to change about working with BIM/VDC at your company

1. No
2. The career path of BIM is murky. This will likely change as the integration of BIM into a company is further implemented.
3. With the amount of work we do with BIM, it would be nice to have more people able to support the process rather than more people asking for results.
4. We need to continue doing more and pushing it out to more projects and expand our capability. BIM is new technology that is just gaining traction in the industry. We are just scratching [sic] the surface of capability.
5. I have had the opportunity to both be on one project for an extended period of time, as well as supporting 2-3 projects at a time, and it is something that I wouldn't want to change. The one thing that I would like to change is being able to be trained in other parts of the company (schedule, estimating, pre-con, etc.).
6. allowing everyone to be exposed and gain experience with BIM/VDC
7. Yes, equipping all project team members with the right technology and solutions to integrate VDC into more of our business processes. More education and training and the ability to transition into other project positions
8. I would like to change the perspective of non-VDC colleagues that the work we put together isn't automatic or instantaneous. It requires researching a problem and actually working through a problem and that takes time which sometimes cannot be estimated accurately depending on the task.
9. More focus on the information being handled, less focus on the software.

10. The stigma of what we do. We are not just CAD people. It would also be nice if the company viewed us as engineers with different specialty skills and allowed us to move up in the company appropriately [sic] instead of stunting our growth.
11. I wish others understood our roles better and were more open to learning about BIM. Maybe the company needs a formal way of making others aware of its accessibility [sic] and more comfortable with using it for minor tasks.
12. It would be nice to have standarization [sic] across the entire company.
13. More appreciation for the BIM specialists. Currently they are still treated as a service provided to the rest of the team rather than part of the project team. It is changing though.
14. I am not sure at this time
15. I believe that operating BIM effectively is a skill set that only a few at the company have. It would be nice to see each project assigned to a BIM manger to help create and manage the model.
16. I think we just need to continue to grow and get to the next level as our elite competition. This will be achieved in continued use and pushing BIM whenever possible.
17. We need to have at least one experienced person on each job.
18. We've had much past success with VDC borne by specialists. Our vision for continued growth intends to find an optimal mix of company-wide practitioner and support specialists. There are professional, social, and technical challenges associated [sic] ith [sic] the change.
19. We are currently running all of the BIM projects from one office. Expanding that to the other offices would be better.
20. I would like to be trained on our BIM system.

21. Not really, I work for a small company so lots of interpersonal communication between individuals and departments gives me good exposure to certain aspects of these technologies. I would like to learn more about how to operate the systems, but in my current position there is no real need for that.
22. It would be nice to have more of an opportunity to utilize BIM/VDC on more projects.
23. We need to fine tune the use of BIM. All personnel should be trained
24. No
25. Not at the current time.
26. Continued development and improvement of hardware capable of running the programs
27. I would like to see it as more of a respected career path.
28. More training.
29. lateral career growth instead of being siloed [sic]
30. Possibly a little more BIM/VDC specific training.
31. It would be nice if there was a higher career path for BIM/VDC. The company does not see career opportunities past BIM/VDC
32. I would like to be more involved with what goes on in the field/changes in the field.
33. At the moment our career path is in a silo....that is to say there little to no movement into other operational tracts of the company. (i.e. Superintendent [sic], PM, Design Phase Mgr [sic], etc.)
34. There is a lot of repetitive [sic] work that we do on every project that eventually will be automated, but it just hasn't happened yet. People still see us as IT (information technologies) support, i.e. setting up servers, smart boards, networks, phone systems, etc. Deeper understanding of what we do by operations level personnel - time will help this.

35. everything is great!
36. It would be nice to see BIM on smaller projects.
37. It pigeonhold [sic] you as a "technology person" instead of a builder.
38. We've experimented with co-locating our VDC staff on-site. For the most part, I think that's the way we're heading... but it's not without its challenges (i.e. slower connections for equipment & additional workload due to being more visible/accessible to on-site team). Additionally, within our company, we in the department have had serious limitations as far as career path and advancement. I honestly don't think they know what to do with us. We began as a very innovative department and are still very active (we touch almost 100% of our projects)... but many of us have been here for years with no real promotion (be it title or compensation). This can be a little rough on morale, especially since we're "sold" on every job we win and are typically frantically busy.
39. No
40. it would be nice if we could have clear career path for BIM/VDC guys
41. Instead of working on multiple projects at a time I wish I could get an opportunity to work full time on a project doing a combined BIM/PE role. This is feasible at [Organization name omitted], but it does depend on luck and timing to get assigned to a job. More importantly, I would like to have a better sense of how my current BIM track will impact my career. I'm worried I might get stuck as the BIM guy.
42. I wish we could get more traction in our field personnel leading the BIM efforts so our full time BIM resources could focus more on the next level of implementation [sic].

43. There is BIG struggle with companies truly adopting BIM/VDC. The industry knows that this is a possibility [sic] but has not standardize processes. That is what the huge race in is and the first company to truly do that will be on top for a while.
44. We would like to see more owners initiate the BIM process into their projects.
45. BIM is still in its infant stages at our company. We are trying to bring more awareness to the advantages of using BIM. Convincing clients to use BIM is proving to be a little difficult.
46. Common language/terminology. De-technify [sic].
47. I think our BIM program works really well with our culture and I wouldn't change anything.
48. No comment.
49. Not at this time.
50. No
51. I wish BIM Engineers on larger projects were able to remain on the project up to completion. When we leave, a lot of background knowledge goes with us.
52. Wish more owners would specify BIM.
53. More standardized between jobsites
54. I wish there were better estimating tools for estimating how many people or length of time it takes to accuratley [sic] model a space--too many variables to estimate and too much variation as it currently stands.
55. I would like to know how to do more in BIM
56. We striving to blur the line between "BIM people" and "non-BIM people". BIM needs to be viewed as an integral part of building.

57. It would [sic] be nice if we had more direct involvement [sic] in project-level decisions,
it would be nice if all users were BIM users
58. It would be great if we didn't have to recreate the model from what the architect gives us.
More upfront coordination. This would mean more of a collaborative construction
process than design/bid/build/, i.e.: IPD
59. BIM is a high priority at [Organization name omitted], if anything I just wish we had
more hours in the day to be able to make faster progress on our BIM initiatives (even
though we have close to 100 full-time BIM Engineers.) I have also spent close to six
years working on Project Management and BIM at a similarly sized General Contractor
and I understand
60. It would be great to nurture and foster those professionals who would like to go in the
BIM career path. We have a high turnover of people with this expertise and
unfortunately, not everyone in our company wants to do this role on-site.
61. It would be nice if BIM employees could move laterally to on-site roles
62. It would be nice if we would use BIM on every job. Right now, we only use it on
complicated projects.
63. I would like to be more innovative with use of VDC or BIM. More R and D to develop a
better program for the industry
64. More openness and training on it so people better understand and use it to its benefit. Not
just having BIM specialist.
65. I am not a BIM Manager however I observed that BIM Managers are typically
underappreciated and relied upon too heavily to solve problems through modeling. "We
are still waiting on someone to model ____ before we can finish ____". BIM is a useful

tool but it should not take the place of other useful tools that allow all team members to solve their own problems.

66. The mentality that BIM is perfect and a catch all for ALL coordination. If everyone is not on board it will not happen.

QUESTION 8

What best describes the relationship between your primary job duties and job title? (*Pick one*)

- My job duties include BIM/VDC but my title does not (Coded as Category 1)
 - My title includes BIM/VDC or a variant but I also have other job duties (Coded as Category 2)
 - My job duties and my title include BIM/VDC (Coded as Category 3)
- Comments (Optional)

Comments

1. At PM level, more involved in planning, implementing/selling the process.
2. I am a Building Systems Coordinator for the Systems Integration Group at [Organization name omitted]. However I am also on the Prolog Development Team and I am currently piloting a program to get iPads out to our field teams.
3. I am a corporate level director, and must also oversee other technical departments, not just the VDC team.
4. I am a development manager and do not use BIM/VDC personally. People working for me use it.
5. I am a project controls manager than manages scope, schedule and cost. I do not use BIM in my daily work. Only our design department uses BIM.
6. I am a VDC Manager
7. I am currently not involved in bim [sic] As the project is towards the end and was already modeled. I do use the model for field issues.

8. I don't typically [sic] separate my duties between BIM/VDC and Project Management, I used BIM/VDC as a tool to perform standard Project Management activities.
9. I have to be able to get into a model and fly around/orientate.
10. I only manage BIM engineers and manage the project engineers. I do not have direct BIM exp [sic] but managers others who manage it for our project.
11. My current position does not include BIM/VDC, but I've previously held positions where my job duties and title fell into all of the above categories.
12. My job duties do not include BIM/VDC responsibilities.
13. My job duties don't include BIM however I have used BIM on a few jobs that I have worked on in the past.
14. My primary job duties do not include BIM/VDC and my title does not either.
15. My title of Design Manager does not contain BIM/VDC. I primarily interact with BIM and those who are BIM managers but I am not the day-to-day manager of BIM.
16. Neither my title or job duties specifically include BIM/VDC work, but as a project manager I often work with the Drafters and Engineers to help alleviate design and fit up issues during the initial design phase.
17. Not part of my job title but I need to be able to use the software
18. We don't have titles
19. We don't have titles at [Organization name omitted] , but for all intents and purposes I'm a BIM Engineer.
20. When workload is low in the operating group I am in, I periodically take on project engineer duties.

QUESTION 10

Please describe any barriers/challenges to your career advancement, in both BIM/VDC as well as in Construction in general (*open ended response*)

Responses

1. I don't think BIM is a barrier/challenge. IT is another tool.
2. Career path past implementation of BIM. Management/ Upper Management has virtually no future.
3. Little time to experiment with additional software packages and learn new tools
4. The recent economic problems have caused a lot of disruption in the industry. I was actually unemployed for 5 months from a PM position in construcion [sic] and luckily had a background in architecture and skills in VDC so I was able to land a position as a VDC Manager. It seems like a solid niche in the industry because demand for people with these skills is increasing. Unfortunately, due to the timing of the job change I make a lot less money than I did before, but that is more a function of the economy than he position.
5. The value that we add to our employer is hard to be realized, monetary-wide. Also being trained or taught in a different field (architecture most often vs. Construction management), we have to prove our worth a little more than others.
6. Unique skills of BIM/VDC push those employees who only do BIM/VDC further onto an 'island' on which it is much more difficult, compared to other positions, to learn any other of the various aspects of the company and of general construction practices
7. N/A
8. Leadership buy-in, field team adoption. One person and one project at a time!

9. Lack of understanding of VDC by upper management. Lack of positions available to advance into within the company.
10. Economy Operating Group not understanding what we do and what comes with the job titles.
11. BIM/VDC: Keeping up with the constant changes in technology Construction: More exposure to the processes of the business
12. Lack of standardization, especially coming out of college and into the field. Lack of standard practices as far as equipment needs.
13. Limited management mentoring support.
14. I am a younger professional, takes time to move up the ranks. Acquire "gray hairs" as they say....
15. N/A
16. The more skills you have the more valuable you become so a barrier is stopping the learning process whether it be with BIM or some other skill set that can set one apart from their peers.
17. The AEC industry largely remains dominated by a "low first-cost" mentality [sic] of decisionmaking [sic]. Committing and actually applying VDC takes an investment- both at an organizational and at a project level. Though the total cost (design and construction) of a facility is less with proper application of VDC using BIMs, there is often a perspective by firms or clients that they "cannot afford BIM"
18. I am the first person in our company to run a full integrated BIM process, so there is a lot of trailblazing [sic] in my current role.

19. I've been with my company for 5 years and have not received one promotion since. That may not seem too terrible but a friend I graduated directly behind in line who works for the same company but went the project engineer/project management path has been promoted twice and is now a project manager. I now have people who are younger than I and who started after me that are getting promoted.
20. nONE [sic]
21. I don't know of any
22. Many architects are unfamiliar with the software at this juncture. It is becoming more prevalent in the industry, and the biggest challenge is the learning curve and the money associated with "Additional Services" or added Scope of Work.
23. None other than time to learn BIM
24. My limits include upper management's willingness to pursue BIM as a companywide standard.
25. Most of upper managment [sic] has very little to zero understanding of how this helps the project and what it takes to implement.
26. None
27. typically siloed [sic] separately from other career paths - limited growth at higher levels, if any
28. The company only sees the BIM/VDC employees as having specialized BIM/VDC skills. They do not see higher advancement [sic] in the BIM/VDC career path.
29. I do not have a CM or Architectural [sic] degree.

30. At the moment our career path is in a silo....that is to say there little to no movement into other operational tracts of the company. (i.e. Superintendent [sic], PM, Design Phase Mgr [sic], etc.)
31. I've been very happy with my career advancement opportunities. In fact, I would take a little less advancement (i.e. a backwards step) in terms of both salary and title for better work life balance, more time with my family, etc. For others younger in the VDC roles, I think there is a lack of understanding of what they do by many in the operations [sic] side of the field, thus less respect and trust. Many construction firms have a tough time building a career ladder above the "doer" positions for technical team members, including VDC team members. I think one thing that many of us are facing is that not as many people have left the higher ranks of construction firms in the last 5-6 years due to the economic downturn, the number of projects has been reduced, and the size of typical projects that are on the books has gotten larger, so the opportunity for promotions across the board has been less than it was in the 2004-2008 timeframe. But I think this is just getting the industry back to where it should have been. Too many underqualified [sic] people got promoted way too quickly in the 'boom' days of the early 2000's.
32. BIM/VDC is often not part of standard evaluation.
33. Having the right projects is necessary [sic] to be able to use these technologies. Some projects are well suited for the process vs. others.
34. More hands on experience on small and large projects
35. Mostly the cyclical nature of the industry. it's a lot about being on the right project at the right time.

36. At least within our company, VDC is still "new" enough that the powers that be don't quite know how to integrate such a department. In a few years, when the leadership changes a bit, I think that will be different. For now, our VDC/BIM capabilities are "neat" service we provide, but I don't feel we're recognized as pertinent to each project as as PM or superintendent might be.
37. no clear career path and positions
38. There's no clear career path for BIM people. Essentially if you want to be a Project Executive you need to be a Project Manager first, and to be a Project Manager you need to be a PE first. So BIM people have to step out of their BIM roles to do PE work in order to advance in their careers. There are of course a few exceptions, with a handful of people that got started with BIM early on and have BIM management positions at a corporate level.
39. There seems to be some level of cap in career development, as a BIM role doesn't typically provide you with the direct skills necessary to efficiently move into a Project Manager role, as a Project Engineering assignment might.
40. The new challenge with for incoming people with to align traditional PE work with new VDC work. There needs to be a balance to relate to the field
41. Lack of on-site experience slows down the career growth.
42. I work with people who had not used a lot of technology till I came in to start BIM. So getting them used to the idea of technology and catching up with the rest of the industry has been challenging. Training our staff has proven to be very helpful.
43. If you do not understand and communicate BIM/VDC, you will be seen as incomplete.
44. Full participation amongst our partners during BIM efforts.

45. Keeping up with different BIM softwares [sic] is a challenge. I know Navisworks well but need to learn Revit, Tekla, and others.
46. No clear career path like other roles
47. BIM career paths are still unclear. Typically there are fewer BIM specific roles, especially as you advance. It's hard to figure out where to advance to if there's no position or role to be filled.
48. I came from the design side to a construction company -- I was hired specifically for my BIM skills, but I'm stiull [sic] pursuing my Architect's license.
49. ?
50. Experience
51. My previous company does not value BIM (I was told this by a Sr. VP there.) As such, I switched companies and my career has advanced much faster while my level of happiness has also increased dramatically. Number one challenge - learning BIM at a company that does not value it and then finding work at a company that does.
52. BIM is often seen as a "support" service within general contractors and not given the proper recognition, advancement, and support that it warrants to those interested in a career in BIM/VDC. The construction industry will need to embrace this role and promote it better than it has thus far in order to attract qualified people and maintain them.
53. Upper management does not understand what it takes to develop the BIM skills and typically won't invest the appropriate funds to develop internally.

54. I don't see many barriers to my career advancement regarding BIM as it is more of an opportunity for Superintendents to move up more quickly if they have an understanding of the program.

55. I think there is a stigma attached and most people in construction view you as a glorified Detailer which i am not. I am a builder first

56. I've worked on 6 projects in 7 years of full time employment. Any positive accomplishment, experience that would constitute a promotion or raise is lost at the transition into a new project with new bosses. The experience is similar to starting with a new company each time I move projects.

57. Most people on the jobsite do not know or understand the process

QUESTION 11

Your BIM/VDC job duties/functions include to...(Check all that apply)

Comments under "Other (Please describe)"

1. Allocate budgets for BIM spending
2. Analyze models for constructability [sic] .
3. As a Project Manager, I need to be aware of where the BIM coordination is heading and whether or not schedule is being maintained.
4. As a Superintendent, I have learned how to walk through the model but not how to actually run the software.
5. Assist in field layout directly from the model, create lift and concrete placement drawings
6. Collaborate on overall company BIM strategies
7. Concrete Lift Drawings, Modeling over Laser Scans/Point clouds, As-built and close out document library, Submittals [sic],

8. Currently none of the above, in the past, all of the above.
9. I am a non-VDC background leader of a VDC and other technical services team.
10. I am using BIM to manage the design / stakeholder collaboration process.
11. I have done all of this in the past.
12. I work with VDC / BIM at a company regional level, so much of my work is building our Team Members' capabilities, determining project [sic] and office-wide strategy for adding value utilizing VDC, and shape our company's overall improvement
13. Integrate systems
14. Present the benefits [sic] of BIM to the client and owner. Demonstrate [sic] its value.
15. Set company BIM/VDC and related technology strategy, business planning, developing VDC integration policies with existing business processes. Research and Development of new technologies

QUESTION 13

Are your work hours flexible? (Yes/No)

Comments

1. 7 or 8 to 5 Monday - Friday
2. Deadlines however are not flexible.
3. For the most part, I work 7am-5pm, but my company is flexible if I should want to work earlier and leave earlier on certain occasions.
4. Give or take an hour or two on the start time. Duration is flexible [sic] beyond 9-10 hours.
5. I have a seasonal company
6. I have no direct supervision and no timecard.

7. My work day is Monday through Friday and an occasional weekend. Normal business hours are 7AM to 5PM.
8. Somewhat, still work 5 days a week, at least 8 hrs./day
9. Start 8:00 AM end 4:30 PM Typical work day is from 7:30 AM to 5:30 PM
10. There is a general expectation of work hours, but actual start and finish times have an approximately +/-2 hour window.
11. There is a set schedule but it isn't hard to move the beginning [sic] and end times a few hours
12. To some degree, but I still need to be in the office and/or available for 60-70 hours per week.
13. To some extent. I travel a lot.
14. Typical hours are "8-5, M-F" but most employees work more like 7-6, M-F.
15. Typically construction waits for no one.
16. We work a more flexible work day than those in the field - Example being I can show up a bit after 8am and just work a bit longer. We are also allowed to leave at 5pm. The typical work day for those in the field is from 6:30-7:00am until 5:30-7:00pm. And they have to rotate on working weekends with the members of their team.
17. With the amount of work required, the hours vary from week to week depending on what is going on, on site. For the most part, hours per week range from 58-65 hours.
18. Work hours are technically 8-4, however as with any other construction job a lot of overtime and odd hours are required. I usually work 7:30 to 5ish when I'm in the office, and travel roughly 25% of the time. The hours during that travel can be all over the place, including weekends and evenings.

19. Work hours start and end times are flexible, often includes work after ours or weekends

20. Yes, I can work from home when needed.

21. You can arrive anywhere from about 6-8ish & leave after you've put in your 8 hours.

QUESTION 14

Does your organization allow you to telecommute? (Yes/No)

Comments

1. as necessary
2. Depending on the project and client
3. depends on the position
4. I believe it would be an option when needed, but not on a regular [sic] basis
5. I have the ability to work from home when appropriate. I also travel often and do work remotely.
6. I wish - most of what I do I could do from home with the proper set-up. The only constraint would be the computer power; we use extremely hefty computers that can handle a lot going on at one time.
7. If work from home/off site is necessary.
8. Maybe, never asked. But demands of job generally require on-site presence
9. My direct supervisor actually lives in Michigan, while our Office is located in Boulder.
10. No, however, I do have a laptop and am able to login to my network server and perform all of my work functions short of printing. This is useful should i be sick, on the road, or have a commitment in the middle of the day and decide to work from home for several hours.
11. On weekends

12. Only if absolutely necessary. Our organization believes that we are best utilized on a project site. I agree with this to an extent.
13. Rarely, but under certain circumstances, this is allowed.
14. Sometimes
15. Technically "No", but I have done it between meetings when my meetings are in the opposite direction of the office.
16. Telecommuting isn't specifically excluded.
17. This is allowed but not encouraged.
18. This is not encouraged. Construction is a hands on in the field business. If you aren't there, you are perceived as not productive.
19. this is on an Operating and PM Basis it is not the same for everyone
20. This isn't really feasible as BIM on a job site is much more effective. I can however do many things remotely, and have been provided the resources required to do this. ‘

QUESTION 15

Do you telecommute? (Yes/No)

Comments

1. I have the ability to work at home, as a last resort.
2. I rarely telecommute due to personal work style and benefits from being visible to Team Members and clients
3. I'm currently running multiple projects simultaneously. As I cannot be everywhere at once, sometimes it's best to set up a central location and work from there.
4. no
5. On weekends

6. Rarely
7. See above comment.
8. Telecommuted for when not traveling for four years. I have been full time on a project for the last 9 months.
9. Very rarely, but it is allowed.
10. Very rarely.
11. With the travel that I do, and the nature of my position(I work with another PM on all of our projects) it is easier for me to be in the office whenever I can be.

QUESTION 23

Do you have yearly performance evaluations? (Yes/No)

Comments

1. 6 months after initial employment, annual reviews after that
2. Annual and mid-year
3. Barf! These are terrible. Because they are once a year, there's always a flurry of activity and everyone stressing out just prior to and just after the reviews in June. The rest of the year it's back to normal. Definitely not the way I would do it if I were the owner.
4. Bi-annual
5. I did with my last company; I have not been with my current company for a year yet, so I don't know exactly how that process will go here.
6. Performance evaluations are once per calendar year and include Goal setting and evaluation of past goals.
7. Semiannual performance evaluations, quaterly [sic] check ins

QUESTION 24

Does this evaluation include a section for measuring performance in BIM/VDC? (Yes/No/In Part)

Comments

1. as it is part of my work.
2. At my previous company, BIM had a major role in what we did so it was part of the performance analysis. For my new company, we don't work with BIM so it is not.
3. Can be added under technical skills
4. Generally the individuals [sic] who are measuring you do not know what you are doing and I don't feel that they give you an accurate review.
5. I have switched between Preconstruction and Operations and only had 1 review during my time in operations. PE's are expected to be able to run the model.
6. It's one of the things I have as items to learn more about
7. it's really more of a development/goals discussion
8. Just if you have skills in it, not how well you know it.
9. My superiors are not BIM people.
10. Not specifically, but considered in general.
11. Not sure, my last job did.
12. Not totally sure, I have not had one yet but would imagine so
13. Since I'm a BIM guy, it's really mostly just about my BIM related work.
14. We have a section for technology usage and goals. Any BIM/VDC related items are referenced in these two sections.
15. Work in Progress

16. yes, but only because it's my specific role

QUESTION 25

Does your pay or promotion depend on this evaluation? (Yes/No/In Part)

Comments

1. again, not totally sure
2. all skills are analyzed
3. Bonus is tied to yearly performance score
4. Depends on all of the questions on evaluation.
5. Get a more than average pay increase if I am performing more than my required duties.
6. I guess, but I'm sure.
7. It does help with a promotion but not entirely based on it.
8. It would if I were in Operations.
9. Its [sic] a component of the overall evaluation, I would not say that is rated heavily in my position.
10. It's mid-year and salaries are reviewed end of year, so it isn't the only measure of salary increases
11. No direct correlation between evaluation and promotion or pay.
12. No numeric measurement that is directly linked to the exact pay increase. For the most part, the company looks at each position title and the local market and makes a percentage adjustment that is pretty much level across all team members unless there is an issue of poor performance, or there is an accompanying promotion. With that said, bonuses are more tied to individual performance than salary.
13. Performance based compensation

14. Promotion is partially work performance related as well as need and experience.
15. same as above
16. The company states that the evaluation does not determine raises, however both raises and evaluations are determined based on the evaluation of performance by the same individuals.
17. There are incentives and multipliers based on existing performance requirements and self-driven objectives.
18. This hasn't [sic] been clarified.
19. Various other factors like company's performance
20. Yes, in some ways performance evaluation relates to pay / promotion. There is no formula though.

QUESTION 26

Does your organization have a clearly defined hierarchy/ path of advancement for BIM/VDC employees? (Yes/No)

Comments

1. Absolutely no. Despite multiple questions to just about everyone in the company, including the top management members, there is no clear path.
2. Create one's own path.
3. not sure
4. Several tiers of titles: - VDC Technician 1 - VDC Technician 2 - VDC Coordinator 1 - VDC Coordinator 2 - Sr. VDC Coordinator 1 - Sr. VDC Coordinator 2 - VDC Manager - Sr. VDC Manager - Corporate Director of VDC

There are not titles currently above the director level. Not much of a chance to become an officer of the company without operations level field construction experience.

5. There is a defined path for VDC advancement [sic], and a less formal means for advancement depending on an individual's career development planning and the company's needs
6. There is a hierarchy, but I don't think there are any positions beyond my current one.
7. Unsure.
8. Within the Engineering and design departments, there is not a direct path for advancement in the construction sector of our company.
9. Yes...but its outdated

QUESTION 27

Does your company support lateral moves to switch between career tracks or job functions?

(Yes/No)

Comments

1. but only at lower levels, not after a certain level - then you're stuck in BIM position
2. Depends on who you are and who you know from the main office
3. I don't honestly know the answer to this question.
4. I have not seen this type of movement, however I believe it would be an option if desired.
5. I think they want to and are trying but again it depends on Operating Group and Senior Leadership. They make it really difficult and make you step back in your career
6. Not really sure, but they do encourage employees from different departments to work together.

7. Officially they do...but in most cases it would be a large step backward in your career.
Currently one of my team is attempting a lateral move. The reason he is interested is that he is young and the step backward is not too severe.
8. The individual must take the initiative and identify a good opportunity and get some luck with timing for things to work out. But the company will support the individual in his efforts.
9. They do but the timing has to be just right. Most of the time we are under staffed or staffed with just enough people that there isn't room to move out of a position and into another one.
10. This is a recent development as our company has started a program focused solely on career development within similar roles or lateral roles.
11. Unsure about my position
12. Yes, but the VDC roles and operations roles are very different, so those that chose to move out of VDC into operations will take some level of step "backwards" on the operations career path chart to do so.
13. Yes, however, we are working on this to make this an easier process. This is currently happening slowly and on a case by case basis. This year HR is working on a complete transition position plan that is inclusive of not just VDC team members but other positions as well.

QUESTION 28

What do you like best about working in construction at your company? (*Open ended response*)

1. Can't really think of anything.
2. Building

3. I enjoy the people and the projects.
4. I get to participate in the most challenging projects, with the most advanced technologies in the world.
5. The people
6. I like working in VDC because I get to touch a lot of projects. My role is critical for project coordination and I can see that my efforts translate into better project outcomes. Since our industry has a lot of overall problems in the way projects are structured is it rewarding to be working in an aspect of the industry that is improving the way project teams work together.
7. Exciting jobs and great people to work with.
8. The people and the opportunity for future advancement
9. Company support. Innovative team members. Lots of passion for VDC. We have been implementing VDC for over 14 years now.
10. Very High Profile projects
11. Working in the field.
12. the different projects
13. The comradery [sic] on the project sites and the interest of my colleagues in learning more about VDC.
14. Good people and projects
15. The people and the challenge [sic] of the projects
16. The broad range of knowledgable [sic] coworkers and opportunitites [sic]
17. the team work / the people
18. My company takes care of me

19. I'm the owner my own company.
20. Ability to work on challenging and interesting projects.
21. My company is flexible and it provides as many learning opportunities as possible to every employee.
22. Building buildings, working with teams, handing over the final product.
23. Company Culture
24. Good people
25. Building is creating
26. Family atmosphere
27. I do not have to sit in an office all day. 70% work in an office 30% in field
28. We build some cool projects including stadiums and theme parks. I enjoy working on projects that we stand the test of time and can be showed off to friends and family.
29. Flexibility and creative solutions.
30. The challenge of constructing a project, coordinating all the trades and getting them moving in an efficient and productive direction.
31. They are employee owned.
32. I work as a shop instructor at a local university. While it is not professionally challenging as I wish, following my spouse and their military career has forced me to be flexible with my own career.
33. The flexibility to manage the project based on decisions made at the job site.
34. Construction is ever-changing. There is always something different to work on & new problems & solutions are always arising.
35. Stability, Pay

36. I enjoy working in construction at [Organization name omitted] because of our professionalism, the high quality of our Team Members, and the challenging yet rewarding work we do.
37. Different every day.
38. In Construction as a whole, I love to see the finished product and know you had a major role in making it come to fruition.
39. No direct supervision. As long as my work is [sic] done, no one [sic] comes looking for me.
40. I like the process of giving the end user a facility to make their lives better/ easier.
41. the paycheck
42. Travel, flexibility, work environment.
43. The people.
44. I actually have a lot more experience in construction than the majority of the office. I work for an engineering firm, they are easily overwhelmed with chaos, my past experience on job sites with large companies gives me the ease to manage.
45. I learn something new every day.
46. The responsibility.
47. Money is a good thing
48. The people.
49. Tangible results
50. Freedom and control of my worksite
51. Family Owned but Nation wide
52. Seeing daily progress of project People Fast Pace [sic] Environment [sic]

53. We manage large projects, risk, time, and schedule. We are also very diverse. Lastly, we are a huge company and have many resources.
54. Co workers
55. The ability [sic] to be a part of something bigger and truly [sic] see the impact I have on leading a team.
56. The people I work around, incredible projects we work on and the financial security the company provides.
57. Learning, Diverse People, Problem Solving
58. The ongoing challenges.
59. It is very rewarding watching the job progress from the ground up.
60. Construction changes day to day and is never the same. I have had the opportunity to see all types of construction which carry different building techniques, project owners, and subcontractors.
61. Impressive projects provide an interesting challenge and we have some very talented people to work with that makes work enjoyable.
62. Smart and hardworking individuals. The company is profitable and pays well.
63. Challenging [sic]
64. seeing my work get built
65. Constructing something permanent, prominent [sic] and that will exist for possibly a hundred years.
66. We are innovators.
67. The people, and the quality of work we perform

68. The variety of projects, the challenge of large complex projects, working around a really strong motivated team of high performers. I just love building things, and seeing the physical fruits of my labor. That is why I chose construction over design or architecture.
69. practical experiences on actual construction sites
70. Ability to manage my own projects within the confines of the company structure.
71. Challenge [sic], opportunity, variable environment, culture, relationships
72. Variety of opportunities
73. The ability to work on several different types of projects. The special project division allows me to gain experience on 5 plus projects in one year.
74. The people I work with and the challengeing [sic] nature of figuring [sic] out how to build new and unique projects.
75. The varied projects, working with people, problem solving and tangible results of work.
76. I love the interaction with the jobsite teams... including designers and subs. I also love that our portion of each project is just a few months at a time - lots of variety.
77. The people
78. Seeing construction go smoothly as a result of a good coordination effort using BIM.
79. I love the built environment, and love seeing projects come to life in the field, particularly after having gone through the build process digitally.
80. Great work environment and everyone works hard to push the envelope
81. The many opportunities to advance in my career and chance to learn many new things.
82. Opportunity to interact with various trades and get an overall understanding of the project
83. The people at the company and the work culture.
84. Nothing at the moment

85. it's very flexible and there is shared leadership
86. We have integrity, we have fun, we are unique, and we continuously look for ways to improve.
87. Change in project teams and locations.
88. The projects are unique and high profile and I am free to dictate operations procedures on the job site.
89. Smart employees and dependable peers.
90. The authority placed on the individual. Fun place to work No titles Flat management structure
91. A sense of pride when the project is done.
92. Projects
93. The flexibility of my position
94. tangible results
95. Being part of creating buildings that people use and rely on.
96. We are amazing and have lots of great people and benefits
97. We have the best group of people to work with. Our culture is awesome, we all support each other, our work environment is great, we have great benefits, we have flexibility, there is work/life balance.
98. The flexibility to work on what you want and to learn what you're interested in. Your job duties can expand into other "job titles"
99. It's fun, and I work with extremely intelligent/motivated people.
100. The type of projects are interesting and always challenging.
101. Every day is different in tasks

102. As a Superintendent, my company gives me a lot of responsibility and I am able to make every decision on my jobsite without having to consult with my supervisor.
103. The trust to make your own decisions and the responsibilities you are given.
104. Challenging work we do. (i.e. OSHPD Hospitals)
105. Each day is different. I like changing environments, new people and new challenges.
106. the changes and challenges
107. Solving problems

QUESTION 29

What is the biggest thing you would like to change about working in construction at your company? (*Open ended response*)

1. HOURS WORKED AND HAVING ADDITIONAL MAN POWER.
2. To limit my commute and work in one location only instead of traveling to projects
3. The need to be constantly in contact via smartphone and e-mail. Sometimes I just have to turn my phone off so I can enjoy my time away from work.
4. More Pay.
5. Project working hours
6. The industry is painfully slow to change. There are a lot of higher level problems with the way projects are approached and structured (from an owner standpoint) that lock in a lot of the inefficiencies and problems that the project will face (for example structuring work around a model where lowest price bids=greatest value). Sometimes that can become a grind... wishing owners would have a different philosophy as to what really provides value and how they approach projects.

7. Moving for different projects
8. Increase the rate of change to keep up with other industries. Construction culture is still very conservative.
9. More staff on the projects
10. Project locations.
11. the attitude of all of the people
12. I want more people to learn about and understand what VDC is and how it can assist in completing a project more efficiently.
13. More flexibility
14. I would like them to be more mobile for change and stream line the processes.
15. unnecessary levels of control
16. Best practices
17. Extra hours of work.
18. I wish we had a more active role in BIM.
19. hours
20. Architect and Engineer responsibilities are going down the drain. They are pawning the design issues off to the subcontractors to design and figure out. Basically they don't care anymore once they have approved drawings from the towns.
21. Increased productivity
22. Nothing
23. hours
24. The hours and uncertainty of where the next job will be.
25. The stress, commute and hierarchy of responsibility.

26. Work too much. It feels that construction requires 85% of your time and the last 15% is for family, friends, sleep and hobbies.
27. Organization
28. I wish I was working more implementing sustainability within the company & in our projects.
29. Flexibility, Work/Life Balance
30. We're a large company, with a lot of Team Members on a lot of projects. This brings a challenge of staying nimble and keeping able to change to more rapidly implement change.
31. Working with more smarter [sic] people.
32. At my current company, it is money related, but I wish we were more technologically advanced.
33. I would like to work closer to home or from home more often.
34. We are slow to change, and it impacts our ability to be effective.
35. the up and down nature of construction work.
36. I wish I could get on site more, but I know what the ratio would be when I accepted the position, so not a huge complaint.
37. Management style from above and overall success celebrations (because there are none).
Involvement with on-site coordination.
38. They are trying to venture out into the construction management role as and engineering firm. This company only has engineers and a lack of construction experience. I believe they should try to hire more professional construction managers. They have a large number of surveyors with a lack of management experience.

39. The hours and the stress
40. Training and or continued education of current processes
41. Life balance
42. The hours, the politics, lack of balance.
43. Work-life balance.
44. Pay
45. More qualified individuals looking for jobs
46. More intergartion [sic] of resources
47. hard to say
48. Commute
49. I would like to see more diversity in the board room
50. I would change the number of hours required to work in a week in order to do my job well.
51. Flexible start hours.
52. More input from supervisors on my performance.
53. A persons age does not mean they have superior construction knowledge of others and shouldn't be paid or promoted based on age.
54. Support of BIM during the buyout or contracting portion is typically a struggle. Improvements with this effort can reduce risk and draw on the subcontractors experience and resources. Shop drawing are already a contract requirement we're simply asking that they be done in both 3D & 2D.
55. Company needs to improve its culture in work/life balance.
56. more integration with other departments/career paths

57. Nothing.
58. Hours worked
59. More family-oriented.
60. Work Life balance is a challenge
61. - More reasonable [sic] work load (i.e. LESS!) - Better work life balance without giving up the opportunity for advancement (there is always someone who is willing to give this all up to fill your role or get that next promotion if you don't - it's a life decision you have to make)
62. not sure
63. I would like to see more zeal for new technology and methods.
64. Vertical [sic] structure, perception/ expectation older employees have about younger employees
65. Company is too large, too much red tape
66. The overwhelming procedures and the speed at which technology is adopted.
67. Streamlining [sic] the processes involved in getting a project going would be a good start.
68. Better communication/expectation.
69. More recognition of what our group actually contributes to each project. Most importantly I'd like to see a viable career path for those in our department.
70. None
71. I would like to get compensated for the time and cost of commuting to the ever changing jobsites.
72. Nothing

73. Having upper management support more of the VDC
74. I would like my company to reward the employees with more sponsored dinners, sports games, company outings/parties.
75. Getting the opportunity to be on site and rotation of work would help in the ovberall [sic] advancement
76. bring in more technology.
77. Top heavy
78. I wouldn't change anything
79. None
80. People have to know firsthand what exactly is going on every day. COMMUNICATION is the key.
81. Processes need to be centralized. Someties [sic], moving to a new jobsite is like working for a completely different company as the jobsite processes may be run differently.
82. Long stressful hours at times.
83. nothing
84. Blurred lines between project engineer and BIM engineer.
85. Hours worked
86. More stringent processes
87. accounting type tasks
88. I would like to make more time to visit job sites.
89. I wish we could get everyobyd [sic] up to speed on BIM - I wish everybody knew what I know.
90. Can't think of any changes.

91. Not much at all, [Organization name omitted] is an amazing company to work for... I would like to procure more work and increase the overall size of the company.
92. Stronger recognition and support for the support tracks such as estimating, preconstruction, design management, BIM/VDC and MEP
93. Subjective upper management
94. I would like the lines of communication open up a little more. In a large company, sometimes valuable information isn't communicated to all employees in a timely or organized manner
95. Not at this time
96. Conservative structure
97. I would like more money and a shorter work day.
98. better understanding of the time commitment for BIM and MEP
99. Training others