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THE PERCEIVED VALUE OF BUILDING INFORMATION MODELING IN THE U.S. BUILDING INDUSTRY

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SUMMARY: *Although measuring the business value of BIM has attracted the attention of practitioners and researchers, there has been a lack of consistent cost-benefit benchmarking associated with BIM process enhancements and innovations. An increase in the availability of cost-benefit information will be significant, as one of the primary motivators for professionals in the building industry to adopt new technologies is the opportunity for direct benefits in their own operations. This paper presents findings from an industry-wide online survey that was carried out in the spring of 2009. The study aims to understand the perceived value of BIM in the U.S. building industry, as seen by various participants in the industry. The survey specifically focuses on tangible benefits and costs associated with BIM use at the project level.*

KEYWORDS: *Building Information Modeling, Value, Study, Use, Cost, Benefit, Building Industry*

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1. INTRODUCTION

The building industry is the largest industry in the world (Department of Commerce 2007), with distinguishing characteristics such as highly fragmented organizations (Department of Commerce 2002), unique projects, relatively short period of production, outdoor and unstructured working conditions, and labor-intensive activities. Successful completion of building projects requires collaboration of numerous multidisciplinary and sometimes geographically separated team members. Continuous, accurate, and real-time information sharing among project participants is key to resolving conflicts, speeding up solutions, and keeping projects on time and on budget. However, poor interoperability and data management costs the building industry approximately $15.8 billion a year, or approximately 3-4% of the total industry turnover (Gallaher et al. 2004). Building information modeling (BIM), a modeling technology and associated set of processes to produce, communicate, and analyze building models (Eastman et al. 2008), is seen as an enabler that may help the building industry to improve its productivity.

Yet, although BIM has been on the market for a number of years, it has not been adopted industry-wide to its full capacity. As of 2009, approximately half of industry representatives do not use any BIM software on projects in the U.S. (McGrawHill 2009). The technology, process, and organizational investments required to implement BIM are costly, and adopting BIM requires substantial changes to how the industry traditionally designs and builds projects (Becerik and Pollalis 2006). An increase in the availability of financial information will be significant, as one of the primary motivators for professionals in the building industry to adopt new technologies is the opportunity for direct benefits in their own operations (Bjork 2003). As the building industry implements BIM, decision-makers and end users need a benchmark to understand the value of BIM for their organizations and projects. This paper focuses on the first part of a four-phase research plan, presenting findings from a survey that aims to understand the perceived value of BIM in the U.S. building industry and thus to provide a benchmark for future studies.

2. MOTIVATION

Leading-edge companies all over the world in all industries increase their overall information technology (IT) expenditures by double-figure percentages annually (Zee 2002). Managers often need to prove that an investment will produce a return before they receive the money to spend on new systems and processes. In the building industry, IT investment evaluations are complicated by the fact that each project is unique in terms of its characteristics (e.g. financing, interorganizational relationships, end user requirements). Metrics to measure the rather complex causal chain affecting overall cost savings and quality improvements have still only been sketched at. Moreover, reliable measurements with large enough data sets to isolate the effects of learning curves, external factors, or project-specific attributes are missing (Bjork 2003). What makes IT investment evaluations even more complicated for the building industry is that there are no benchmarks to build on or measure from to provide meaningful comparisons.

Specifically with BIM, there has been a lack of consistent financial benchmarking associated with the conversion from CAD to BIM, let alone from BIM to BIM process enhancements and innovations. The problem is that IT has often been implemented as an act of faith, without a full understanding of how business values from investment can be shown (Baldwin et al. 1998). Building industry participants feel sure that there must be benefits, but they have neither been able to predict what these benefits are nor been able to measure them after the investment has been made, frustrating all those interested in pushing the technological state of the art forward. In addition, IT investments are often characterized as being extremely hard to evaluate due to difficulties in quantifying the relevant costs and benefits, as well as due to the high degree of uncertainty with respect to the expected technology value. Many of the benefits fall into the semi-intangible or intangible category (for example, improved product quality, better decision-making capabilities, increased availability of data) and therefore lack the weight of clear revenue improvements. Confidentiality roadblocks that are also common in the building industry remain a large impediment to data collection. The lack of a framework to measure the value of IT (Svavarsson, et al. 2002, Brynjolfsson 1993) and the resulting skepticism (Keen 1991) cause resistance from the industry.

3. PREVIOUS STUDIES

The advent and proliferation of BIM in the building industry has produced a wealth of information related to its use and implementation. There are numerous case studies (Khanzode et al. 2008, Eastman et al. 2008, Khemlani 2004, Kymmell 2008, Gerber 2007, Kam et al. 2003) that provide anecdotal evidence to support the idea that the use of BIM makes the building process more efficient and effective. They present the following benefits: accurate and consistent drawing sets, early collaboration, synchronized design and construction planning, clash detection, model-driven fabrication and greater use of prefabricated components, support of lean construction techniques, and streamlined supply chain management. However, these case studies provide insight into singular situations; they fail to provide a complete and comprehensive list of benefits and associated costs, and they rarely assign quantitative values.

Even though the value of BIM is a topic currently discussed heavily in the industry, research shows that most construction organizations do not employ a formal methodology to evaluate the benefit of IT investments, and formal cost-benefit analyses are not widely used (Sulankivi 2004). McGrawHill (2008) addressed this issue briefly in its SmartMarket report published in 2008 and emphasized the importance of tracking return-on-investment metrics for BIM. Recently, McGrawHill (2009) published a SmartMarket report on the business value of BIM. While this report specifically explored BIM's value proposition, its focus is mostly on the semi-tangible and intangible benefits and it doesn't provide specific facts on benefits that are quantifiable in monetary terms. BIM software vendors also highlight the positive return on investment for BIM solutions. BIM vendors' in-house staff (who may not be sufficiently objective or may be inadequately trained) or outside consulting firms hired by vendors usually conduct these value studies. Professional organizations have also conducted surveys on the use of BIM in the past. FMI and CMAA released the Eighth Annual Survey of Owners (2007) in which they surveyed owners and specifically asked them to rate benefits that BIM solutions provide to their capital construction projects. Although this report is significant as it explores the problem from owner's point of view, its scope is limited in terms of BIM value proposition.

The value of BIM is also a challenging topic for many in academia. Gilligan and Kunz (2007) focused on the rate of adoption of BIM and of virtual design and construction (VDC) and the effects of that adoption process. They established several value groups including benefits, unintended consequences, and benefit impediments for BIM use, but they did not try to assign values to these items. Sacks and Barak (2008) studied the effects of BIM on three-dimensional parametric modeling productivity through experiments in which parallel activities were completed in 2D and 3D. While the study gives real insight into the hours expended for the tasks, it does not take into account the costs of software implementation and focuses on the problem from the productivity point of view only. Additionally, Mitropoulos and Tatum (1999) studied how industry professionals make decisions about technology adoption and the monetary impacts of these decisions, but they did not specifically focus on the outcomes. Recently, Suermann and Issa (2009) focused on industry perceptions of BIM's impact on construction. In this study, the authors focused on BIM's impact with respect to six construction key performance indicators only. These were safety, cost, cost per unit, units per man-hour, duration, and quality.

Finally, there are several research papers on the distribution, data collection, and results of surveys on IT value measurement for different countries (Rivard 2000, El-Mashaleh 2007, Samuelson 2008, Howard et al. 1998). While these studies provide insight into survey techniques and IT value in the building industry in general, they do not focus specifically on BIM. These studies were analyzed in detail during this survey's methodology development stage.

4. RESEARCH GOALS

Although this topic has attracted attention in the industry as well as in academic research and the private consulting industry, an objective, comprehensive, and quantitative study is still needed to:

- Establish a benchmark for costs and benefits associated with BIM implementations so that the "value" over time can be measured;
- Explore how BIM investments have been valuable for the building industry;
- Enable an organization with limited resources to understand how BIM could positively contribute to their profits and what some of the cost factors for BIM implementation could be.

IT benefits could be categorized in three areas: (1) tangible benefits: quantifiable in monetary terms; (2) semi-tangible benefits: quantifiable, but not in monetary terms; and (3) intangible benefits: non-quantifiable, described qualitatively (Sulankivi 2004, Becerik 2006). This paper focuses on the first phase of a four-phase research project, trying to identify and benchmark tangible benefits and costs associated with BIM use. Following phase one, the next phases will focus on: identification and benchmarking of semi-tangible or intangible benefits along with reassessment of tangible benefits; detailed case studies of real-world examples that will focus on the research question from different team members' point of view; and development and validation of a value analysis tool.

5. METHODOLOGY

The study began by focusing on a single project with two phases: the new buildings at the School for Cinematic Arts at the University of Southern California. The authors started attending weekly project team meetings and followed up by interviewing the project team members. Through these meetings, interviews, and the team members' insights, it became clear that the use of a survey would be the most effective method of data collection, as it provides anonymity and confidentiality and allows for data collection from a large constituency within the industry.

The survey was developed with information derived from interviews, research, and literature reviews. The type, amount, and configuration of questions were refined in a series of iterations between January 28 and March 13, 2009. A preliminary draft of the survey was sent to industry experts for a clarity check. A first round of surveys was distributed among a number of industry colleagues in the week of March 16, 2009. These results were primarily analyzed for data clustering as a result of inadequate response ranges. The survey was revised and subsequently distributed to the recipients by professional organizations, participating software vendors, and through newsletters, forums, and blogs, from March 29 through May 8, 2009. A total of 424 respondents completed the survey.

The survey invitation text and link were distributed via professional organizations' or vendors' email lists/announcements, embedded with other topics, and it was also posted in discussion boards and forums. No personalized and direct emails were sent. Although the survey was distributed to a vast number of respondents, not all recipients clicked on the link provided in announcements, discussion boards, or forums. Two of the distributors were able to track how many recipients opened the link to the survey. Of these two, one reported that less than 0.1% of recipients clicked on the link; the other presented a more detailed report. Their numbers demonstrate that 11.2% of recipients opened the email, and of those 29.8% clicked on the survey link (that is, the link was clicked by the recipient in 3.3% of the total number of emails sent by the distributor). Also, the authors anticipate that a respondent might have received the survey link from multiple organizations or groups. It is hard to accurately estimate how many potential respondents this survey was distributed to, and therefore what the actual return rate was.

The survey is broken down into four sections with a total of twenty-two questions. The first section focused on general questions related to the type of firm, software they use, and patterns of BIM use. The second section was project-specific and focused on descriptive information for a particular project selected by the respondent. Sections three and four concentrated on the costs and the benefits of BIM, respectively. Respondents were asked to choose a specific project in which they have used BIM software and answer the questions related to BIM benefits/costs. In order to maintain some confidentiality, cost- and benefit-related questions primarily asked for percents in relation to the overall project costs. When asked to compare or give percentages, they were asked to use either another similar project in which BIM was not used or an aggregate of their personal experiences on non-BIM projects.

6. SURVEY FINDINGS

6.1. Respondent Profiles

The survey had 424 complete responses. Figure 1 categorizes the total respondents by discipline, and figure 2 by region. Even though the survey was distributed to all types of firms, most of the respondents worked for architecture and engineering firms. Seventy percent of the respondents are in senior management positions (presidents, vice presidents, chief-level positions, principals, associates, directors, and managers). This could be attributed to the high interest in the topic from these groups. Ninety-nine percent of the respondents were based in the U.S., in 27 different states. The US West Coast has the highest concentration of BIM users (McGrawHill 2009). The most frequent response by state was from California, with 44% of the total.

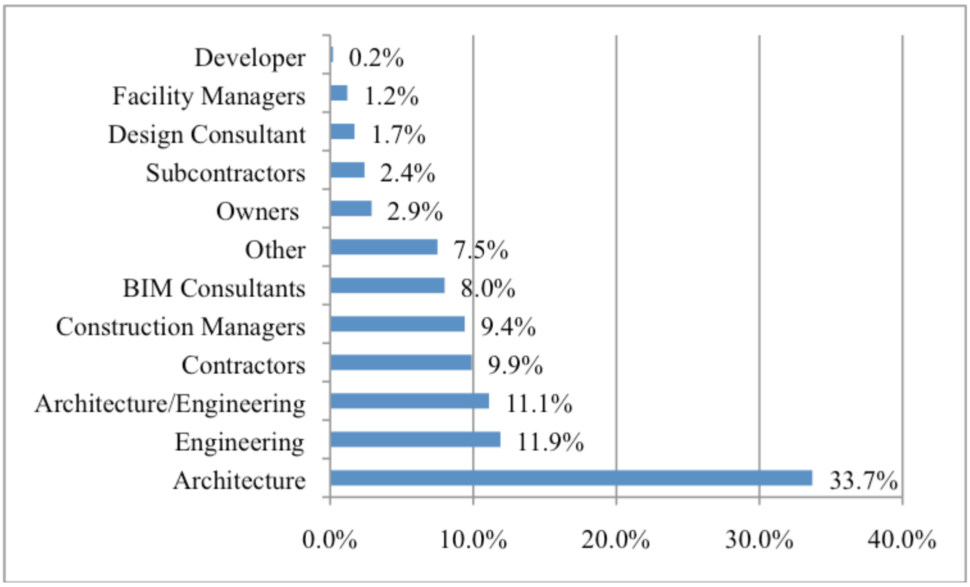

FIG. 1: Respondent profiles by occupation

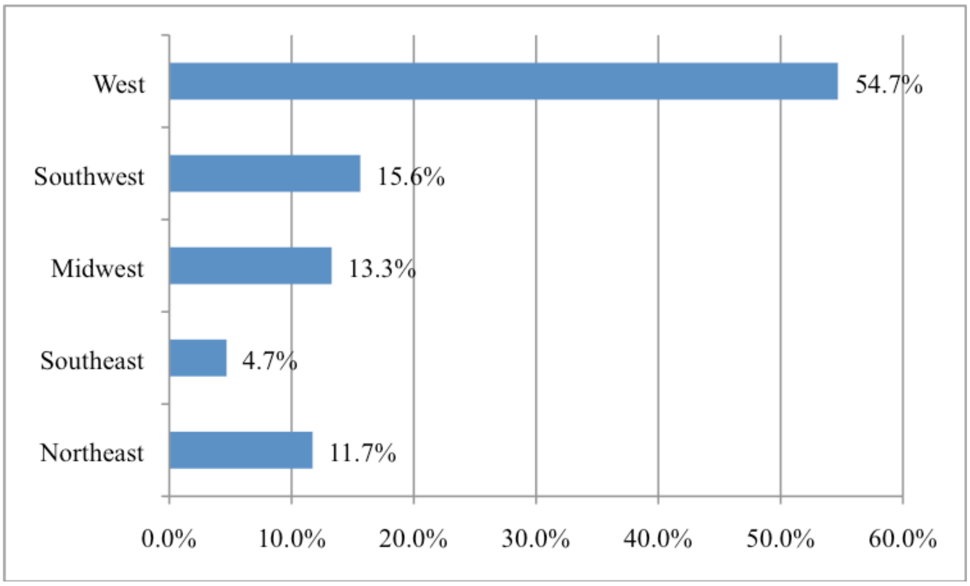

FIG. 2: Respondent profiles by region

6.2. BIM Project Profiles

Respondents were asked to choose a specific project and answer cost- and benefit-related questions with that particular project as a reference point. Although there are some civil/heavy civil project implementations of BIM, current BIM usage is focused on a variety of building types. The findings don't suggest that BIM solutions are more applicable to one type of building than another. By value, these projects primarily fell into the less than $20 million range (45%), followed by more than $100 million (29%) based on the survey data. Based on the comments provided by the respondents, BIM is more suitable for larger projects.

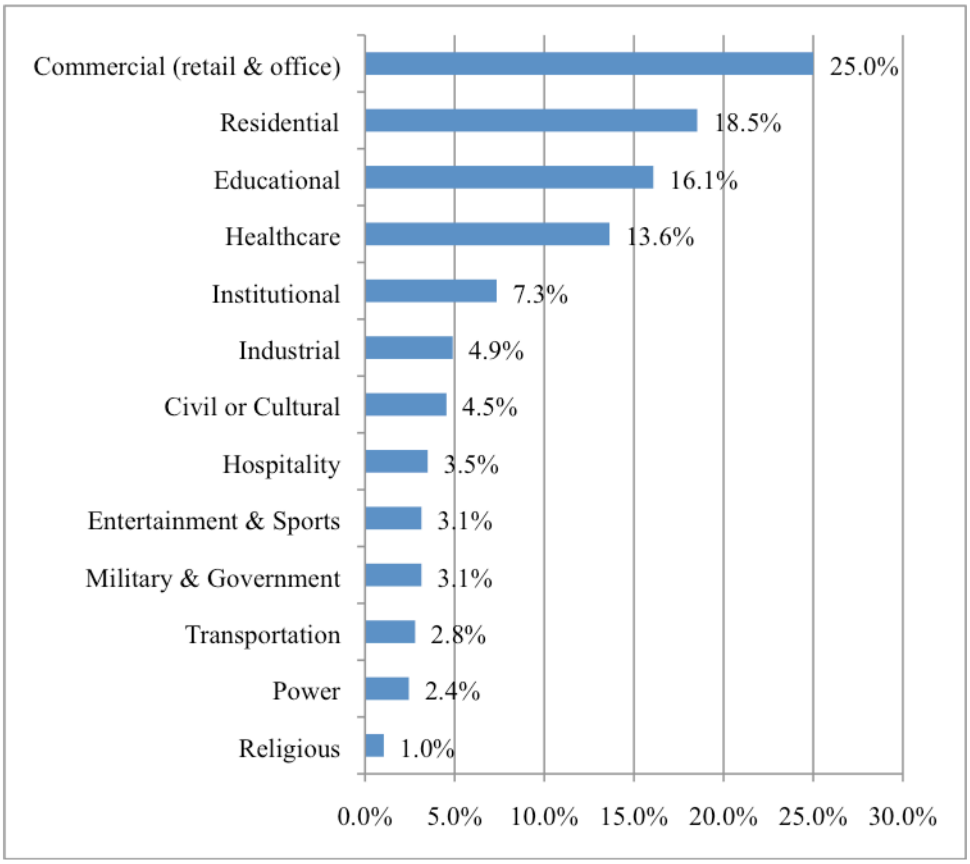

FIG. 3: Type of projects for which the respondents answered cost/benefit-specific questions

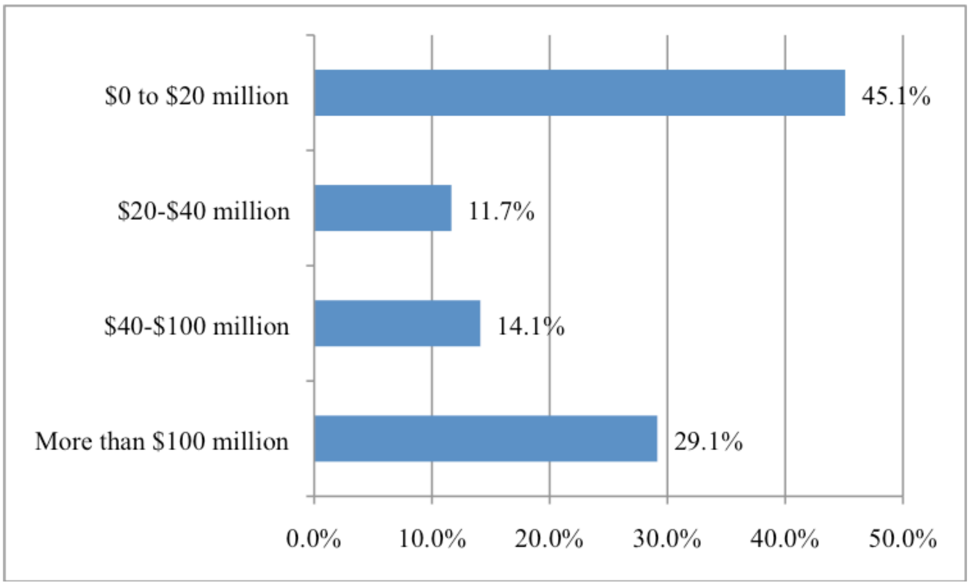

FIG. 4: Total value of projects BIM is used for

Although the traditional design-bid-build delivery system is still the most widely used delivery system for these projects, it is interesting to note that many of the projects are delivered under more recent and collaborative delivery methods, including design-build, integrated project delivery (IPD), performance-based contracts, and project alliancing. IPD is cited by the respondents as the most effective project delivery method in facilitating the use of BIM for construction projects. IPD attempts to create the collaborative atmosphere required for the most comprehensive use of BIM by aligning the goals of all team members and incentivizing them to work closely together throughout all phases of a project (AIA 2007). The coupling of BIM with IPD enables a level of collaboration that not only improves efficiency and reduces errors but also enables exploration of alternative approaches and expansions of market opportunities (Middlebrooks 2008).

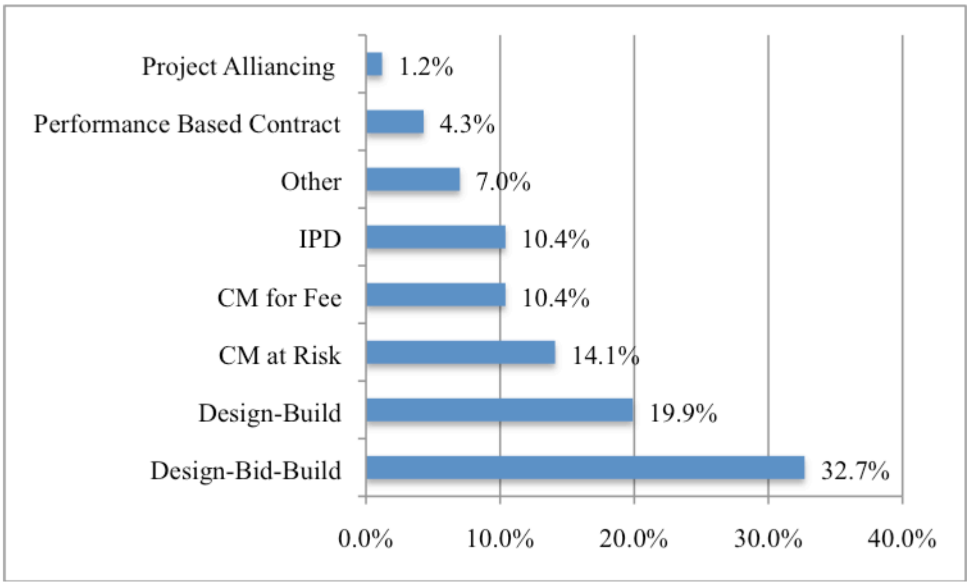

FIG 5. Delivery methods used for projects

6.3. Adoption of BIM

Almost two-thirds of the respondents use BIM on more than 60% of their projects. The rates of use tend to fall at the two ends of the spectrum; most respondents used BIM either for less than 20% or for more than 80% of their projects. Almost 23% of total respondents indicated that their firm uses BIM on 100% of their projects. However, one-third of the respondents use BIM on less than 20% of their projects. In part, this reflects the fact that BIM still is a new technology to many users. These results might be a representation of where the industry stands in terms of BIM implementation. At the high end of the spectrum might be the innovators and early adopters, and an early majority might be following the innovators. Of different firm types surveyed, architecture firms, who were early adopters of BIM technology (McGrawHill 2009), remain the highest users of BIM; one-third of the architecture firms use BIM for 100% of their projects.

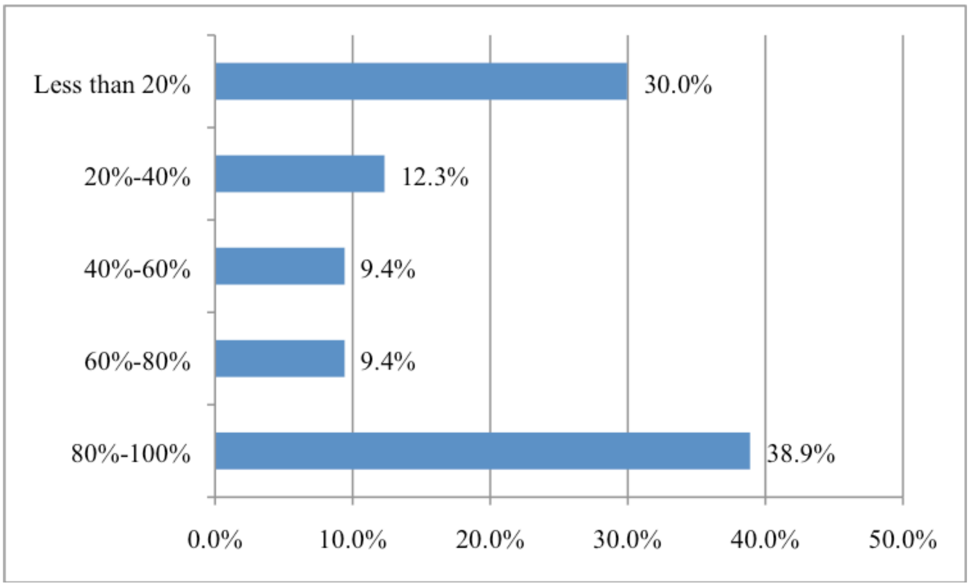

FIG. 6: Percentages of projects for which BIM software is used (for all categories of firms)

Today, there are numerous BIM authoring and analysis tools available to the building industry. AutoDESK BIM solutions are widely used in the U.S. building industry, based on the survey results. Graphisoft Archicad follows with 11% and Bentley BIM solutions with 8%. Contractors utilize a broader range of BIM solutions than architecture firms (which use mostly BIM authoring tools). Almost one-third of the engineering firms use Tekla.

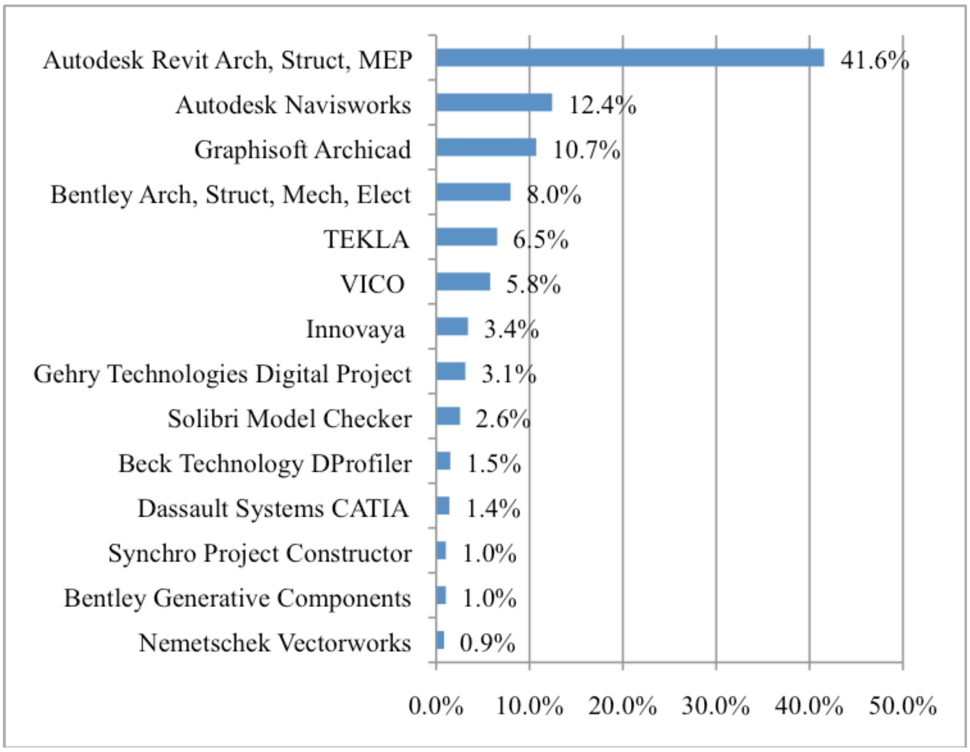

FIG. 7: BIM solutions used by respondent firms

Respondents were asked which tasks they used BIM for on the chosen project. Visualization (rendering, 3D presentations, model walk-throughs, etc.), clash detection, and building design were the top three tasks BIM is used for, with roughly equal rates of use. Architecture firms use BIM heavily for design-related functions such as building design, visualization, and programming/massing studies. Contractors' top three BIM use areas were clash detection, visualization, and creation of as-built models. Exploration of a building as an assembly of architectural objects and sub-assemblies was also among the top five uses of BIM software overall. Use of BIM in direct fabrication, where BIM replaces traditional shop drawings and drives fabrication equipment, is still limited; however, almost one-fourth of the respondents utilize BIM for direct fabrication. Research shows that BIM has limited impact on green building processes today, but it may become a valuable tool in the coming years. More specifically, only a few users (19%) are currently getting a high level of value from it for environmental analysis, which is a key process in building performance. In addition, there is only a limited use of BIM to assist Leadership in Energy and Environmental Design (LEED) certification compliance. LEED is a certification system used in the U.S. for environmentally sustainable buildings. Only 15% of the respondents indicated that they used BIM for LEED certification. Again, this may change, especially if owners seeking LEED certification embrace BIM. Although the arguments for the benefits of using information from BIM for building lifecycle management are compelling, the use of BIM for facilities management (FM) is still limited, with only 16% of the respondents confirming their use of BIM in FM functions. Moreover, though BIM can easily be adapted for forensic analysis to graphically illustrate potential failures, leaks, or evacuation plans, based on the survey results forensic analysis is the least used BIM task.

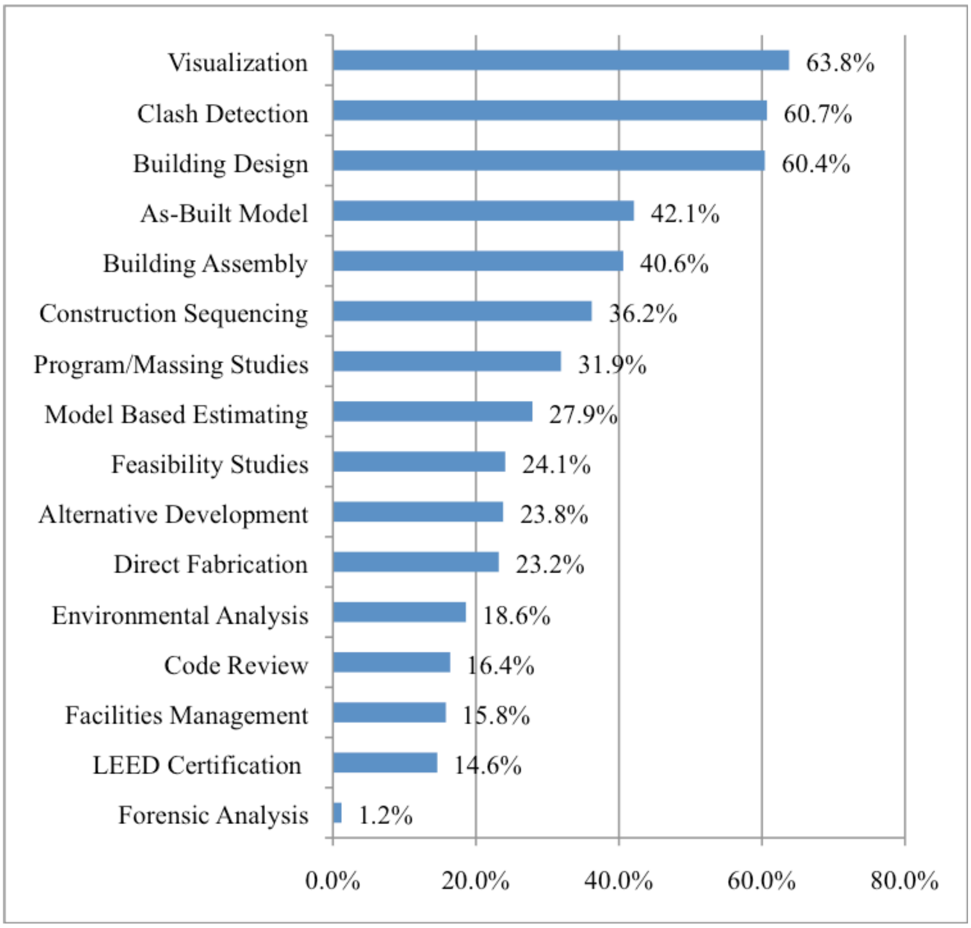

FIG. 8: Tasks is BIM used for

While 38% of respondents have used BIM on more than 10 projects, surprisingly 18% (the next largest category) responded "none, this is the first one." Architects are the most experienced group in terms of number of projects BIM has been used for. Fifty percent of architects have used BIM software for 10 or more projects, and only 9% said this is their first BIM project. The group with the next most experience is contractors: 32% have used it on 10 or more projects, but 24% said this is their first BIM project. Contractors are getting more experienced in BIM faster than any other group, as more users discover the value of BIM beyond the design process. The group least experienced with BIM software is construction managers; 35% were using BIM software for the first time, 24% have used it on 1-2 projects, and only 4% have used it for more than 10 projects.

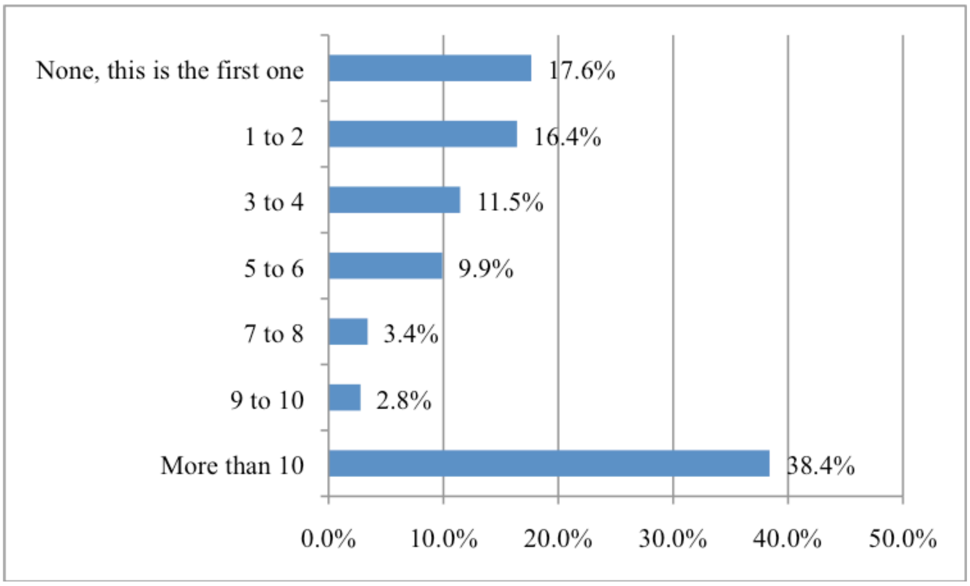

FIG. 9: Number of projects the respondents used BIM software for

In order to assess respondents' BIM experience level, the survey asked how much of their time they spent on tasks that require hands-on BIM experience. Almost one-third of the respondents spent less then 20% of their time on BIM-related tasks. When different firm types are analyzed, construction managers have the least hands-on experience; 70% of construction managers spent less than 20% of their time using BIM, followed by 42% of the general contractors. An interesting trend for these two firm types is that they either used BIM for less than 20% of their projects or in more than 60% of their projects. Architects again have more hands-on experience with BIM than the other disciplines.

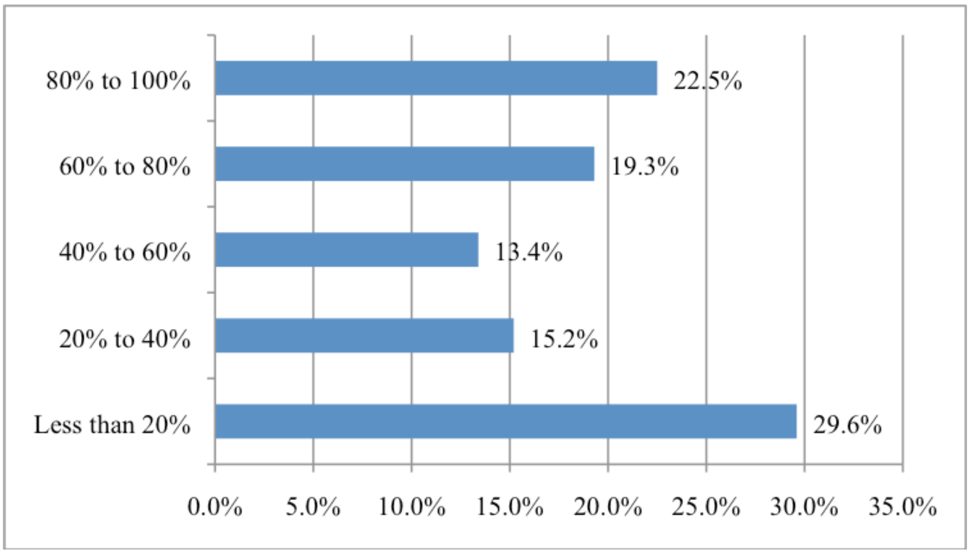

FIG. 10: Time spent on tasks that require hands-on BIM experience

6.4. Costs

The survey investigated tangible costs associated with outsourcing of BIM tasks, staff and space requirements, and hardware, software, and training. While these costs are certainly not the only factors contributing to the perceived value, they are among the easier ones to find and quantify.

Most firms handle BIM tasks in-house. The study shows that relatively little is being spent on outside BIM consultants, with 59% saying they hired no consultants at all. Another 31% of the respondents said that 1% to 5% of total job cost was spent on outside BIM consultants. When analyzed in detail, 19% of total respondents said consultant hiring added less than 1% to the total job. When different firm types are analyzed, the general trend of handling BIM tasks in-house doesn't change. However, contractors and construction managers were more likely to outsource BIM work than architects and engineers.

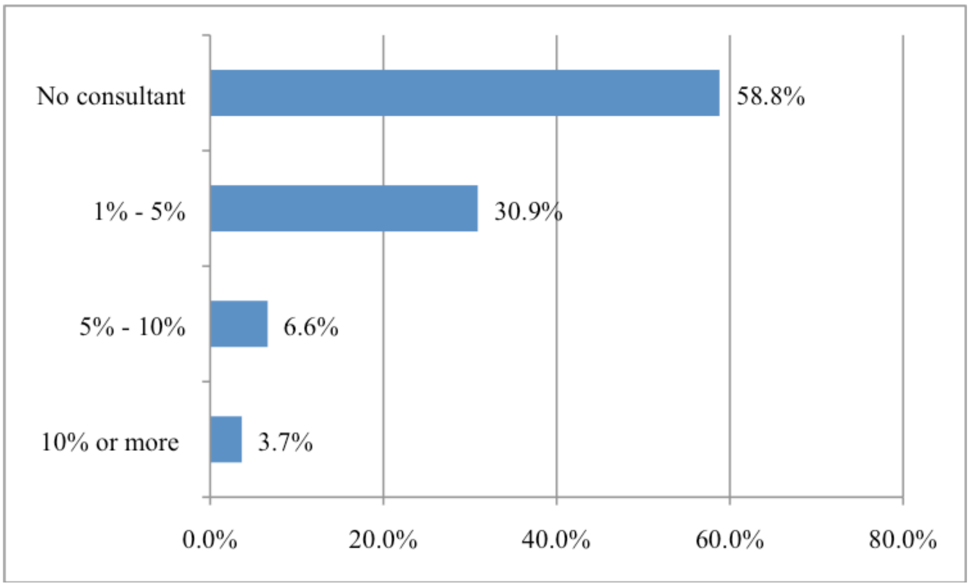

FIG. 11: Percentage of total project cost that spent on outside BIM consultants or BIM outsourcing companies

A large portion of respondents said BIM use had no impact on staff or office space requirements. Fifty-nine percent of the respondents indicated that it caused no changes in space needs, and only 11% of the respondents indicated that they actually could decrease their space because of BIM use. This could be a result of how difficult changing office locations can prove to be. Additionally, when companies realize a reduction in space requirements, they may not move in hopes of re-expanding into their current location. Twenty-one percent of the respondents found that they need less staff because of using BIM, while 13% of the respondents reported that they needed more staff. Again, the majority (41%) reported no change in their staffing requirements. The survey results clearly enumerate that while there are some reductions in these areas, it is unlikely that BIM will really provide a cost savings to the individual company through changes in staffing or space needs. In the future, the survey will seek to equate staff productivity or output per unit as a measure, as this is a critical factor in measuring the value of BIM.

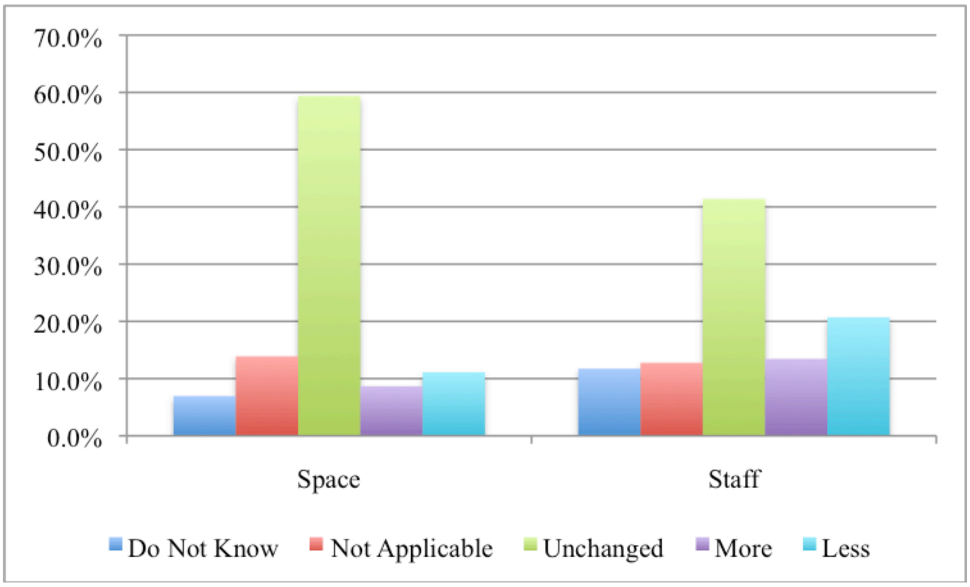

FIG. 12: Change in space and staff requirements

At the core of the problem of measuring the value of BIM, one must consider the effect of BIM implementation costs on fees. Based on the survey results, the industry is unable to pass on the costs of the implementation and use of BIM to clients, either through fees or direct client participation. Around 85% of the respondent firms are absorbing the costs of BIM software, software upgrades, hardware, hardware maintenance, and training. Less than 4% report that owners are directly covering any of these costs. Anecdotally, it seems that owners are asking for BIM, but that they consider many of the costs as retainable and reusable. Therefore, if the owner is not a frequent builder, they do not invest in these perceived expenses. Roughly one in ten of the respondents pass the costs on to owners through fees. As it stands now, the cost of BIM is primarily borne by architects, engineers, and contractors. Although the results don't change dramatically when different firm types are compared, architecture, engineering, and A/E firms absorb each of these costs more than contractors and construction managers.

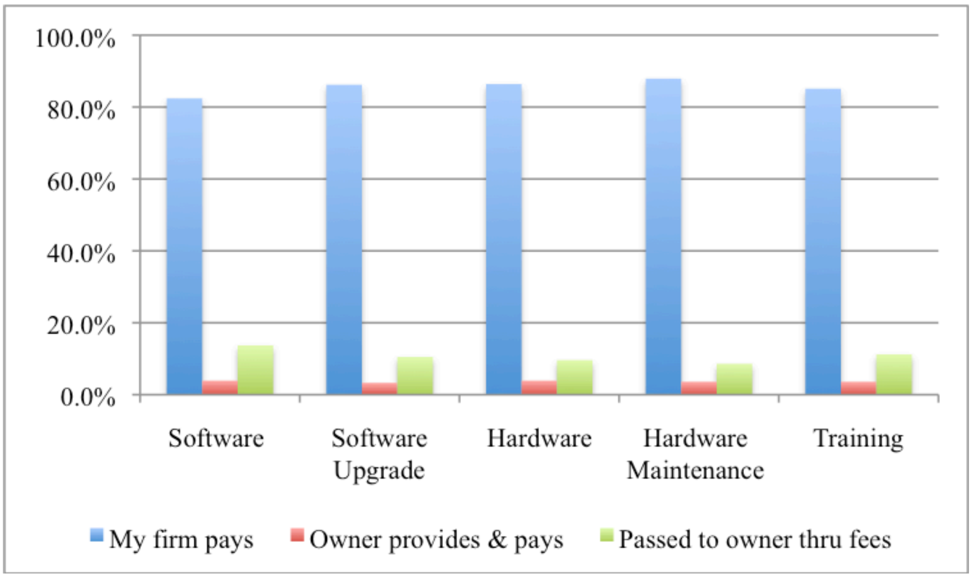

FIG. 13: Who pays for software, software upgrades, hardware, hardware maintenance, and training costs

However, the majority of the respondents spent less than 2% of their net revenue on software, software upgrades, hardware, hardware maintenance, or training. Comparatively, software and hardware costs contributed the most to overall expenses, whereas software upgrades and hardware maintenance costs are less than 0.5 of overall net revenue of the firms. Training is a critical investment for successful BIM implementations, as training issues have been the greatest hurdles on the path to BIM adoption (McGrawHill 2009). Based on the survey findings, respondents have recognized this issue and firms are providing training to their BIM users.

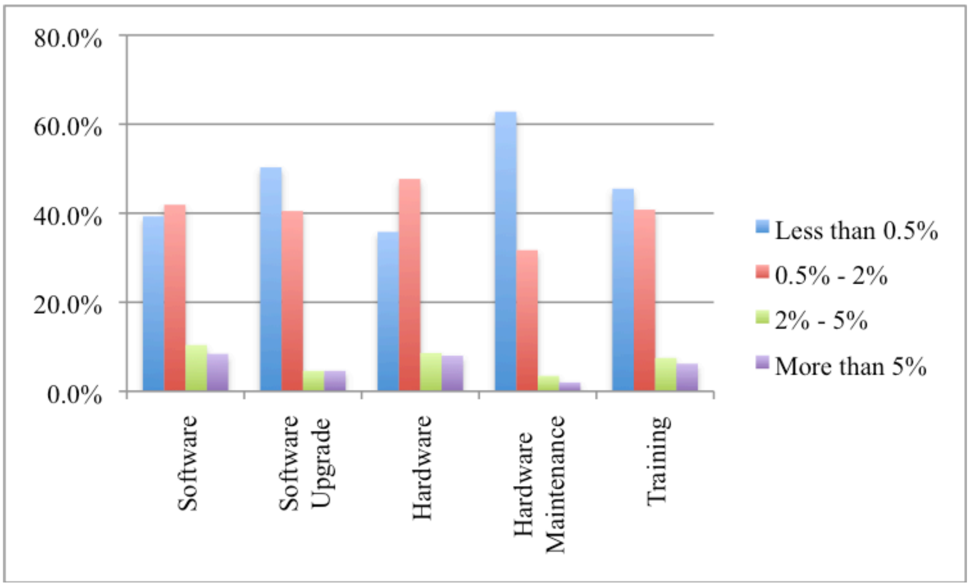

FIG. 14. Ratio of software, software upgrades, hardware, hardware maintenance, and training costs to overall net revenue

6.5. Benefits

One of the objectives of this survey is to find out how use of BIM affects project profitability. Around 41% of the respondents realized an increase in overall project profitability with the use of BIM, while 12% of the respondents reported that there was a decrease. For firms that indicated more experience in implementing BIM, their return was likely to be higher. The results support this argument—of the respondents who are implementing BIM on 100% of their projects, 73% found an increase in profitability and only 3% stated a decrease, an anomaly one would expect given the uniqueness factor within the building industry. The initial model setup is time-consuming because the software forces the design to be modeled early on, translating into a disproportional time spent in schematics and early design stages compared to the standard process in drafting software. Others believe that BIM software has little effect on overall project success or profit, which is mostly a function of project management, fee and contract negotiation, and client and contractor cooperation. They have found that BIM's advantages are typically involved in marketing, conceptual design, construction document creation, and the ability to offer visualization services. Respondents who are implementing BIM for the first time think that they are making a huge investment to embrace the technology and that their profitability is affected negatively. Nevertheless, they indicated that they are learning from this experience and hoping that they will leverage the initial investment for subsequent projects.

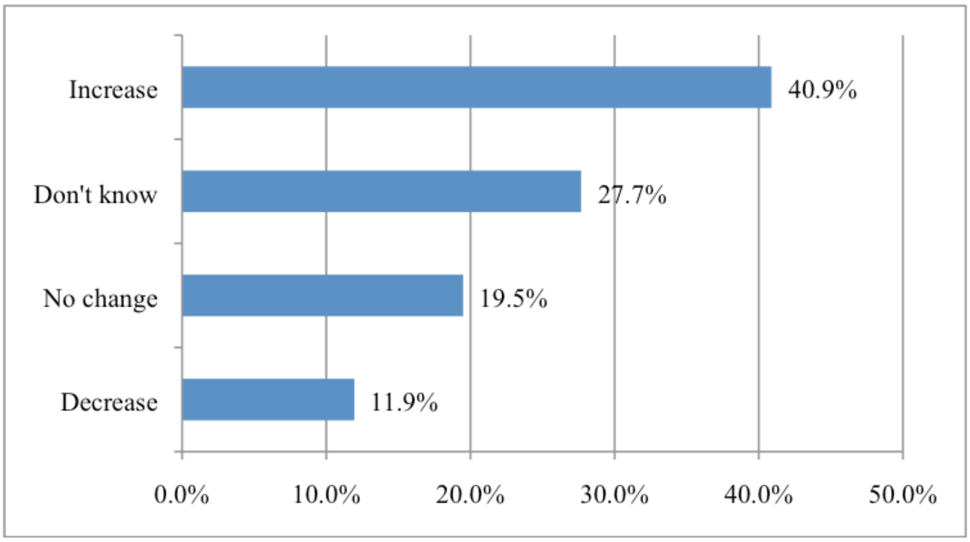

FIG. 15: Effect of BIM use on project profitability

The reduction of both project duration and associated costs contributes in some part to project profitability. A majority of the respondents (55%) said BIM helped cut project costs, with 50% indicating project costs were reduced by up to 50%. Fifty-eight percent of the surveyed industry professionals found that overall project duration was reduced by up to 50%. This is quite substantial when you put it in terms of how long projects can take and their costs. If a project takes four years from conceptual design to occupancy and you reduce that time frame by a quarter, you save an entire 12 months; if it is reduced by 50%, you save two years. While these are numbers at the higher end of the surveyed spectrum, even the mid-range is remarkable—at a 12.5% reduction, there is a saving of 6 months.

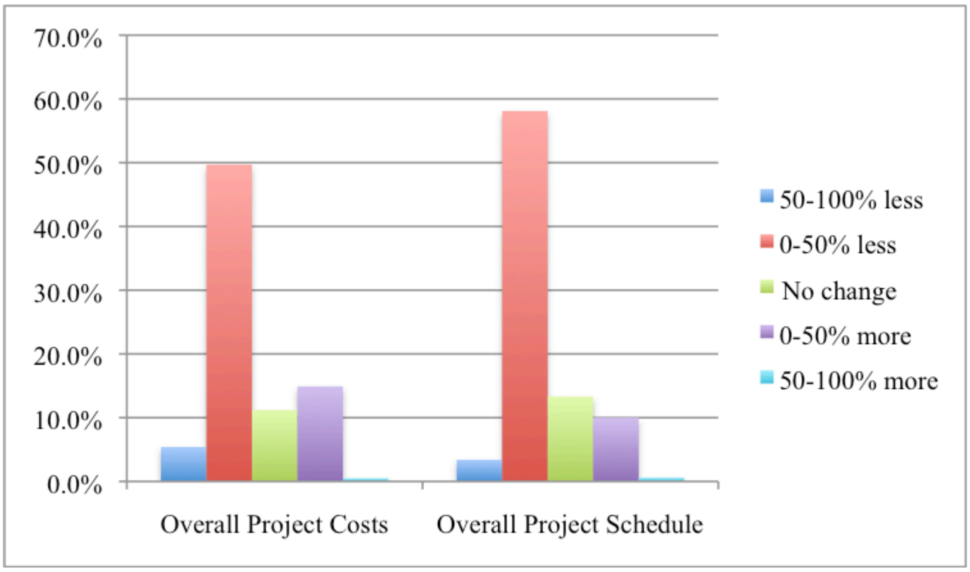

FIG. 16: Overall project cost and schedule changes because of the use of BIM

When project phase durations are analyzed, schematic and conceptual design phases take slightly longer when BIM is used, while the duration of the detailed design phase is reduced. Overall, 48% of the respondents think that the detailed design phase takes less time with BIM, whereas 31% think this phase takes more time. This could be attributed to the fact that BIM projects require more time to set up and additional services might be added during the early design phases. Some of the respondents commented that BIM is forcing them to model more than they anticipated. Others commented that they have not noticed any change in design as it is a purely creative venture that is not aided or hindered by technology. Almost all respondents agree that the construction drawings phase is almost non-existent when using BIM. One of the major benefits of BIM is coordinated design drawings; any change done to the model is propagated at the database, therefore there is no need to update drawings individually. In addition, many BIM solutions automate the drawing sheet setup. There was a consensus that the quality of the documents produced is improved substantially when BIM is used. There are fewer errors and omissions and the use of BIM increases accuracy of documents, albeit with additional upfront effort. Respondents also agreed that these improvements are realized as benefits in the construction phase as well as in overall project costs. There is a substantial difference in the value added to the project in the way of presenting design options, design visualization, quantity takeoff, and discipline coordination.

While 44% of the respondents think that there is no change to bid preparation time with BIM, 47% think that the bid preparation phase takes less time, whereas only 9% think this phase takes more time. Though there is a reduction of duration at most stages, the most substantial one is in the construction phase, with approximately 58% of respondents reporting a reduction in duration then, whereas only 6.8% think this phase takes more time. Comments provided also support that the construction phase takes less time due to the coordinated documents with fewer errors and omissions. Each one of these small or large reductions adds up to an overall reduction that is noticeable and impacts return on investment. The survey results suggest that time reduction is possible for all types of project team members and at all phases of the project.

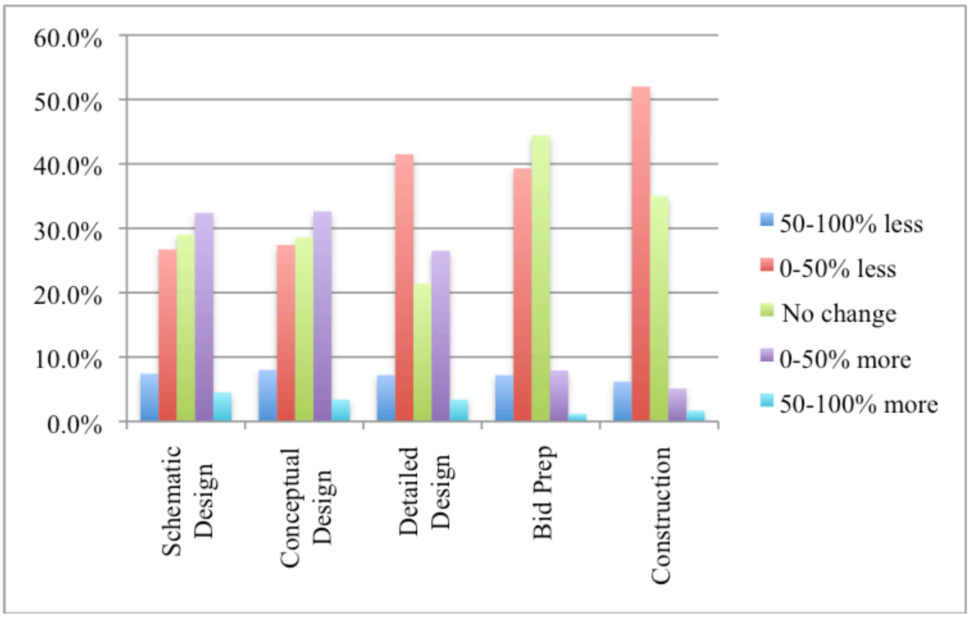

FIG. 17: Changes in project phase durations because of BIM use

The majority of the respondents realized "no change" in printing, document shipping, and travel costs. Of those who did see a change in these costs, however, most reported a decrease, so that BIM use evidently has a positive impact on costs in these categories. Several commented that travel costs actually increased by choice, because they can get more work done faster and are better coordinated because their client contact has increased. While these categories might be a small percentage of project cost, any cost reduction that is a byproduct of a process change (BIM implementation) should be surveyed and factored appropriately into value modeling and benchmarking.

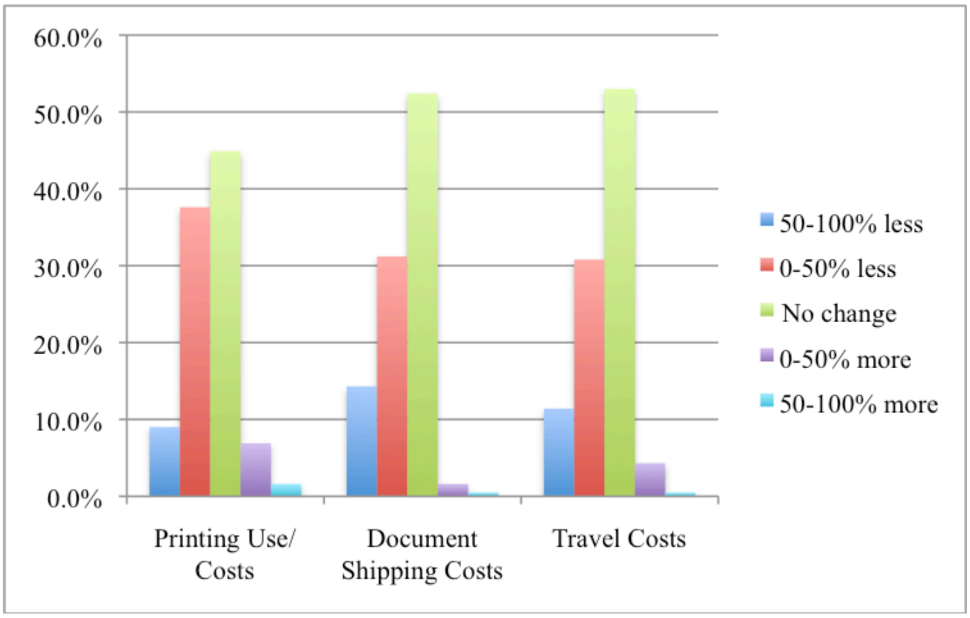

FIG. 18: Changes in printing, document shipping, and travel costs because of the use of BIM

The survey also examined the ratio of dollar amounts of approved change orders, claims and disputes, and correcting errors and omissions to overall project costs. Overwhelmingly, each of these expenses cost less than 0.5% of the total project cost, according to the respondents.

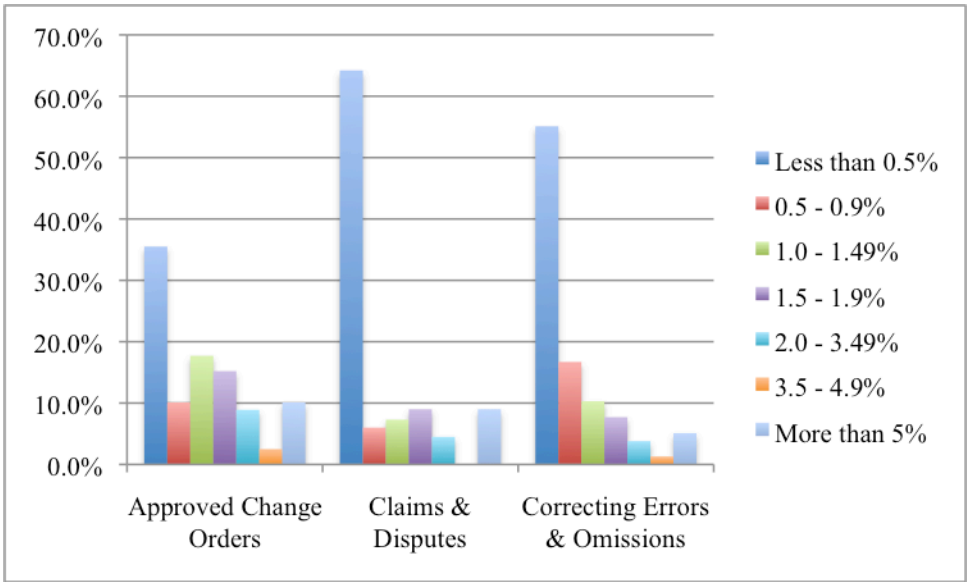

FIG. 19: Ratio of dollar amounts of approved change orders (unrelated to owner requested change orders), claims and disputes, and correcting errors and omissions to overall project costs

7. DISCUSSION AND CONCLUSIONS

While this survey represents a first step towards understanding and benchmarking the realized value associated with the use and implementation of BIM, there are several avenues that should be pursued further. Some were not addressed in the survey at all, for example, the intangible and semi-tangible benefits and costs associated with BIM. These benefits would be better examined in detailed case studies with extensive interviews and concurrent project documentation. Additionally, the concept of cost avoidance as a means of savings was not analyzed in detail. Some of the respondents themselves elicited additional questions, for example, which types of projects are more profitable and why? Are the benefits amplified for higher-value projects? What other costs are being reduced to see the overall reduction in projects costs? More importantly, the value of BIM for each discipline should be explored in detail, as the value to the owner is different from the value to the contractor or to the architect. Further study of the value of BIM to the owner is a must. In addition, it would be worthwhile to distribute the survey internationally to analyze use and value of BIM for different world regions. Finally, the survey or versions of the survey could be distributed at future points in time to compare the progression of change in the costs and benefits as the industry as a whole becomes more proficient and experienced with BIM software and process (Samuelson 2008).

It is important to note that several respondents commented that it is too early to determine the value of BIM, as the industry is still at its early stages of BIM adoption. According to these respondents, in order to effectively study the value of BIM and for significant returns on investment to be noticed, a time frame of 5 to 8 years is needed. Many firms are still working on initial deployment of BIM, and even though there are some efficiencies achieved such as consistency, accuracy, availability, and coordination of project information, there are still huge and steep learning curves, as well as generational differences in those that are ready to adopt and make the investment. Many believe that as BIM use is still limited, the true value of BIM has yet to be achieved. Models, metrics, and benchmarks need to be researched and made available to the industry as a whole.

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