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Building Information Modeling (BIM) technology adoption and implementation in the Sri Lankan Construction Industry - The diagnosis

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Abstract

The first of a two-part study to assess the adoption and implementation levels of Building Information Modeling (BIM) in the Sri Lankan Construction industry was designed using both quantitative and qualitative inquiries. The research conducted was an assessment of the existing conditions which is referred to as the diagnosis phase of the project to be used as a foundation for further study and exploration in the second phase; the prescription phase. The focus on the diagnosis phase was to better understand the industry environment for implementing technologies that takes into account the opinions and expertise of the different construction professional disciplines, including Design, Engineering and Project Management disciplines and also examines the perceived challenges to the adoption of BIM as shared by these professionals through an online survey and multiple personal interviews. Existing conditions of the construction industry in Sri Lanka were also studied in attempting to understand the background of perceived challenges and they were considered in the proposed preliminary strategies recommended in this paper for further exploration in the second phase of this study.

Key Words
BIM, Sri Lanka, adoption, construction industry, survey, interviews

1. Introduction

This paper is the first part of a two phase study that is targeted at understanding the state of the Sri Lankan construction industry in adopting Building Information Modeling (BIM) technology and sets the foundation for further exploration and study through a secondary phase which would explore potential strategies to improve and increase the adoption and implementation of BIM in Sri Lanka. BIM is a growing phenomenon within the construction industry and can be simply described as a platform that uses technology to enhance and create efficiency and productivity in construction management processes. These processes include all phases of construction including pre-construction, physical construction and facility management. This study conducted in the Civil Engineering & Construction Management department of Georgia Southern University was crafted through multiple discussions with industry professionals, including VDC Directors and BIM experts from renowned general contracting firms and many BIM technology software development companies in the United States of America. It was strategically designed to assess the level of adoption and implementation of BIM in the Sri Lankan construction industry and employed a mixed strategy of both quantitative and qualitative

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inquiries to derive results that would help the researchers in understanding the current state of implementation and further develop strategies to increase adoption and implementation of BIM in the Sri Lankan construction industry. The study also partnered with local contractors to gain inputs from their experiences and understanding of the Sri Lankan construction industry. When beginning the work on this research project, the student author (who is from Sri Lanka) was aware of many of Sri Lanka's existing construction industry conditions as he had grown up in a family environment which owned and operated construction businesses in the region. However, the author and the research mentor evaluated the goals of the comprehensive research project and established ways and means of challenging these assumptions with the purpose of either validating or disproving them. The strategies employed are further explained in the methodology and research section of this paper. The researchers hope that once this two phase study is completed, it can be further used as a base for the potential development of a working strategy for BIM adoption and implementation in the Sri Lankan construction industry. They will also explore input and potential collaboration with key organizations and stakeholders of the construction industry as they will proceed with phase two of this project which will allow for more comprehensive study and analysis of the actual strategies that may be employed for increasing adoption and implementation of BIM.

2. Introduction to Building Information Modeling (BIM)

The Associated General Contractors of America describes Building Information Modeling as "the development and use of a computer software model to simulate the construction and operation of a facility. The resulting model, a Building Information Model, is a data-rich, object-oriented, intelligent and parametric digital representation of the facility, from which views and data appropriate to various users' needs can be extracted and analyzed to generate information that can be used to make decisions and improve the process of delivering the facility" (AGC of America, n.d.). However there are multiple ways of defining BIM and another of the definitions as per Autodesk, a major software developer in US, reads "Building Information Modeling (BIM) is an intelligent 3D model-based process that equips architecture, engineering and construction professionals with the insight and tools to more efficiently plan, design, construct, and manage buildings and infrastructure (Autodesk, BIM Solutions Overview, 2016).

2.1 Why is it beneficial for the construction industry?

Amidst the definitions provided above, it is important to understand that BIM is a much more complex platform that is growing in the construction industry at a very fast pace. In view of this, it is important to understand the different areas in which BIM is being used to better understand its effectiveness. The construction project process is typically broken into three distinct categories of its lifecycle and it is defined as follows:
- Pre-Construction – designing , costing, project planning and scheduling
- In-Construction – project budget and schedule management, human resource management and other resource allocations, site management (materials, equipment, safety, logistics etc.) with its various phases
- Post-Construction – facility management, maintenance and operations

Building Information Modeling as a professional's tool can be used in all of the above categories. Independent software can be used to address the different needs of each of the individual stages; the advantage of BIM is that the developers and vendors of the different software are working to increase the inter-operability of software, so that all the

relevant information can be accessed in one centralized format for streamlined communication and better project management. This is further emphasized by

Autodesk's statement on its commitment to interoperability with the support of groups such as buildingSMART Alliance and supporting the initiatives on COBie (Construction Operations Building information exchange) a BIM data standard (Autodesk, BIM Interoperability, 2013). Other BIM vendors and stakeholders have also made similar commitments to increasing interoperability within the different platforms, allowing for greater growth prospects for BIM with construction professionals' uses of a federated

BIM model and plan on projects due to increased interoperability being made available in the industry. This is a crucial component of integrating the BIM in the construction process and allowing for growth in adoption and implementation of it globally.

3. Methodology and Research

The methodology established for the study was a mixed one, which employed both quantitative and qualitative measures of inquiry and data collection. The quantitative analysis incorporated a survey that was deployed to multiple professionals in the Sri Lankan construction industry and its process can be observed in the following sections. The student researcher also organized multiple face-to-face, in-depth interviews with industry professionals to better understand their views and experience based opinions on Building Information Modeling as an approach to acquire qualitative information gathered for the study. The information was gathered and analyzed carefully by authors and the results are presented herein. The mixed strategy proved to be successful as it had compensated for areas that seemed lacking data during the course of this research project.

3.1 Research Survey

A research survey (Appendix) was prepared for deployment through an online Qualtrics platform, which is available through Georgia Southern University portal of electronic services. The survey was compiled by the student author and reviewed by the faculty mentor who then assisted with sharing the survey with multiple general contractors who are known for their use and adoption of BIM and also to software companies that specialize in the development of BIM related software, for the purpose of assessing the effectiveness of the survey from an industry standpoint. The industry review process resulted with positive and constructive feedback that allowed for better arrangement and structure within the survey and after about a month of developing and restructuring, the survey was submitted for Internal Review Board (IRB) approvals and was deployed under the survey title "BIM Technology adoption and implementation in Sri Lanka" with IRB tracking number H16177. The survey consisted of 22 questions that were developed with the purpose of understanding the respondent's professional background and expertise along with their understanding and interest in BIM while also clarifying the challenges that maybe faced in the industry when attempting to adopt and implement BIM in the respective companies/institutions. The survey was deployed to 829 professionals including architects, engineers, estimators and general contractors of the Sri Lankan construction industry with contact data obtained through professional organization directories and also through personal contacts. While the survey was well responded by the professionals who did participate, the researchers only had 59 persons who attempted the survey with only 22 persons completing the survey. Following discussions with senior professionals in the industry, the authors speculate that the lack of responses may have been due to the limited and constricted awareness of BIM in Sri

Lanka which will be further discussed through the results analysis section of this paper. The authors also wish to acknowledge that the low response (7.1%) and completion rate (37.3%) in surveys may question the validity of the survey results due to the lack of responses for this quantitative method of analysis. However, the employed qualitative inquiry for many construction professionals explained below could be used as sufficient data to balance the results obtained through this study and complement the analysis of the results herein.

3.2 Interviews with industry professionals

The CEO/Managing Director of Dwellco (Pvt) Ltd, Mr. Dharshan John was very helpful with the study as he assisted in arranging for interviews with multiple senior and reputed construction professionals in the Sri Lankan construction industry. These professionals included: Dr. Wedikkara, often credited for the introduction and promotion of the Quantity Surveying discipline through academia in Sri Lanka with multiple professional certifications and qualifications in the construction industry, architect Rukshan Widyalankara, former president of the Sri Lankan Institute of Architects (SLIA) and current president of the Commonwealth Association of Architects (CAA), Mr. Aponso, former president of the Institute of Quantity Surveyors of Sri Lanka (IQSSL) and also the Managing Director of Savisevan Construction (Pvt) Ltd. Other senior architects and construction industry professionals were also met for in-depth interviews in relation to BIM adoption and implementation. All interviews were structured off the deployed survey, but investigated in more depth the professionals concerns and the foreseen challenges for adoption and implementation of BIM in Sri Lanka. The interviews proved to be very insightful and also brought to light external factors that were not initially considered in the study but are presented in discussion through the results and analysis of this project. The information gathered was also very useful in identifying some aspects that need to be considered more closely during the second/prescription phase of this project.

4. Results Analysis

The results gathered through this study were analyzed with the purpose of understanding the existing conditions of the Sri Lankan construction industry with an emphasis on finding out the understanding of BIM and its implementation levels in the whole country. The primary analysis was done on the data collected through a research survey that was deployed to construction professionals in Sri Lanka. The secondary portion of the study was a qualitative approach through which the researchers were able to conduct in-depth interviews with senior construction professionals in the country to get a better understanding of the prevailing conditions and also assess the thoughts and ideas of these individual professionals in relation to the promotion of BIM adoption and implementation in the Sri Lankan construction industry. This mixed strategy proved to be very insightful about the research environment in Sri Lanka that relates to the attitudes and mindset when responding to academic related surveys and also a tendency to avoid responding if there is a lack of awareness and understanding about the topic being discussed. This gave great insight into potential strategies that would need to be explored for the second phase following up this first phase.

4.1 Research Survey (quantitative analysis)

The research survey was deployed in multiple rounds to the construction professionals with scheduled reminders in order to encourage more participation and also to increase the seemingly low completion rates. The researchers acknowledge that the validity of the research survey results maybe in question due to its low response rate. However, the qualitative methods bring a balance to certifying the validity of the study as it greatly reinforced the data collected through the quantitative method of survey.
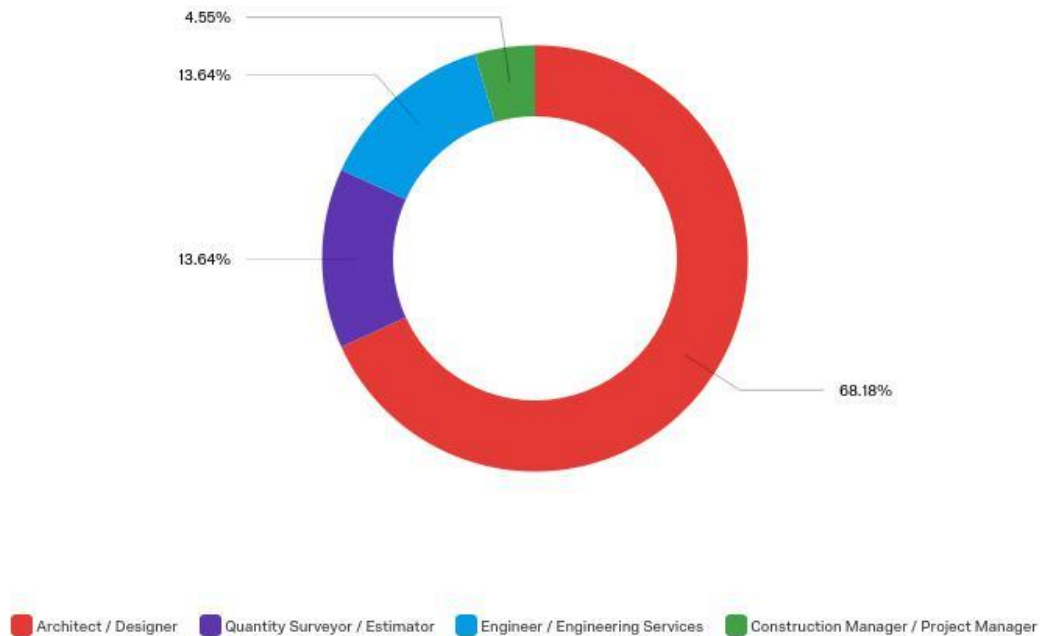

Figure 1 - Professional Affiliations of Survey Respondents

As observed in Figure 1 above, extracted from the survey deployed through our study, researchers found that approximately 68% of the respondents were from an architecture and design background, engineers and quantity surveyors/cost estimators came in second with a 13.6% in each category with project managers/construction managers being the smallest group with approximately 4.6%. A significant percentage of the respondents at 45.4% had worked in the industry between 0 – 10 years and approximately 22.7% of the respondents have been in the Sri Lankan construction industry for over 25 years. The observations made from the low participation and completion rates and the results on the professional affiliations is that the design community seem to be the most open to discussions relating to BIM and senior professionals may be less comfortable responding to questionnaires posed in relation to industry topics that they may have not heard of before. The study also showed that nearly 80% of the respondents had heard of BIM before taking the survey, which reinforces the idea that persons who had heard of BIM before were mostly comfortable with responding to the survey. Unfortunately, researchers do not have a means of testing this assumption but they would consider

redeploying a survey at the end of phase two of this project to evaluate if the conditions in the Sri Lankan construction industry have changed.
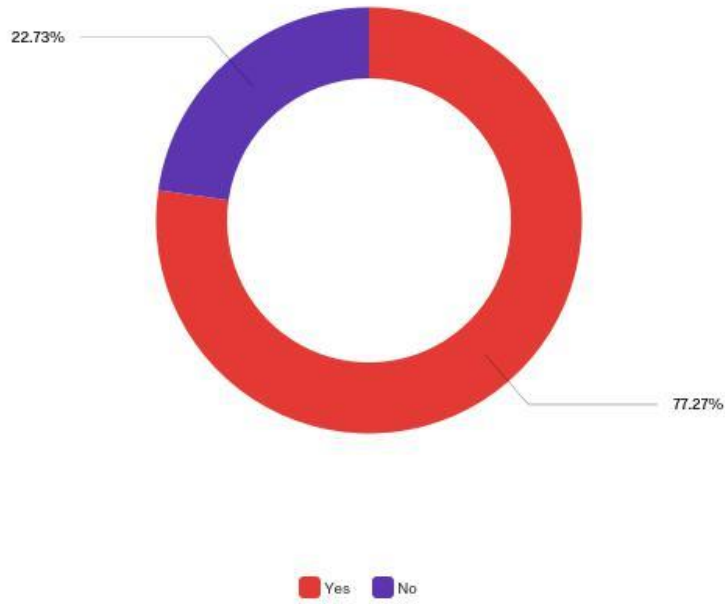

22.73%

77.27%

Yes   No
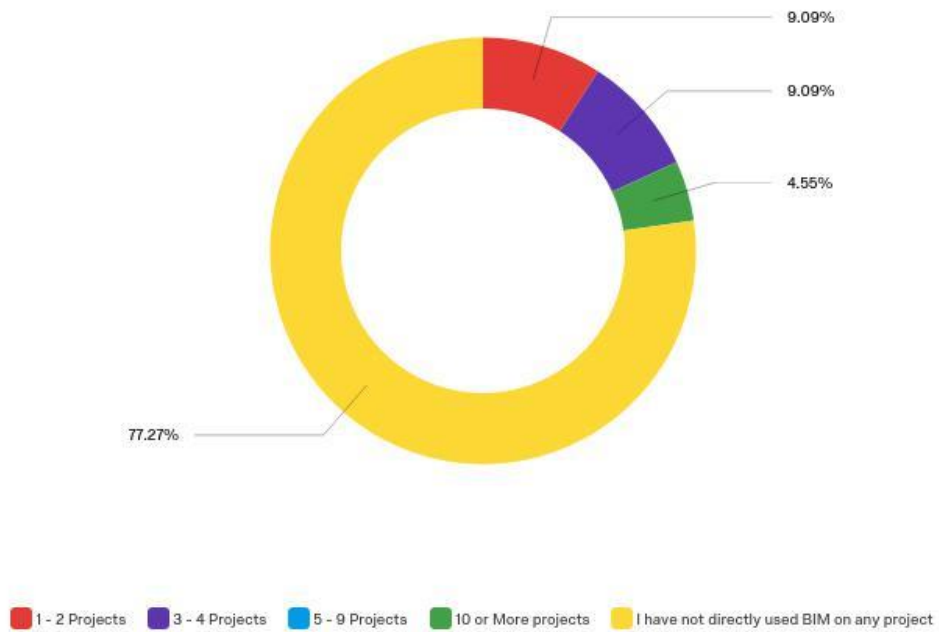
Figure 2 – Respondents who had previously heard of BIM

9.09%

9.09%

4.55%

77.27%

1 - 2 Projects   3 - 4 Projects   5 - 9 Projects   10 or More projects   I have not directly used BIM on any project

Figure 3 - Experience with BIM

#	Projects using BIM in Sri Lanka	%	Count
1	Government contract / Construction Project	9.09%	2
2	Foreign Client (Foreign Investment Project)	0.00%	0
3	Commercial Space (Office)	9.09%	2
5	Hotel / Leisure Industry	0.00%	0
6	I have not used BIM / BIM in Sri Lanka	81.82%	18

Table 1 – Type of projects which have used BIM in Sri Lanka
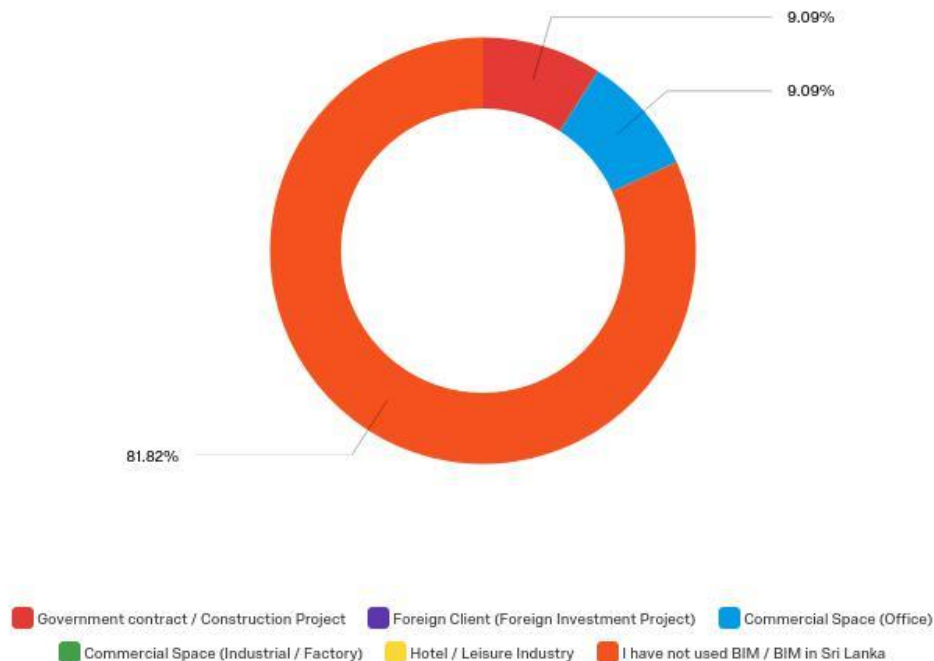

Figure 4 – Type of projects which have used BIM in Sri Lanka

Figure 2 shows the results that respondents gave with regards to their experience and exposure to BIM. As seen in the pie-chart, nearly 78% stated that they have never used BIM on any project before with a very small percentage of 4.6% stating that they have worked on more than 10 projects as seen in Figure 3. Further investigations into these responses as portrayed in Table 1 and Figure 4, revealed that the respondents who had done projects were mostly affiliated with foreign construction projects and served as consultants in the design and architecture consultancy profession, those that had used BIM in Sri Lanka had used it for construction projects that served the Sri Lankan Government as a client and in some instances were used for commercial (office) spaces. Some of the respondents also perceived that usage of Revit Architecture alone constituted the usage of BIM on their construction projects. The misconception about the

understanding of BIM as a comprehensive platform as opposed to just a software for three-dimensional modeling may have resulted in the responses to this question having less reliability. However, it does add credibility to the assumption that the Sri Lankan construction industry is still at a very early stage of its awareness of the potential and capabilities of BIM. The study also created a list of most probable industry implementation challenges and had them ranked by the respondents to understand which challenges were considered the most significant in BIM adoption and implementation in the Sri Lankan context. The following were noted as the top five challenges:

- Lack of knowledge about BIM
- Initial hardware/software cost
- Lack of training resources
- Feasibility/cost of implementation
- Existing construction industry culture

The ranking of the five challenges as expressed above were very much in line with the unranked challenges expressed during the face-to-face interviews with senior construction professionals. There can be close comparisons made to the results found in a study called the State of BIM adoption and outlook in India (RICS - Amity University, 2014), where the Indian market seemed to identify with all of the above challenges. The findings as reported by the RICS study in 2014 may also show potential collaboration for a regional strategic adoption and implementation plan to increase the scope and feasibility.
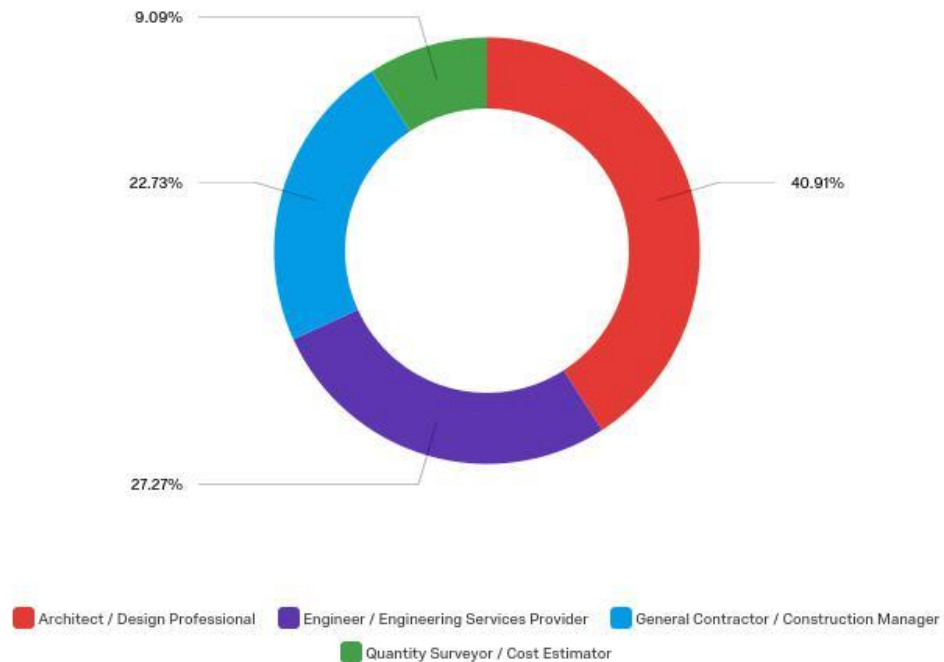

Figure 5. Professional disciplines that would best benefit from BIM adoption

Figure 5 is also an extraction from the survey report and evaluated the responses in terms of the professional disciplines within the construction industry which would

most benefit from the increased adoption and implementation of BIM. Nearly 41% of respondents stated that architects and design professionals would come out on top as the profession within the industry that is expected to benefit the most through BIM adoption and the quantity surveyors and cost estimators seemed to be ranked as the bottom tier beneficiaries with about 9%. The observations that can be made about these responses is that the Sri Lankan construction industry still is in the belief that BIM relates predominantly towards visualization capabilities, this is a notion that needs to be addressed through any adoption and implementation strategies moving forward so that the industry is more aware of the growing capabilities and scope of BIM benefits. The responding engineers who seemed to see more benefits to the engineering discipline did reference both "visualization" and "clash detection". While not many engineers responded or completed the survey, a good number of engineers who did participate and complete the survey were aware of clash detection and multiple construction trades model visualization and coordination capabilities.
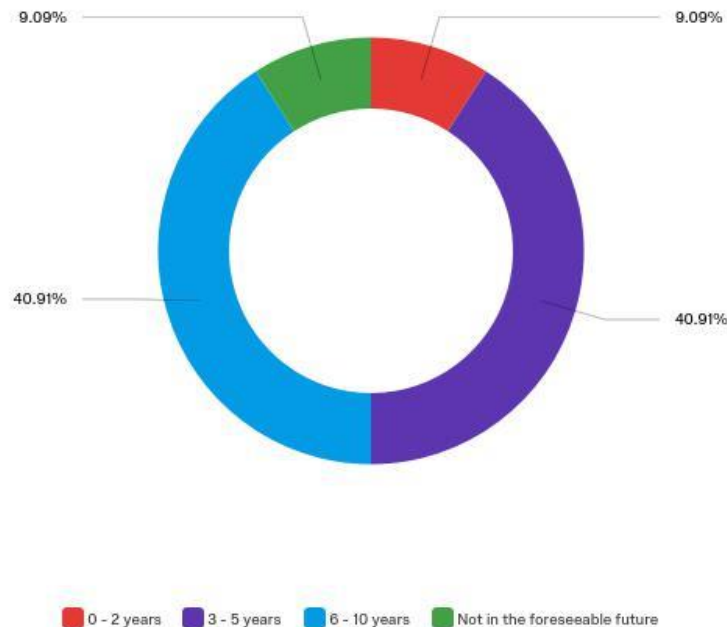

Figure 6. Time frame for BIM to be widely adopted in Sri Lanka

When questioned on how long the respondents feel it would take for BIM to be widely adopted and implemented in Sri Lanka, approximately 41% responded that it would take between 3-5 years while another approximately 41% responded that it would take between 6-10 years. 9% stated that they could not see BIM being adopted in Sri Lanka in the near future, while another 9% stated that it could be as soon as 0-2 years as observed in Figure 6 above. It was also interesting to note the linkage with younger construction professionals which was a glaring contrast when compared to the results of neighboring India, through the RICS report that "BIM is more popular amongst experienced professionals, possibly as they are more aware of its value proposition" (RICS - Amity University, 2014). In Sri Lanka however, it was the younger professionals who were being more optimistic of its adoption and

implementation while the more senior construction professionals seemed to be a little more skeptical about the ability to adopt and implement BIM in a short time span. This became more apparent through the in-depth interviews with external factors being cited as challenges. It is also possible that the newer industry competitors are more aware and comfortable with BIM as a result of a formal education that alluded to BIM and therefore held more optimism with regards to its adoption and implementation time frame. A more realistic time frame was also discussed and shared during the in-depth interviews and can be seen in the in-depth interviews section of this study.

One of the most interesting discoveries through the survey was that there was a BIM platform developer based in Sri Lanka. The company named Mitra Innovation had developed a cloud computing based product called BIMaaS (Mitra Innovation, 2016) and it was a BIM platform which was designed to compete with platforms such as Autodesk 360 (Autodesk, 2016) which is also a cloud based BIM platform. This was a positive sign as it showcased that Sri Lanka had the necessary technological resources to help and support the adoption and implementation of BIM. However, it was interesting that BIMaaS was predominantly being marketed to companies outside of Sri Lanka as the company had not seen any large scope for profitability in the Sri Lankan context. This could be considered another indicator that the country lacks readiness for BIM adoption and implementation and would also suggest that any adoption and implementation initiative may need to have a deliberate and purposeful focus that allows for an increase in knowledge of BIM within Sri Lanka's construction industry. When asked in the survey as to which BIM software platform was most popularly known, 77% of the respondents stated Autodesk with 18% stating that they had not heard of any of the suggested BIM platforms and 5% referencing WSO2 which is the platform that BIMaaS is built upon.

An open ended question on the survey, presented an opportunity for respondents to discuss other perceived challenges for the adoption and implementation of BIM. While most of the responses further elaborated on the list of the top five challenges stated before in this paper, other perceived challenges were also provided as follows:
- industry reluctance for adoption
- non-standardized construction documents and process
- difficulties in translating BIM from design stage to use by contractors
- lack of emphasis on BIM through construction education programs
- regulatory bodies not emphasizing the importance of BIM
- no concerted effort by any professional discipline to promote BIM

The above list of additional challenges shared and presented by the construction professionals seemed to indicate other external challenges that need to be collectively addressed in creating the foundation for successful adoption and implementation of BIM. All these thoughts and challenges that were presented to the researchers would be further analyzed in the development of BIM adoption and implementation strategies through the follow up phase of this research project. The questions that followed related to interest in learning about BIM in which a unanimous 100% interest was found, while a lesser 86% indicated that they would like to promote BIM

to their stakeholders through their professional offerings, and 13% declared that they are not yet ready to promote BIM adoption through their professional practices.

The survey yielded a lot of useful information that gave researchers a good understanding of the Sri Lankan construction industries current positioning in terms of BIM adoption and implementation and was further reinforced with data collected through the qualitative data as discussed in the following section of this paper.

4.2 Interviews with senior construction professionals (qualitative analysis)

Interviews were conducted with senior professionals who represented the architecture, quantity surveyor and project management fields. These interviews were arranged with the help of senior management from Dwellco Developments (Pvt) Ltd, a reputable residential and commercial construction company in Sri Lanka. The interviews reinforced many of the challenges that have been stated above but provided a new view point and perspective on some of these challenges bringing a deeper understanding about why some of these were considered challenges and also led to some discussions on what strategies may be employed in order to effectively address these challenges for a more streamlined adoption and implementation of BIM. "Compatibility and adoption within the existing framework of the Sri Lankan construction industry is a concern specially in terms of the individual professional disciplines and if the accuracy of the model is low it would almost be like garbage-in and garbage-out"(Widyalankara, personal communication, 2016).

Architect Widyalankara, expressed serious concern over the potential productivity and project challenges that may be faced during an introductory period where modeling accuracy may be low. He also expressed excitement and was very optimistic about its adoption as long as it was approached with proper planning and implementation strategies and also indicated the importance of stressing the more comprehensive benefits of implementing BIM when trying to promote its adoption, especially with rising software costs concerning the architect and design community. This interview also led to further discussion and a presentation to a group of his architecture students at the Colombo School of Architecture (CSA) on the topic of BIM, with it being a potential first step of exploring greater promotion of BIM amongst the design community which would be further explored during second phase of this research project. A second interview was conducted with Mr. Aponso, a prominent quantity surveyor who discussed how the quantity surveying professional body called Institute of Quantity Surveyors of Sri Lanka (IQSSL) has been exposed to BIM through organizations such as the Pacific Association of Quantity Surveyors (PAQS) and stated that he had observed Singapore to have taken large strides in the push for BIM adoption and implementation. "The mindset of senior construction professionals in Sri Lanka will be harder to change at this stage and a more determined effort should be made in engaging the young construction professionals through their academic programs to pioneer this, and I feel it would be the best and most effective means of promoting the adoption and implementation of BIM in Sri Lanka"

(Aponso, personal communication, 2016). Mr. Aponso also stated that it is important to be aware of the need to ensure that the challenges between greater information management and actually getting the job done should not be forgotten in the process of exploring BIM adoption as construction is not just about planning and managing as it is a very involved process and also requires a lot of planning and performance. These thoughts expressed by Mr. Aponso are very beneficial to this study as this caution in how BIM may be understood by the industry needs to be strategically responded to in any implementation and adoption plans. The idea of productivity losses and total dependence

on process as opposed to the management and successful completion of tasks seemed to be a big concern which if not managed effectively could discredit the benefits of BIM to the construction industry of Sri Lanka. The final interview to be highlighted in the qualitative analysis is with one of Sri Lanka's most prominent and accomplished construction professionals, Professor Chitra Wedikkara. The interview with Professor Wedikkara brought about new insight to this study as she herself is involved with education programs at the Colombo School of Construction Technology (CSCT) along with her professional engagements as a chartered architect, chartered quantity surveyor and a project manager. She informed that BIM is being introduced to students through the courses taught at the institution and also expressed that it will take some time before BIM can be widely adopted in Sri Lanka. "Keep in mind that Sri Lanka was a state at war for

30 years and therefore the construction industry had limitations on its growth potentials with the use and engagement of technologies; now there is an opportunity to grow, so we must allow time for the industry itself to grow and allow for these technologies to be used more effectively" (Wedikkara, personal communication, 2016). This statement in itself shed light on the state of the Sri Lankan construction industry and how a seemingly external factor had a significant negative impact on the entire industry as a whole. This also proved valuable insight to better grasp and understand some of the reasons for why professionals were skeptical to consider some of the technologies and processes in the local construction industry. This is because the industry was focused on survival during the long periods of civil war and did not have as much opportunity to grow through scale of projects and funding was not available and as a result traits of industry complacency would have settled in. She also mentioned she does not believe that any entity in Sri Lanka understands or it is currently using the total scope of BIM and reinforced the idea that it would definitely come to Sri Lanka but that it would need to follow a process of introduction which would need to be a culmination of combined factors such as education and industry preparation. Professor Wedikkara is also actively involved with multiple projects in Sri Lanka which have large foreign general contractors. She stated that even they were not using the full extent of BIM in Sri Lanka as there was no partner group in Sri Lanka able to cater to BIM needs on projects, BIM was being used in a very minimal scale and mostly in a visualization context and not much in terms of project and resources management.

The interviews complemented qualitatively the quantitative findings, as this approach generated new information and reinforced data collected through the survey. The quantitative survey was reassured in terms of the consistency and validity of the data gathered. This mixed strategy gave access to review multiple thoughts and ideas of stakeholders in the Sri Lankan construction industry to develop a better direction for potential BIM adoption and implementation strategies which are discussed in the next section.

5. Recommendations for further research in phase two
Coming into this research project, there were a few outline options considered as potential strategies that should be structured, explored and tested for the successful adoption and implementation of BIM in Sri Lanka. However, the research and study brought into researchers' attention the need of a more comprehensive approach in order to formulate the best strategies for the adoption and implementation of BIM.

Based on the study conducted and on the researchers' findings, it is strongly recommended to conduct a PEST (Political, Economic, Social and Technological) analysis of the external environment in Sri Lanka prior to approaching the next phase, so there is more data about the existing external conditions. This will also allow for the adoption and implementation strategy to take a more strategic approach as a whole. Once a PEST analysis has been conducted and the findings taken into consideration, the researchers would then need to address the findings on the research data available through both survey data collection and the in-depth interviews; there are five potential components that the researchers suggest should be explored in greater detail in phase two of this project. The five potential components are as follows:

- BIM training and education
  - o This component is recommended through the findings in the research, which cited training and education as a critical need
- Sri Lanka BIM forum
  - o This component was developed through in-depth interviews and recommendations by the researcher to industry professionals; this would be in the hope of increasing the conversations/project experiences on BIM
- Selective and strategic adoption
  - o Follow-up to the above two recommendations as the scope of understanding about BIM and its potential would need to be first promoted, before pitching selective and strategic adoption
- Strategic partnerships
  - o Partnerships with industry professionals, BIM platform development companies and educational institutions
- Trial business model
  - o Explore the potential through operating a trial business and evaluate the interest and success of a BIM service provision from a company that is designed to provide BIM services

6. Conclusions

The researchers would like to state this diagnosis phase was successful as there was significant value in the data collected and it has been compiled and studied to formulate a background for future research that could result in effective studies for the general and useful adoption and implementation strategies in the Sri Lankan construction industry moving forward. Among the key findings of this study are the following:

1. It is important to reflect on the lessons learned about the responsiveness of professionals, and with this understanding, it may be necessary to evaluate effective strategies of increasing the engagement and responsiveness of industry professionals, so that researchers have better data availability when approaching future studies and the second phase of this project in developing a prescription and solutions for effective BIM adoption and implementation
2. The Industry as a whole may not yet be at a point of maturity for BIM implementation and adoption. There is need for industry preparation and more education on BIM and its capabilities in order to ensure appropriate and effective adoption of BIM in Sri Lanka

3. The research analysis showed a deep interest in BIM, a significant readiness for the learning of BIM and also revealed that the AEC community would need to be engaged in effectively promoting BIM
4. The fact that external factors, such as a Civil War and its effects on the Sri Lankan Construction industry, may suggest industry and market environment analysis such as PEST analysis should be conducted for added information and perspective when developing BIM adoption and implementation strategies

It is important to understand the above findings and the perspectives of industry practitioners' in the Sri Lankan construction industry when formulating the approach and strategies that would need to be employed. Based on the survey responses and the qualitative consultations with construction professionals in Sri Lanka, it could be concluded that based on the existing understanding of BIM and the professionals expressions of challenges and concerns, the timeline of 6- 8 years could be estimated in order to allow this industry to experience growth to cater for implementation. Also this timeframe will allow enough accumulation of knowledge for professionals to be trained and made confident in the adoption and implementation of BIM. Some observations that have surfaced, and also as a result can be noted as concern for the Sri Lankan construction industry, is that efforts would need to be made to engage the Sri Lankan construction professionals to pick up the pace in engaging ideas and discussions revolving around BIM, in order to ensure that the local professionals are not made obsolete by the growth of BIM adoption and also the entrance of foreign contractors and consultants to the Sri Lankan market. If the industry does not supply professionals who are equipped to cater the demand and expectation of construction professional in terms of the knowledge and use of BIM, local professionals may begin to see an increase of importing construction professional and as a result reduced work and profitability for local practitioners and businesses. This study is of noteworthy value to the construction professionals of Sri Lanka and may be used as preliminary groundwork for BIM adoption and implementation in the country's construction industry.

7. References

AGC of America, A. G. (n.d.). *Contractors Guide to BIM - Edition 1*.

Autodesk. (2013). *BIM Interoperability*. Retrieved from Autodesk Cimmitment to interoperability: http://www.autodesk.com/campaigns/interoperability

Autodesk. (2016). *BIM Solutions Overview*. Retrieved from Autodesk BIM Overview: http://www.autodesk.com/solutions/bim/overview

Autodesk. (2016). *Product - BIM 360*. Retrieved from Autodesk BIM 360: http://www.autodesk.com/products/bim-360/overview

Mitra Innovation. (2016). *BIMaaS*. Retrieved from Mitra Innovations: http://mitrai.com/bimasaservice/

Mr.Aponso. (2016, January 5). Managing Director of Savisevana Construction. (D. John, Interviewer)

RICS - Amity University. (2014). *State of BIM adoption and outlook in India.* RICS School of Built Environment.

Wedikkara, P. C. (2016, January 6). Chartered Architect, Chartered Quantity Surveyor and
Project Manager. (D. John, Interviewer)

Widyalankara, A. R. (2016, January 5). President CAA. (D. John, Interviewer)

8. Appendix

Survey Questions

☐ What is your professional affiliation within the Construction Industry of Sri Lanka?

☐ How many years have you worked in the Construction industry?

☐ Have you heard of Building Information Modeling (BIM) before?

☐ Have you had any direct experience with Building Information Modeling (BIM)?

☐ If you have used Building Information Modeling (BIM) on a Sri Lankan construction project, what type of project was it?

☐ What do you feel is the biggest challenge (current) for Building Information Modeling (BIM) implementation / increased implementation in Sri Lanka

☐ What do you feel is the second biggest challenge (current) for Building Information Modeling (BIM) implementation / increased implementation in Sri Lanka

☐ What do you feel is the third biggest challenge (current) for Building Information Modeling (BIM) implementation / increased implementation in Sri Lanka

☐ What professional discipline do you feel could have the most positive impact in the Sri Lankan Construction Industry, if Building Information Modeling (BIM) were to be more widely used

☐ BIM will be a crucial component of the Sri Lankan construction industry in

☐ Have you heard of any Building Information Modeling (BIM) solution providers (BIM specialists, BIM Planners, BIM / Software trainers) in Sri Lanka?

☐ Have you heard of any one of the following software platforms, and if so, which one have you heard of the most?

☐ Please state what are the perceived challenges of Building Information Modeling (BIM) implementation / increased implementation in Sri Lanka

☐ Please state how BIM can be best utilized on your construction projects

☐ Please state your professional affiliation (Note - please do not abbreviate, list out entire name of affiliated organization) Example: Sri Lanka Institute of Architects as opposed to SLIA

☐ What is the name of your professional practice / Company and what is your title?

☐ Please list the software you currently use in your professional practice / Company Example: AutoCAD, Revit, Excel, BlueBeam, PlanSwift, PlanGrid etc.

☐ Have you used a mobile device / tablet PC for any of your projects?

- ☐ Are you interested in further investigating Building Information Modeling (BIM) and how it works?
- ☐ Are you interested in learning and promoting BIM in your company or to your stake holders
- ☐ Any additional comments with regards to Building Information Modelling (BIM) adoption in the Sri Lankan Construction industry?