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WORKPLACE EXPERIENCES FOR WOMEN AND MEN USING BIM/VDC IN CONSTRUCTION

Inguva, G[1,4]
[1] United Rentals, USA
[4] girija.inguva@gmail.com

Clevenger, C.[1,4]
[1] University of Colorado Denver, USA
[4] caroline.clevenger@ucdenver.edu

Ozbek, M.
Colorado State University, USA
mehmet.ozbek@colostate.edu

Abdallah, M.
University of Colorado Denver, USA
[4] moatassem.abdallah@ucdenver.edu

Abstract: The use of Building Information Modeling or Virtual Design and Construction (BIM/VDC) in construction is prompting cultural change in the construction industry. This research presents survey results documenting differences in self-perceived workplace experience for workers whose duties include the use of BIM/VDC and workers whose do not. Further breakdown of results is presented for women and men and organizations with and without specific BIM departments. Findings suggest that, overall, individuals who use BIM/VDC perceive more benefits than barriers. Specific findings suggest that individuals see most benefit related to leading change, having greater access to technology and more educational opportunities. Career barriers generally relate to being siloed as an employee, and not having a clear career path. Findings related to both benefits and barriers can differ across gender. The contribution of the research is to provide statistical and descriptive insight into the impact of BIM/VDC on workplace experience. Such information is valuable to construction leaders and researchers interested in promoting, implementing, and studying the adoption of such technology in construction practice.

1 INTRODUCTION

The construction industry is in need of technological disruption (McKinsey, 2017). McKinsey (2016) identified 5 key elements for digital change including increased digital collaboration, and stated that that the "winners of tomorrow" in the construction sector will be the leaders in technological innovation and digitization. With increased adoption of digital technologies comes changes to the workplace. Specifically,

the use of Building Information Modeling or Virtual Design and Construction (BIM/VDC) in construction is creating new roles and relationships within project teams and companies (Gu and London, 2010). Research suggests that successful information technology adoption is frequently linked to employee experience and satisfaction (Sweis, Sweis, Attar, Abu Hammad, 2011). Jeston and Nelis (2014) found that one of the most significant reasons for failure in implementation of a business process is a lack of employee buy-in. One study found that construction employees using BIM/VDC perceive their role to be related to leading change, while non-BIM users perceived their role to be more technically focused (Bosch-Sijtsema, Gluch, Sezer, 2019). Another study identified the role of BIM/VDC users to include both external/internal alignment of stakeholders and technical coordination of tools and processes (Jacobsson and Merschbrock, 2018). Assessing pereceived impacts of BIM/VDC on employee workplace experience, therefore, is an important element in the pursuit of successful and enduring technology integration in the construction industry.

Initial research findings suggest that the paradigm shift to wider application of Building Information Modeling or Virtual Design and Construction (BIM/VDC) may be positively affecting the career paths of many personnel in the AEC industry, and that such a shift is opening up new opportunity for young construction professionals (Uddin and Khanzode, 2014). Research in other industries suggests that employees value individual benefits (e.g., career advancement, workplace experience), over goals of management, including technology adoption (Francik, Rudman, Cooper, Levine, 1991). While relatively limited research exists studying changes in workplace experience related specifically to increased use of BIM/VDC, Lee, Yu, and Jeong (2013) emphasize that in order to ensure that BIM is utilized throughout construction workflows on a continuous basis, employees must be motivated to use the technology. This research studies individual employees' self-reported perceptions regarding potential workplace experience benefits and barriers to career advancement as indicators of the impact of BIM/VDC adoption on construction employees.

2 RESEARCH METHOD

Based on literature review, the authors generated a list of potential workplace experience benefits related to technology adoption as well as a list of potential barriers to career advancement for construction employees. To date, much research related to barriers to career advancement in construction has focused on women and minorities (Azhar and Griffin, 2014; Dainty, Bagilhole, Ansari, Jackson, 2004; Dainty, Bagilhole, Neale, 2001; Bagilhole, Dainty, Neale, 2000.) The final list of barriers used in the survey was adapted from research by (Fielden, Davidson, Gale, Davey, 2000) and (Worrall, Harris, Stewart, Thomas, McDermott, 2010) with gender specific items adjusted for the applicability to BIM/VDC employees.

The list of potential workplace experience benefits used in this research included:

- Access to technology
- Opportunity to pioneer change
- Compensation/Incentives
- Time spent at a desk
- Time spent on an active construction jobsite
- Opportunity to travel
- Ability to telecommute
- Work hours
- Work culture
- Visibility/Interaction with decision makers
- Continuing Education Opportunities
- Teaching/Mentoring/Outreach

The list of potential barriers to career advancement used in this research included:

- Lack of clear career path

- Shortage of mentors
- Glass ceiling
- Lack of career advancement opportunities
- Lack of networking opportunities
- Gender
- Race

To collect such data, the authors developed an on-line survey targeting individuals working for commercial or industrial general contracting and construction management firms. The survey was administered through email with recruitment relying on a combination of convenience and snow-ball sampling methods. Professionals both with and without BIM/VDC related job duties were asked to participate. All answers were self-reported based on individual perception. The survey included questions regarding work-life balance, career advancement, workplace experience and work-related skills. However, only results from the workplace experience section are presented in this paper. To analyze the data collected, the authors applied descriptive statistics to identify patterns and trends. Due to the size of the sample as well as sampling techniques results may be representative, but are not necessarily generalizable to the rest of the population.

Data were parsed by BIM employees (i.e., professionals who reported their job duties involve BIM/VDC) versus Non-BIM employees (i.e., professionals who reported their job duties do not involve BIM/VDC) as well as by gender and whether or not the employer had a separate, designated BIM/VDC department. Questions used Likert type responses coded from 1-5, with 1= Very Low or Extremely Irrelevant and 5 = Very High or Extremely Relevant. Overall averages for BIM/VDC employees versus non-BIM/VDC employees were generated.

3 SURVEY DEMOGRAPHICS

A total of 129 respondents answered the survey. Response rate is unknown since distribution utilized convenience and snowball sampling. 65% of the respondents were from western United States, with most respondents from Colorado and California, followed by 15% of respondents each, from the South and Midwest regions. 75% of the respondents were 20-35 years old, 23% were female and 30% were non-caucasians. 64% of respondents' work/job duties involved BIM/VDC to varying degrees. Regardless of BIM/VDC duties, 75% of respondents reported that their company provided support in terms of time, compensation and training materials for BIM/VDC initiatives, while 22% indicated that there was no organizational support for BIM/VDC initiatives. 53% of respondents worked for organizations with a separate, dedicated BIM/VDC department, 12.4% worked for organizations without a BIM/VDC department. The remaining 35% of respondents indicated that either 1) select individuals in their company had BIM skills, 2) their company intended to have all employees know BIM/VDC, or 3) their company outsourced BIM/VDC work to consultants.

4 RESULTS

4.1 Descriptive Comparisons

Average Likert-type responses coded from 1-5 are presented regarding workplace benefits (Table 1) and barriers (Table 2) as self-reported by the following user-groups: Non-BIM Employees- Overall, Female, Male, and BIM Employees- Overall, Female, Male, at Companies with a BIM department, and at Companies without a BIM department. Due to the disparity in sample size for male versus female, the authors averaged the average values of both populations to arrive at the Overall values for BIM and Non-BIM categories so as not disproportionately represent male experience.

Table 1. Self-reported Level of Workplace Benefit by User-group.

Potential Benefit	Non-BIM			BIM				
	Overall	Female	Male	Overall	Female	Male	BIM-Dept.	No BIM-Dept.
Access to technology	3.79	3.78	3.79	4.22	4.00	4.44	4.60	4.04
Opportunity to pioneer change	3.18	2.78	3.58	3.99	3.78	4.20	4.36	3.96
Compensation/Incentives	3.29	3.33	3.25	3.32	2.73	3.90	3.69	3.74
Time spent at a desk	3.18	3.22	3.13	2.94	2.64	3.24	3.04	3.48
Time spent on an active construction jobsite	3.17	2.71	3.63	3.21	2.91	3.50	3.31	3.73
Opportunity to travel	3.09	2.88	3.29	3.23	3.00	3.46	3.32	3.41
Ability to telecommute	2.17	2.00	2.33	2.20	1.91	2.48	2.41	2.42
Work hours	2.99	3.22	2.75	3.22	3.40	3.04	3.09	3.15
Work culture	3.60	3.44	3.75	3.83	3.64	4.02	3.94	4.11
Visibility/Interaction with decision makers	3.65	3.13	4.17	3.82	3.73	3.90	3.92	4.11
Continuing Education Opportunities	3.21	3.00	3.42	3.85	3.82	3.88	3.81	4.07
Teaching/Mentoring/Outreach	3.25	3.11	3.38	3.47	3.09	3.84	3.77	3.89

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

Table 2. Self-reported Level of Barriers to Career Advancement by User-group.

Potential Barrier	Non-BIM			BIM				
	Overall	Female	Male	Overall	Female	Male	BIM-Dept.	No BIM-Dept.
Lack of Work-life balance	4.17	4.00	4.33	3.68	3.33	4.02	3.85	4.07
Lack of a clear career path	3.16	3.20	3.11	3.57	4.00	3.14	3.36	3.19
Shortage of mentors	3.13	3.00	3.26	2.99	3.08	2.90	3.09	2.74
Glass ceiling	3.33	3.80	2.85	3.22	3.73	2.71	2.89	2.81
Lack of career advancement opportunities	2.93	3.00	2.85	3.04	3.17	2.90	3.13	2.63
Lack of networking opportunities	2.67	2.80	2.54	2.42	2.50	2.34	2.32	2.41
Gender	3.07	4.30	1.83	2.01	2.50	1.51	1.62	1.67
Race/ethnicity	1.78	1.67	1.88	1.65	1.83	1.46	1.46	1.67
Nationality	1.94	2.00	1.88	1.66	1.83	1.49	1.49	1.60

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

4.1 Statistical Findings

The distribution of respondents across response categories was tested for independence using either Pearson's chi square test or Fisher's exact test, as applicable. The following distributions were found to be statistically significant across BIM and Non-BIM employees parsed by female and male respondents, as well as BIM employees who worked at companies with or without designated BIM departments.

4.1.1 Statically Significant Workplace Benefits

The following are statically significant differences in workplace benefits reported across BIM and Non-BIM employees:

1. 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
2. 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
3. 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.

Some benefits, however, were not shared evenly across gender. The following are statically significant differences in workplace benefits reported across gender.

4. BIM female respondents reported a significantly lower score for "compensation/incentives" than BIM male respondents.
5. 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.

Of note, while not statistically significant based the sample, survey respondents anecdotally suggest that gender is much less of a barrier for BIM females than Non-BIM females.

4.1.2 Statically Significant Workplace Barriers:

The following are statically significant differences in workplace barriers reported across BIM and Non-BIM employees:

1. BIM male respondents reported significantly lower score for relevance of "lack of work life balance" than Non-BIM male respondents.
2. BIM female respondents reported a significantly lower score for relevance of "gender" as a barrier than Non-BIM female respondents.
3. 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.

The following are statically significant differences in workplace barriers reported across gender, although not necessarily resulting from the use of BIM/VDC:

4. Both BIM and Non-BIM female respondents reported a significantly lower score for relevance of "lack of work life balance" than their male counterparts.

5. Both BIM and Non-BIM female respondents reported significantly higher scores for relevance of "glass ceiling" and "gender" than their male counterparts.

4.3 Open-Ended Responses

In addition, respondents were asked several open-ended questions. When asked about what they best like about using BIM/VDC in the workplace, the most frequent responses included, "networking with people from varied backgrounds", "being in the frontlines of emerging technologies," and "continuous educational opportunities," were mentioned the most. Other factors identified included "increased visibility," "gaining an edge over colleagues," "opportunities to work on multiple projects," "opportunities to participate in business development," and "being able to better understand a project."

When asked about what they would change about working with BIM/VDC, the most frequent responses were "provide a clear career path," "avoid of being pigeonholed," "need for upper management to understand the value of BIM/VDC," "need to hire more BIM/VDC employees to share workload," "need for more field/on-site exposure," and "better integrate technology across company and/or projects to avoid siloing".

When asked about barriers to career advancement, responses generally aligned with the responses describing what they would change. The most mentioned barriers in the open-ended responses were "lack of understanding by upper management of value of BIM/VDC," " lack of a clear career advancement path," "lack of formal and on-going training," "being pigeon holed, and/or lack of exposure to the construction field," and "unclear evaluation system for promotion."

Finally, BIM employees were also asked to generally indicate their level of satisfaction with regard to pay grade and promotions. The responses generally suggested that male BIM employees perceived that their BIM/VDC skills gave them access to faster promotions and a higher pay grade; whereas, female BIM employees generally felt that their BIM/VDC skills neither gave them access to faster promotions nor a higher pay grade. Such responses were in line with the statistically significant Likert-based responses.

5 DISCUSSION

For this research, data from 129 construction professionals' survey responses were analyzed. When average Likert response values are compared between BIM and Non-BIM respondents, BIM respondents report higher values regarding benefits experienced in the workplace across all indicators except "time spent on a desk". BIM respondents also report lower levels of barriers experienced in the workplace with the exception of "lack of clear career path" and "lack of career advancement opportunities". When data is further parsed according to male and female populations within these two groups, overall, male BIM respondents report higher levels of benefits experienced 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 for benefits experienced. However, female Non-BIM respondents report higher values for "Compensation/incentives," "Time spent at a desk," "Ability to telecommute," and "Teaching/mentoring/outreach."

Both male and female populations generally reported that the levels of barriers experienced are lower for BIM employees than non-BIM employees across all indicators with one exception – female BIM respondents report that a shortage of mentors is of higher relevance as a barrier to career advancement than female Non-BIM 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 as a barrier to career advancement.

Of note, and aligned with other research (Gale, Davidson, 2006; Worrall, Harris, Thomas, Stewart, Jessop, McDermott, 2008) for both Non-BIM and BIM populations, female respondents report lower levels of benefits experienced in the construction workplace compared to their male counterparts with the exception of “work hours” where both Non-BIM and BIM female respondents report higher levels of benefits experienced than respective male respondents. With regard to compensation, in particular, BIM female respondents differed from BIM male respondents in that they perceived they received less benefit with regard to compensation or incentives. This result may be related to the fact that previous research has demonstrated that women who use BIM (similar to men who use BIM) perceive they have higher levels of skills (Inguva, Clevenger, Ozbek, 2014) Finally, of note, Non-BIM female respondents report experiencing a higher level of benefit with regard to “compensation” than Non-BIM male respondents, suggesting that construction provides relatively high paying jobs to women.

For both Non-BIM and BIM populations, female respondents also report experiencing higher relevance of barriers to career advancement than their male counterparts, with the exception of “work life balance” to which all female respondents reported experiencing lower levels of barriers than male respondents. Another exception that only applies to Non-BIM population is that Non-BIM female respondents reported experiencing lower level of barriers regarding “shortage of mentors” than Non-BIM male respondents.

Finally, BIM employees who belong to organizations with separate BIM departments report experiencing lower levels of benefits for all indicators with the exceptions of “access to technology” and “opportunity to pioneer change”. BIM respondents from organizations with separate BIM departments also report experiencing higher levels of barriers to career advancement for four out of the seven barriers listed, specifically “lack of a clear career path,” “shortage of mentors,” “glass ceiling,” and “lack of career advancement opportunities.”

6 CONCLUSION

The use of BIM/VDC and other digital resources is changing processes and practices across the construction industry. Notably, the use of BIM/DC is changing individuals’ job duties and work experience. For this research, survey data from 129 respondents employed by commercial or industrial general contracting and construction management firms were collected to analyze the impact of using BIM/VDC in terms of perceived workplace benefits and potential barriers to career advancement. Data were parsed by individuals who use BIM/VDC and those that do not, as well as by gender, and finally by organizations that have a separate BIM/VDC department and those that do not. Findings suggest that the individuals that use BIM/VDC generally perceive the experience to be a benefit. In particular, they recognized benefits such as “access to technology,” and “opportunity to pioneer change”. Respondents also identified several potential barriers to career advancement; namely, “siloing” and “lack of a clear career path.” Although both genders perceived improvement in work-life balance, women reported more of an improvement when using BIM/VDC. Furthermore, while results may not be generalizable, survey responses suggest that gender is much less of a barrier for females using BIM/VDC.

Additional research is motivated by these findings. Namely, questions arise as to whether, as the adoption of BIM/VDC technologies matures, will the perceived impact BIM/VDC on workplace benefits and career barriers persist or evolve over time. Finally, the statistical differences identified specifically between men and women using BIM/VDC in the workplace compared to their non-BIM counterpart are ripe for additional study. The contribution of this research is to begin to explore the effects and impact of technology in the construction workplace. Information regarding the nature and extent of the benefit and barriers experienced

by technology users in construction will be critical for decision-makers and leaders hoping to promote the adoption of digital technologies within the construction workforce. In particular, such information may be critical when trying to attract and retain top talent and diversity in the workforce.

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