THE ROLE OF BUILDING INFORMATION MODELLING DESIGN APPLICATION IN MITIGATING THE VARIATION ORDER IN JORDANIAN CONSTRUCTION INDUSTRY

JA'FAR A. A. (AL-DIABAT AL-BTOOSH)

DOCTOR OF PHILOSOPHY

UNIVERSITI MALAYSIA PAHANG

SUPERVISOR'S DECLARATION

We hereby declare that We have checked this thesis and, in our opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy of Science in Civil Engineering.

_____

(Supervisor's Signature)

Full Name : DR. AHMAD TARMIZI BIN HARON

Position :

Date :

_____

(Co-Supervisor's Signature)

Full Name : PUAN FADZIDA BINTI ISMAIL

Position :

Date :

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

_____

(Student's Signature)

Full Name : JA'FAR A. A. (AL-DIABAT AL-BTOOSH)

Position : PAC15002

Date :

THE ROLE OF BUILDING INFORMATION MODELLING DESIGN APPLICATION IN MITIGATING THE VARIATION ORDER IN JORDANIAN CONSTRUCTION INDUSTRY

JA'FAR A. A. (AL-DIABAT AL-BTOOSH)

Thesis submitted in fulfillment of the requirements
for the award of the degree of
Doctor of Philosophy

Faculty of Civil Engineering & Earth Resources
UNIVERSITI MALAYSIA PAHANG

November 2018

ACKNOWLEDGEMENTS

This study would not be accomplished without the noble people I interacted with when conducting this research, first and foremost, a special thanks to the Almighty God for bringing me this far.

With heartfelt gratitude I wish to acknowledge my supervisor Dr. Ahmad Tarmizi Bin Haron for his guidance, time, critical comments, suggestions and the encouragement he provided throughout the period of conducting this research.

I also would like to thank my brother for his constant encouragement and friendship, finally, I would like to thank my family, my dad soul, my lovely mother, my wife, my children; Ooon, Leen, lean, Hadeel, for their patience and encouragement.

ABSTRAK

Perubahan kerja (VO) merupakan salah satu cabaran utama dalam bidang industri pembinaan di Jordan. Perubahan kerja (VO) bermaksud suatu perubahan di dalam Dokumen Kontrak yang berbeza daripada Dokumen Kontrak yang asal. Perubahan ini menyebabkan pengubahsuaian dari segi kualiti, kuantiti atau rekabentuk yang menyebabkan perubahan dalam sesebuah projek. Walaupun banyak penyelidikan serta cadangan telah dijalankan bagi mengenalpasti punca kewujudan VO, namun masalah ini masih menjadi isu di dalam industri pembinaan. Pembangunan Model Berinformasi (BIM) merupakan salah satu cara bagi mengurangkan VO yang tidak lagi digunakan Jordan. Penyelidik telah mengenalpasti industri pembinaan di Jordan masih mempunyai jurang yang besar dalam ilmu serta kesedaran mengenai BIM. Kajian mendapati industri pembinaan di Jordan agak ketinggalan jauh dalam BIM. Tujuan kajian ini dijalankan adalah untuk membangunkan rangka kerja bagi mengurangkan VO dalam projek kerajaan di Jordan. Untuk mencapai matlamat ini, penyelidikan ini bermula dengan menjalankan kajian sastera intensif terhadap kedua-dua, penyebab VO dan BIM di seluruh dunia. Kajian ini dijalankan melalui kaedah tinjauan. Data dikumpul menggunakan sejumlah 150 soal selidik. Penyiasatan ini mencapai kadar pulangan sebanyak 70%. Parameter Minimum Separa (PLS), peratusan, dan Indeks Kepentingan Relatif (RII), digunakan untuk menganalisa data yang dikumpulkan. Data dianalisa melalui dua tahap utama, di mana tahap pertama melibatkan analisis awal data. Proses ini adalah penting untuk memastikan data mencukupi dengan andaian asas dalam menggunakan Model Persamaan Struktur (SEM). Secara umum, set data semua item diedarkan secara normal dan bebas dari kegagalan, nilai-nilai yang hilang dan outlier yang univariat. Peringkat kedua menggunakan kedua-dua peringkat SEM. Peringkat pertama termasuk penubuhan model pengukuran untuk pembinaan laten dalam penyelidikan. Selepas mengesahkan uni-dimensionaliti, kebolehpercayaan dan kesahihan pembinaan dalam peringkat pertama, tahap kedua ditubuhkan untuk menguji hipotesis penyelidikan melalui pembangunan model-model struktur. Sehubungan itu, dua model struktur telah dibangunkan untuk mengkaji 12 kesan langsung hipotesis. Ini dilakukan dengan menjalankan analisa laluan menggunakan SMART-PLS dan menguji signifikan pekali jalan untuk setiap laluan hipotesis. Hasilnya menunjukkan bahawa Pihak Kontrak, Perunding, Kontraktor dan Hal-hal Lain mempunyai kesan negatif yang signifikan dalam meminimumkan VO. Walau bagaimanapun, kesan Aplikasi Reka BIM, Simulasi Operasi Kemudahan, Skenario Reka Bentuk Eksplorasi, Pengesanan Reka BIM, Pengeluaran Kuantiti BIM dan Anggaran Kos pada pengurangan VO didapati positif. Penyelidikan ini diharap dapat memberikan sumbangan yang bermanfaat melalui pendekatan teori yang mengenalpasti punca VO bermula dalam kerja-kerja pembinaan, faktor-faktor bagi pesanan VO dan bagaimana pesanan VO diuruskan dalam sektor pembinaan yang memberi motivasi kepada pihak berkepentingan di Jordan untuk menggunakannya. Kajian ini juga menegaskan bahawa tiada sistem pengurusan VO yang ada untuk projek-projek kerajaan di Jordan. Pendekatan BIM, akan membantu mengurangkan berlakunya VO.

ABSTRACT

Variation order is a major challenge facing the construction industry. It can be defined as changes to the contract documents in the original agreement. It might be a change in quality, or quantity or any forms of change that affect the project. Several researchers in Jordan have inspected the variation orders sources, and a variety of clarifications have been recommended to minimize their causes, nevertheless variation order kept hardly influencing the construction industry. Though, Building Information Modelling (BIM) as a tool to minimize the variation order effects in Jordan has not been examined. Moreover, researchers confirmed a knowledge gap, in terms of BIM awareness through Jordanian construction industry. Literature indicates that the use of BIM in the Jordanian construction industry is lagging behind. The aim of this study is to develop a BIM framework to minimize the variation orders causes on the governmental construction project in Jordan. To meet that aim, a comprehensive literature review was conducted in terms of BIM capability to reduce V.O. impact on construction project around the world. Furthermore, the researcher designed a questionnaire to collect the data required in regard of VO causes and the BIM capability to address this issue. The response rate was around 70% (105/150). The questionnaire answers were analyzed descriptively and statistically by Partial Least Squares (PLS), and Relative Importance Index (RII). The causes of variation order in the Jordanian construction industry were further categorized into four main groups, namely client-related causes, contractor causes, consultant causes and causes arising from unforeseen circumstances of the project. The outcomes of this research (dependent on a relative importance index (RII)) indicate that the most frequent causes of variation orders in Jordan construction industry were, inaccurate quantity take-off, unskilled labourers, missing material specifications, logistic delays, internal politics, shortage of equipment and tools, technology changes, shortage of human and equipment Resource, absence of construction manuals and procedures, unavailability of the required labour skills, change of scope or plans by owners. It was also found that 50% of these causes were initiated by consultants, 20 % by clients and unforeseen variations, while 10 % only were initiated by contractor. Moreover, it was found that BIM Design Applications, Facility Operations Simulation, Exploration Design Scenarios, BIM Design Detection and BIM Quantity Take-off and Cost Estimation were found to be significantly capable to minimize VO. The research concluded that there is a significant positive relationship between the use of BIM applications and minimizing in the variation order in Jordanian construction industry. This means that the variation orders will decrease significantly if BIM applications is used and supports a case for using BIM as a means of reducing the variation order in the Jordanian construction industry. Finally, focus group workshop was used to validate this framework. Focus group workshop was used to investigate the relationship between the causes of variation order and the functions and features of BIM, which validated the positive effects of using BIM in terms of minimizing the variation order by minimizing the main causes. This research introduced a helpful contribution through a detailed BIM design application framework to minimize variation order, the study recommended to use this framework to solve many problems related to construction industry.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AEC	Architecture, Engineering and Construction Industry
AECO	Architecture, Engineering, Construction and Owner/Operator
BIM	Building Information Modelling
BIMDA	BIM Design Applications
C&D	Construction and Demolition
CFA	Confirmatory Factor Analysis
CNP	Contract Parties
CNS	Consultant
CNT	Contractor
COBie	Construction Operations Building Information Exchange
DCI	Design Changes Caused by Improvement
DCO	Design Changes Originated by Owner
DCP	Design Changes Originated by Professionals
DSD	Design Detection
EDS	Exploration Design Scenarios
FIDIC	International Federation of Consulting Engineer (Fédération Internationale Des Ingénieurs-Conseils)
FM	Facilities Management
FOS	Facility Operations Simulation
GDP	Gross Domestic Product
H	Hypothesis
IFC	Industry Foundation Class
IPD	Integrated Project Delivery
JOD	Jordanian Dinar
MPWH	Ministry of Public Work and Housing
OBG	Oxford Business Group
OWN	Owner
PCA	Principle Component Analysis
PGI	Programmatic Integration
PLS	Partial Least Squares
QTCE	Quantity Take-off and Cost Estimation
RII	Relative Importance Index

SD	Standard Deviation
SEM	Structural Equation Modelling
TOC	Taking-Over Certificate
TPP	Technology, Process and Policy
UNFV	Unforeseen Variations
VIS	Visual Simulation
VO	Variation Order
VOM	VO minimizing

LIST OF SYMBOLS

AVE	Average Variance Extracted
CR	Construct Reliability
N	Total Number of Population
Nf	Sample Size from Finite Population
P	Probability
Q2	Quantification
R	Regression
S2	The Standard Error of Sampling Population
V	The Variance of the Population Elements

REFERENCES

Abdul-Malak, M. A. U., El-Saadi, M. M., & Abou-Zeid, M. G. (2002). Process model for administrating construction claims. *Journal of Management in Engineering*, *18*(2), 84-94.

Aibinu, A. A., & Jagboro, G. O. (2002). The effects of construction delays on project delivery in Nigerian construction industry. *International Journal of Project Management*, *20*(8), 593-599.

Aibinu, A. A., & Odeyinka, H. A. (2006). Construction delays and their causative factors in Nigeria. *Journal of Construction Engineering and Management*, *132*(7), 667-677.

Akinsola, A. O., Potts, K. F., Ndekugri, I., & Harris, F. C. (1997). Identification and evaluation of factors influencing variations on building projects. *International Journal of Project Management*, *15*(4), 263-267.

Al Awad, O. S. (2015). *The uptake of advanced IT with specific emphasis on BIM by SMEs in the Jordanian construction indus*try (Doctoral dissertation). University of Salford, Manchester, UK.

Al-Hammad, A. M., & Assaf, S. (1996). Assessment of work performance of maintenance contractors in Saudi Arabia. *Journal of Management in Engineering*, *12*(2), 44-49.

Al-Momani, A. H. (1996). Construction cost prediction for public school buildings in Jordan. *Construction Management & Economics*, *14*(4), 311-317.

Alnuaimi, A. S., Taha, R. A., Al Mohsin, M., & Al-Harthi, A. S. (2009). Causes, effects, benefits, and remedies of change orders on public construction projects in Oman. *Journal of Construction Engineering and Management*, *136*(5), 615-622.

Alsuliman, J., Bowles, G., & Chen, Z. (2012). Current practice of variation order management in the Saudi construction industry. *Proceedings of the 28th Annual Association of Researchers in Construction Management (ARCOM) Conference*, Edinburgh, UK, 1003-1012

Altschuler, A., Picchi, T., Nelson, M., Rogers, J. D., Hart, J., & Sternfeld, B. (2009). Physical activity questionnaire comprehension-lessons from cognitive interviews. *Medicine and Science in Sports and Exercise*, *41*(2), 336-343.

Anantatmula, V. S. (2010). Project manager leadership role in improving project performance. *Engineering Management Journal*, 22(1), 13-22.

Andresen, E. M. (2000). Criteria for assessing the tools of disability outcomes research. *Archives of Physical Medicine and Rehabilitation, 81*, S15-S20.

Andresen, J., Baldwin, A., Betts, M., Carter, C., Hamilton, A., Stokes, E., & Thorpe, T. (2002). A framework for measuring IT innovation benefits. *Journal of Information Technology in Construction (ITcon), 5*(4), 57-72.

Arain, F. M. (2005). Strategic management of variation orders for institutional buildings: Leveraging on information technology. In *2005 PMI Global Congress Proceedings*, Toronto, Canada, 1-17.

Arain, F. M. (2008). IT-based approach for effective management of project changes: A change management system (CMS). *Advanced Engineering Informatics*, *22*(4), 457-472.

Arain, F. M., & Pheng, L. S. (2005a). The nature and frequency of occurrence of variation orders for educational building projects in Singapore. *International Journal of Construction Management*, *5*(2), 79-91.

Arain, F. M., & Pheng, L. S. (2005b). How design consultants perceive potential causes of variation orders for institutional buildings in Singapore. *Architectural Engineering and Design Management*, *1*(3), 181-196.

Arain, F. M., & Pheng, L. S. (2005c). The potential effects of variation orders on institutional building projects. *Facilities, 23*(11/12), 496-510.

Arain, F. M., & Pheng, L. S. (2006a). Developers' views of potential causes of variation orders for institutional buildings in Singapore. *Architectural Science Review, 49*(1), 59-74.

Arain, F. M., & Pheng, L. S. (2006b). A framework for developing a knowledge-based decision support system for management of variation orders for institutional buildings. *Journal of Information Technology in Construction (ITcon)*, *11*(21), 285-310.

Arain, F. M., & Pheng, L. S. (2007). Modeling for management of variations in building projects. *Engineering, Construction and Architectural Management*, *14*(5), 420-433.

Arain, F. M., Assaf, S., & Pheng, L. S. (2004). Causes of discrepancies between design and construction. *Architectural Science Review*, *47*(3), 237-249.

Aranda-Mena, G., Crawford, J., Chevez, A., & Froese, T. (2009). Building information modelling demystified: does it make business sense to adopt BIM? *International Journal of Managing Projects in Business*, *2*(3), 419-434.

Ashton-James, C. E., & Ashkanasy, N. M. (2008). Affective events theory: A strategic perspective. In J. Z. Wilfred, E. J. H. Charmine, N. M. Ashkanasy (Eds.), *Emotions, Ethics and Decision-Making (Research on Emotion in Organizations, Volume 4)* (pp. 1-34). West Yorkshire, England: Emerald Group Publishing Limited.

Assaf, S. A., & Al-Hejji, S. (2006). Causes of delay in large construction projects. *International Journal of Project Management*, *24*(4), 349-357.

Assem, I. (2000). *Estimating productivity losses due to change orders* (Doctoral dissertation). Concordia University, Montreal, Québec, Canada.

Azhar, S. (2011). Building information modeling (BIM): Trends, benefits, risks, and challenges for the AEC industry. *Leadership and Management in Engineering*, *11*(3), 241-252. ~ previously: h, BIM

Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science*, *16*(1), 74-94.

Bakis, N., Kagioglou, M., & Aouad, G. (2006, April). Evaluating the business benefits of information systems. In *3rd International SCRI Symposium.* Symposium conducted at the Salford Centre for Research and Innovation, University of Salford, Salford.

Bakr, G. A. (2014). Studying the Status of Variations in Construction Contracts in Jordan. *Computing in Civil and Building Engineering Proceedings*, Orlando, Florida, 187-194. doi:10.1061/9780784413616.

Barbour, R. (2007). *Doing Focus Groups.* London: SAGE Publications.

Barlish, K., & Sullivan, K. (2012). How to measure the benefits of BIM: A case study approach. *Automation in Construction*, *24*, 149-159.

Barlish, K., & Sullivan, K. (2012). How to measure the benefits of BIM—A case study approach. *Automation in Construction*, *24*, 149-159.

Becerik-Gerber, B., & Rice, S. (2010). The perceived value of building information modeling in the US building industry. *Journal of Information Technology in Construction (ITcon)*, *15*(15), 185-201.

Brown, C. E. (1998). *Applied Multivariate Statistics in Geohydrology and Related Sciences*. New York: Springer-Verlag Berlin Heidelberg. doi:10.1007/978-3-642-80328-4.

Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of building information modelling (BIM). *International Journal of Project Management*, *31*(7), 971-980.

Bubshait, A. A., & Al-Musaid, A. A. (1992). Owner involvement in construction projects in Saudi Arabia. *Journal of Management in Engineering*, *8*(2), 176-185.

Burati, J., Matthews, M., & Kalidindi, S. (1992). Quality management organizations and techniques. *Journal of Construction Engineering and Management*, *118*(1), 112-128.

Bust, P. D., Gibb, A. G., & Haslam, R. A. (2005). Manual handling of highway kerbs - focus group findings. *Applied Ergonomics*, *36*(4), 417-425.

Chan, D. W., & Kumaraswamy, M. M. (1997). A comparative study of causes of time overruns in Hong Kong construction projects. *International Journal of Project Management*, *15*(1), 55-63.

Chin, W. W. (2010). How to write up and report PLS analyses. In V. V. Esposito, W. W. Chin, J. Henseler, & H. Wang (Eds.), *Handbook of Partial Least Squares: Concepts, Methods and Applications* (pp. 655-690). Berlin, Germany: Springer Heidelberg.

Churchill, G. A. (1979). A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research*, *16*(1), 64-73.

Clough, R. H., & Sears, G. A. (1994). *Construction Contracting*. New York: John Wiley & Sons.

Coffman, D. L., & MacCallum, R. C. (2005). Using parcels to convert path analysis models into latent variable models. *Multivariate Behavioral Research*, *40*(2), 235-259.

Cooper, D. R., Schindler, P. S., & Sun, J. (2006). *Business Research Methods* (Vol. 9). New York: McGraw-Hill Irwin.

Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (3rd ed.). Los Angeles: Sage Publications Incorporated.

Creswell, J. W. (2013). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, CA: Sage Publications, Inc.

D'Agostino, B., Mikulis, M., & Bridgers, M. (2007). FMI/CMAA eighth annual survey of owners: The perfect storm - Construction style. from Fails Management Institute website http://www.fmiresources.com/pdfs/07SOA.pdf.

Dawes, J. (2008). Do data characteristics change according to the number of scale points used. *International Journal of Market Research*, *50*(1), 61-77.

Dickson, O. D., Gerryshom, M., & Wanyona, G. (2015). Variations in Civil Engineering Construction Projects in Kenya: Causes and Effects. *International Journal of Engineering Research & Technology (IJERT)*, *4*(2), 1124-1129.

Dissanayaka, S. M., & Kumaraswamy, M. M. (1999). Evaluation of factors affecting time and cost performance in Hong Kong building projects. *Engineering Construction and Architectural Management*, *6*(3), 287-298.

Doody, O., Slevin, E., & Taggart, L. (2013). Focus group interviews in nursing research: Part 1. *British Journal of Nursing*, *22*(1), 16-19.

Eastman, C. M., Eastman, C., Teicholz, P., & Sacks, R. (2011). *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors* (2nd ed.). Hoboken, New Jersey: John Wiley & Sons, Inc. (previously: Liston)

ECONOMICS, T. 2018. *Jordan GDP From Construction 2003-2018* [Online]. Available:https://tradingeconomics.com/jordan/gdp-from-construction [Accessed].

Egbu, C. O. (1999). Skills, knowledge and competencies for managing construction refurbishment works. *Construction Management & Economics*, *17*(1), 29-43.

El-Mashaleh, M., O'Brien, W. J., & Minchin, R. E. (2006). Firm performance and information technology utilization in the construction industry. *Journal of Construction Engineering and Management*, *132*(5), 499-507.

Enshassi, A., Arain, F., & Al-Raee, S. (2010). Causes of variation orders in construction projects in the Gaza Strip. *Journal of Civil Engineering and Management*, *16*(4), 540-551.

Fisk, L. A., Schwadron, N. A., & Gloeckler, G. (1997). Implications of fluctuations in the distribution functions of interstellar pick-up ions for the scattering of low rigidity particles. *Geophysical Research Letters*, *24*(1), 93-96.

Fornell, C., & Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. *Journal of Marketing Research*, *18*(3), 382-388.

Fredrickson, K. (1998). Design guidelines for design-build projects. *Journal of Management in Engineering*, *14*(1), 77-80.

Gaddie, S. (2003). Enterprise programme management: Connecting strategic planning to project delivery. *Journal of Facilities Management*, *2*(2), 177-191.

Garrett, T. & Garside, M. (2003). Fab pilot of a multi-dimensional CAD system. *Future Fab International, 14*.

Geisser, S. (1975). The predictive sample reuse method with applications. *Journal of the American Statistical Association, 70*(350), 320-328.

Ghodsypour, S. H., & O'Brien, C. (1998). A decision support system for supplier selection using an integrated analytic hierarchy process and linear programming. *International Journal of Production Economics, 56*(1), 199-212.

Gil, N., Tommelein, I. D., Stout, A., & Garrett, T. (2005). Embodying product and process flexibility to cope with challenging project deliveries. *Journal of Construction Engineering and Management, 131*(4), 439-448.

Gray, C., & Hughes, W. (2001). *Building Design Management*. Oxford: Butterworth Heinemann.

Grover, V., Lee, C. C., & Durand, D. (1993). Analyzing methodological rigor of MIS survey research from 1980–1989. *Information & Management, 24*(6), 305-317.

Gu, N., & London, K. (2010). Understanding and facilitating BIM adoption in the AEC industry. *Automation in Construction, 19*(8), 988-999.

Gu, N., Singh, V., London, K., Brankovic, L., & Taylor, C. (2008). BIM: expectations and a reality check. *Proceedings of 12th International Conference on Computing in Civil and Building Engineering & 2008 International Conference on Information Technology in Construction*, Beijing, China.

Gündüz, M., Nielsen, Y., & Özdemir, M. (2012). Quantification of delay factors using the relative importance index method for construction projects in Turkey. *Journal of Management in Engineering, 29*(2), 133-139.

Günhan, S., & Arditi, D. (2007). Budgeting owner's construction contingency. *Journal of Construction Engineering and Management, 133*(7), 492-497.

Günhan, S., Arditi, D., & Doyle, J. (2007). Avoiding change orders in public school construction. *Journal of Professional Issues in Engineering Education and Practice, 133*(1), 67-73.

György, L., & Sebestyén, D. (2013). Solving the 'Malay Problem' in Singapore - A Lesson for Hungary: Focus on change in attitude. *Periodica Polytechnica Social and Management Sciences, 21*(2), 99-110.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (1998). *Multivariate Data Analysis* (Vol. 5). Upper Saddle River, NJ: Prentice Hall.

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate Data Analysis* (6th ed.). Upper Saddle River, NJ: Prentice Education, Inc.

Hair, J. F., Celsi, M. W., Ortinau, D. J., & Bush, R. P. (2008). *Essentials of Marketing Research*. New York: McGraw-Hill/Higher Education.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed, a silver bullet. *Journal of Marketing Theory and Practice*, *19*(2), 139-152.

Hanna, A. S., Camlic, R., Peterson, P. A., & Nordheim, E. V. (2002). Quantitative definition of projects impacted by change orders. *Journal of Construction Engineering and Management*, *128*(1), 57-64.

Hanna, A. S., Russell, J. S., Nordheim, E. V., & Bruggink, M. J. (1999). Impact of change orders on labor efficiency for electrical construction. *Journal of Construction Engineering and Management*, *125*(4), 224-232.

Hanna, A.S., Chang, C.K., Lackney, J.A., and Sullivan, K.T. (2005, April) Overmanning impact on construction labor productivity. In *Construction Research Congress: Broadening Perspectives (ASCE)*, San Diego, CA.

Haron, A. T. (2013). *Organisational readiness to implement building information modelling: A framework for design consultants in Malaysia* (Doctoral dissertation). University of Salford, Salford, Manchester, England.

Harty, C., Throssell, D., Jeffrey, H., & Stagg, M. (2010, June). Implementing building information modeling: A case study of the Barts and the London hospitals. *Proceedings of the International Conference on Computing in Civil and Building Engineering ICCBE*. Nottingham, UK.

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. In R. R. Sinkovics, & P. N. Ghauri (Eds.), *New Challenges to International Marketing: Advances in International Marketing* (Vol. 20, pp. 277-319). Bingley: Emerald Group Publishing Limited.

Hira, T. K., & Mugenda, O. M. (1999). The relationships between self-worth and financial beliefs, behavior, and satisfaction. *Journal of Family and Consumer Sciences*, *91*(4), 76-82.

Ho, R. (2006). *Handbook of Univariate and Multivariate Data Analysis and Interpretation with SPSS*. Boca Raton, FL: CRC Press.

Ho, Y. S. (2006). Review of second-order models for adsorption systems. *Journal of Hazardous Materials*, *136*(3), 681-689.

Hök, G. S., & Jaeger, A. V. (2010). *FIDIC: A Guide for Practitioners*. Berlin: Heidelberg.

Homayouni, H., Neff, G., & Dossick, C. S. (2010). Theoretical categories of successful collaboration and BIM implementation within the AEC industry. In *Construction Research Congress 2010: Innovation for Reshaping Construction Practice* (pp. 778-788). Banff, Alberta, Canada.

Hughes, W., & Murdoch, J. R. (2001). *Roles in Construction Projects: Analysis and Terminology*. Birmingham: Construction Industry Publications.

Hussain, M. A., Elyas, T., & Nasseef, O. A. (2013). Research paradigms: A slippery slope for fresh researchers. *Life Science Journal*, *10*(4), 2374-2381.

Hwang, B. G., & Low, L. K. (2012). Construction project change management in Singapore: Status, importance and impact. *International Journal of Project Management*, *30*(7), 817-826.

Ibbs, C. W. (1997). Quantitative impacts of project change: size issues. *Journal of Construction Engineering and Management*, *123*(3), 308-311.

Ibbs, C. W. (2005). Impact of change's timing on labor productivity. *Journal of Construction Engineering and Management*, *131*(11), 1219-1223.

Ibbs, C. W., Wong, C. K., & Kwak, Y. H. (2001). Project change management system. *Journal of Management in Engineering*, *17*(3), 159-165.

Ibbs, W., Nguyen, L. D., & Lee, S. (2007). Quantified impacts of project change. *Journal of Professional Issues in Engineering Education and Practice*, *133*(1), 45-52.

INDUSTRY, J. C. O. 2014. Buildings Sectors [Online]. Available:(http://www.jci.org.jo/EchoBusV3.0/SystemAssets/PDF/AR/SectorsPDFAR/BuildingsSector.pdf) [Accessed].

Innovaya. (2010). Innovaya visual estimating [Computer software]. Oregon, USA: Innovaya, LLC.

Isaac, R. G., Herremans, I. M., & Kline, T. J. (2010). Intellectual capital management enablers: A structural equation modeling analysis. *Journal of Business Ethics*, *93*(3), 373-391.

Ismail, A., Pourrostam, T., Soleymanzadeh, A., & Ghouyounchizad, M. (2012). Factors causing variation orders and their effects in roadway construction projects. *Research Journal of Applied Sciences, Engineering and Technology*, *4*(23), 4969-4972.

Jackson, S. (2002). Project cost overruns and risk management. *Proceedings of 18th Annual Association of Researchers in Construction Management (ARCOM) Conference*, Newcastle, Northumber University, UK (pp. 2-4).

Jawad, R. S., Abdulkader, R., & Ali, A. A. A. (2009). Variation orders in construction projects. *Journal of Engineering and Applied Sciences*, *4*(3), 170-176.

Jordan, C. B. O. 2016. Annual report [Online]. Available: http://www.cbj.gov.jo/Pages/viewpage.aspx?pageID=337 [Accessed].

Jung, Y., & Joo, M. (2011). Building information modelling (BIM) framework for practical implementation. *Automation in Construction*, *20*(2), 126-133.

Kagioglou, M., Aouad, G., Cooper, R., & Hinks, J. (1998). The process protocol: Process and IT modelling for the UK construction industry. *Product and Process Modelling in the Building Industry: Proceedings of ECPPM'98 - the Second European Conference on Product and Process Modelling in the Building Industry*, BRE, UK.

Karshenas, S. (2005, April). Cost estimating in the age of 3-D CAD software and object databases. Paper presented at the *Construction Research Congress 2005: Broadening Perspectives* (pp. 1-8).

Keane, P., Sertyesilisik, B., & Ross, A. D. (2010). Variations and change orders on construction projects. *Journal of Legal Affairs and Dispute Resolution in Engineering and Construction*, *2*(2), 89-96.

Khanzode, A., Fischer, M., & Reed, D. (2008). Benefits and lessons learned of implementing building virtual design and construction (VDC) technologies for coordination of mechanical, electrical, and plumbing (MEP) systems on a large healthcare project. *Journal of Information Technology in Construction (ITcon)*, *13*(22), 324-342.

Khosrowshahi, F., & Arayici, Y. (2012). Roadmap for implementation of BIM in the UK construction industry. *Engineering, Construction and Architectural Management*, *19*(6), 610-635.

Knoepfel, H., & Burger, R. (1987). Project organization and contract management. *International Journal of Project Management*, *5*(4), 204-208.

Kolawole, A., Peter, K., & Gerryshom, M. (2016). Determinants of change orders in building construction projects in Northern Nigeria. *American International Journal of Contemporary Research 6*(3), 95-107.

Koo, B., & Fischer, M. (2000). Feasibility study of 4D CAD in commercial construction. *Journal of Construction Engineering and Management*, *126*(4), 251-260.

Koskela, L. (1992). *Application of the new production philosophy to construction* (Technical Report No. 72). Stanford, CA: Stanford University.

Kothari, C. R. (2004). *Research Methodology: Methods and Techniques* (2nd ed.). Delhi, India: New Age International.

Krigsvoll, G. (2007). Life Cycle Costing as part of decision making-use of building information models. In L. Bragança, M. Pinheiro, S. Jalali, R. Mateus, R. Amoêda, & M. C. Guedes, *Portugal SB07 Sustainable Construction, Materials and Practices: Challenge of the Industry for the New Millennium* (pp. 433-440). Amsterdam: IOS Press.

Kumar, R., Luthra, A., & Datta, G. (2006). Linkages between brand personality and brand loyalty: A Qualitative Study in an emerging market in the Indian context. *South Asian Journal of Management, 13*(2), 11-35.

Kuprenas, J. A., & Mock, C. S. (2009). Collaborative BIM modeling case study—Process and results. *Proceedings of the 2009 ASCE International Workshop on Computing in Civil Engineering*, Austin, Texas (pp. 431-441).

Lankford, S. V., & Howard, D. R. (1994). Developing a tourism impact attitude scale. *Annals of Tourism Research, 21*(1), 121-139.

Lazar, F. D. (1997). Partnering: New benefits from peering inside the black box. *Journal of Management in Engineering*, *13*(6), 75-83.

Le-Hoai, L., Dai Lee, Y., & Lee, J. Y. (2008). Delay and cost overruns in Vietnam large construction projects: A comparison with other selected countries. *KSCE Journal of Civil Engineering*, *12*(6), 367-377.

Leicht, R. M., & Messner, J. I. (2007). Comparing traditional schematic design documentation to a schematic building information model. *Proceedings of 24th CIB-W78 Conference: Bringing ITC knowledge to work*, Maribor, Slovenia.

Lim, C. S., & Mohamed, M. Z. (1999). Criteria of project success: An exploratory re-examination. *International Journal of Project Management, 17*(4), 243-248.

London, K., Singh, V., Taylor, C., Gu, N., & Brankovic, L. (2008). Building information modelling project decision support framework. *Proceedings of the Twenty-Fourth Annual Conference Association of Researchers in Construction Management (ARCOM)*, Cardiff, UK.

Love, P. E., Matthews, J., Simpson, I., Hill, A., & Olatunji, O. A. (2014). A benefits realization management building information modeling framework for asset owners. *Automation in Construction*, *37*, 1-10.

Lyons, R. E., Lesieur, E., Kim, M., Wong, D. C., Huson, M. G., Nairn, K. M., ... & Elvin, C. M. (2007). Design and facile production of recombinant resilin-like polypeptides: Gene construction and a rapid protein purification method. *Protein Engineering, Design & Selection*, *20*(1), 25-32.

Manning, R., & Messner, J. I. (2008). Case studies in BIM implementation for programming of healthcare facilities. *Journal of Information Technology in Construction (ITcon), 13*(18), 246-257.

Marshall-Ponting, A. J., & Aouad, G. (2005). An nD modelling approach to improve communication processes for construction. *Automation in Construction*, *14*(3), 311-321.

Matarneh, R., & Hamed, S. (2017). Barriers to the adoption of building information modeling in the Jordanian building industry. *Open Journal of Civil Engineering*, *7*, 325-335. doi: 10.4236/ojce.2017.73022.

McCabe, B. (2003). Construction engineering and project management III: monte carlo simulation for schedule risks. *Proceedings of the 35th Conference on Winter Simulation: Driving Innovation* (pp. 1561-1565), New Orleans, Louisiana.

McGraw Hill Construction. (2008). *Building Information Modeling Trends SmartMarket Report: Transforming Design and Construction*. Bedford, MA: McGraw Hill Construction.

McGraw Hill Construction. (2009). *The Business Value of BIM: Getting to the Bottom Line.* New York: McGraw Hill Construction.

Memon, A. H., Rahman, I. A., & Hasan, M. F. A. (2014). Significant causes and effects of variation orders in construction projects. *Research Journal of Applied Sciences, Engineering and Technology*, *7*(21), 4494-4502.

Meuser, M., & Nagel, U. (2009). The expert interview and changes in knowledge production. In A. Bogner, B. Littig, & W. Menz (Eds.), *Interviewing Experts* (pp. 17-42). Basingstoke, UK: Palgrave MacMillan

Migilinskas, D., Popov, V., Juocevicius, V., & Ustinovichius, L. (2013). The benefits, obstacles and problems of practical BIM implementation. *Procedia Engineering*, *57*, 767-774.

Moselhi, O., Leonard, C., & Fazio, P. (1991). Impact of change orders on construction productivity. *Canadian Journal of Civil Engineering*, *18*(3), 484-492.

Motawa, I. A., Anumba, C. J., Lee, S., & Peña-Mora, F. (2007). An integrated system for change management in construction. *Automation in Construction*, *16*(3), 368-377.

Mugenda, O. M. (1999). *Research Methods: Quantitative and Qualitative Approaches*. Nairobi, Kenya: African Centre for Technology Studies.

Murphy, J. J., Allen, P. G., Stevens, T. H., & Weatherhead, D. (2005). A meta-analysis of hypothetical bias in stated preference valuation. *Environmental and Resource Economics*, *30*(3), 313-325.

Myers, R. H. (1991). Response surface methodology in quality improvement. *Communications in Statistics-Theory and Methods*, *20*(2), 457-476.

Nasu, M., Nemoto, T., Mimura, H., & Sako, K. (2013). Development of qualitative and quantitative analysis methods in pharmaceutical application with new selective signal excitation methods for 13C solid-state nuclear magnetic resonance using 1H T1rho relaxation time. *Journal of pharmaceutical Sciences*, *102*(1), 154-161.

Ndihokubwayo, R., & Haupt, T. (2008). Origin-cause matrix: A practical approach for identification of waste associated with variation orders. *Acta Structilia: Journal for the Physical and Development Sciences*, *15*(2), 126-142.

Ndihokubwayo, R., & Haupt, T. (2009). Variation Orders on Construction Projects: Value adding or Waste? *International Journal of Construction Project Management, IJCPM, 1*(2), 1-17.

Ngwepe, L., Aigbavboa, C., & Thwala, W. (2015, September). The determinants of variation orders on SA public sector construction projects. *The 6th International Conference on Engineering, Project and Production Management* (pp. 231-241). Australia: Association of Engineering and Production Management.

Nunnally, J. C., & Bernstein. I. H. (1994). *Psychometric Theory* (3rd ed.). New York: McGraw-Hill.

O'Brien, W. J. (1999, August). Construction supply-chain management: A vision for advanced coordination, costing, and control. Paper presented at *NSF Berkeley-Stanford Construction Research Workshop* (Vol. 6). Stanford University, California:

O'Connor, B., Chan, E. P., Chan, C., Conrad, B. R., Richter, L. J., Kline, R. J., ... & DeLongchamp, D. M. (2010). Correlations between mechanical and electrical properties of polythiophenes. *Acs Nano*, *4*(12), 7538-7544.

O'Brien, J. J. (1998). *Construction Change Orders: Impact, Avoidance, Documentation*. New York: McGraw Hill Professional.

Oladapo, A. A. (2007). A quantitative assessment of the cost and time impact of variation orders on construction projects. *Journal of Engineering, Design and Technology*, *5*(1), 35-48.

O'Leary, Z. (2004). *The Essential Guide to Doing Research*. London: Sage Publications Ltd.

Oloo, D. D. (2015). *Modified variation order management model for civil engineering construction projects* (master's thesis). Jomo Kenyatta University of Agriculture and Technology, Kenya.

Osman, Z., Omran, A., & Foo, C. K. (2009). The potential effects of variation orders in *Construction* Projects. *Journal of Engineering*, *2*, 141-152.

Othman, N. (1997). Management of variations in construction contracts. *Proceedings of the 13th Annual Association of Researchers in Construction Management (ARCOM)* (pp. 15-17). Cambridge.

Panzarine, S., Slater, E., & Sharps, P. (1995). Coping, social support, and depressive symptoms in adolescent mothers. *Journal of Adolescent Health*, *17*(2), 113-119.

Petty, N. J., Thomson, O. P., & Stew, G. (2012). Ready for a paradigm shift? Part 1: Introducing the philosophy of qualitative research. *Manual Therapy*, *17*(4), 267-274.

Pheng, L. S., & Abeyegoonasekera, B. (2001). Buildability in design and construction through ISO 9000 quality management systems: Concepts and survey findings. *Architectural Science Review*, *44*(4), 355-366.

Pollalis, S. N., & Becerik, B. (2006). *Computer Aided Collaboration in Managing Construction.* Cambridge: Harvard University Graduate School of Design.

Pullen, C. B., Schmitz, P., Hoffmann, D., Meurer, K., Boettcher, T., von Bamberg, D., ... & van Wyk, A. (2003). Occurrence and non-detectability of maytansinoids in individual plants of the genera Maytenus and Putterlickia. *Phytochemistry*, *62*(3), 377-387.

Quaddus, M., & Hofmeyer, G. (2007). An investigation into the factors influencing the adoption of B2B trading exchanges in small businesses. *European Journal of Information Systems*, *16*(3), 202-215.

Reichard, D. D., & Norwood, C. L. (2000). Analyzing the cumulative impact of changes. *AACE International Transactions*, CD61.

Ritterband, L. M., Gonder-Frederick, L. A., Cox, D. J., Clifton, A. D., West, R. W., & Borowitz, S. M. (2003). Internet interventions: In review, in use, and into the future. *Professional Psychology: Research and Practice*, *34*(5), 527-534.

Rowland, H. J. (1981). *The causes and effects of change orders on the construction process* (master's dissertation). Georgia Institute of Technology, Atlanta, Georgia, USA.

Sambasivan, M., & Soon, Y. W. (2007). Causes and effects of delays in Malaysian construction industry. *International Journal of Project Management*, *25*(5), 517-526.

Sanvido, V. E., & Medeiros, D. J. (1990). Applying computer-integrated manufacturing concepts to construction. *Journal of Construction Engineering and Management*, *116*(2), 365-379.

Sanvido, V., Grobler, F., Parfitt, K., Guvenis, M., & Coyle, M. (1992). Critical success factors for construction projects. *Journal of Construction Engineering and Management*, *118*(1), 94-111.

Sharma, K. J., Rahul, V. S., & Rao, P. B. (2012). Delays affecting construction projects. Paper presented at National Conference on contemporary Civil Engineering Research and Practices, Manipal Institute of Technology, Manipal, Karnataka, India.

Shen, Q., & Liu, G. (2003). Critical success factors for value management studies in construction. *Journal of Construction Engineering and Management*, *129*(5), 485-491.

Smith, D. K., & Tardif, M. (2009). Building information modeling: A strategic implementation guide for architects, engineers, constructors, and real estate asset managers. Hoboken, NJ: John Wiley & Sons.

Smith, W. (2016). *The effect of variation orders on project cost and schedule overruns* (master's dissertation). Stellenbosch University, Stellenbosch, South Africa.

Stake, R. E. (1995). *The Art of Case Study Research*. Thousand Oaks, California: Sage Publications, Inc.

Stocks, S. N., & Singh, A. (1999). Studies on the impact of functional analysis concept design on reduction in change orders. *Construction Management & Economics*, *17*(3), 251-267.

Stone, M. (1974). Cross-validatory choice and assessment of statistical predictions. *Journal of the Royal Statistical Society. Series B (Methodological)*, *36*(1), 111-147.

Stumpf, A. L., Chin, S., Liu, L. Y., & Ganeshan, R. (1995). Use of a relational database system to integrate product and process information during construction. *Proceeding of CIB W78: TGIO Workshop on Modeling of Buildings Through Their Life-Cycle* (pp. 316-326). Stanford University, California, USA.

Succar, B. (2009). Building information modelling framework: A research and delivery foundation for industry stakeholders. *Automation in Construction*, *18*(3), 357-375.

Succar, B., Sher, W., & Williams, A. (2012). Measuring BIM performance: Five metrics. *Architectural Engineering and Design Management*, *8*(2), 120-142.

Suermann, P. C., & Issa, R. R. A. (2008). Case studies: Evaluating building information modeling impact on United States Army Corps of Engineer's construction. *Proceedings of CIB W78: 2008 International Conference on Information Technology in Construction*. Santiago, Chile.

Sunday, O. A. (2010, September). *Impact of variation orders on public construction projects*. Paper presented at 26th Annual ARCOM Conference, Leeds, UK.

Sweeney, D. W., Hudyma, R. M., Chapman, H. N., & Shafer, D. R. (1998, June). *EUV optical design for a 100-nm CD imaging system*. Paper presented at Emerging Lithographic Technologies II (Vol. 3331, pp. 2-11). Santa Clara, California, USA.

Sweet, J. J. (2016). *Sweet on Construction Industry Contracts: Major AIA Documents (Construction Law Library)*. Philadelphia: Aspen Publishers.

Sweis, G. J., Sweis, R., Hammad, A. A., & Shboul, A. (2008). Delays in construction projects: The case of Jordan. International Journal of Project Management, 26(6), 665-674.

Sweis, G. J., Sweis, R., Rumman, M. A., Hussein, R. A., & Dahiya, S. E. (2013). Cost overruns in public construction projects: the case of Jordan. Journal of American Science, 9(7), 134-141.

Tabachnick, B. G., & Fidell, L. S. (2007). *Experimental Designs Using ANOVA*. Thomson/Brooks/Cole.

Tabachnick, B. G., Fidell, L. S., & Osterlind, S. J. (2001). *Using Multivariate Statistics.* Boston: Allyn and Bacon.

Tadelis, S. (2012). Public procurement design: Lessons from the private sector. *International Journal of Industrial Organization*, *30*(3), 297-302.

Tahir, M. M., Haron, N. A., Alias, A. H., Harun, A. N., Muhammad, I. B., & Baba, D. L. (2018). Improving cost and time control in construction using building information model (BIM): A review. *Pertanika Journal of Science & Technology*, *26*(1), 21-36

Thomas, H. R., & Napolitan, C. L. (1994). The effects of changes on labor productivity: Why and how much. In *Pennsylvania Transportation Institute Reports 1993-1994*. The Institute.

Thomas, H. R., & Napolitan, C. L. (1995). Quantitative effects of construction changes on labor productivity. *Journal of Construction Engineering and Management, 121*(3), 290-296.

Thomas, H. R., & Sakarcan, A. S. (1994). Forecasting labor productivity using factor model. *Journal of Construction Engineering and Management*, *120*(1), 228-239.

Thomas, J. W. (2000). A review of research on project-based learning. San Rafael, CA: Autodesk Foundation. Retrieved from Bob Pearlman website http://www.bobpearlman.org/BestPractices/PBL_Research.pdf.

Thomas, L., Buckland, S. T., Rexstad, E. A., Laake, J. L., Strindberg, S., Hedley, S. L., ... & Burnham, K. P. (2010). Distance software: design and analysis of distance sampling surveys for estimating population size. *Journal of Applied Ecology, 47*(1), 5-14.

Thompson, P., & Perry, J. G. (Eds.). (1992). *Engineering Construction Risks: A Guide to Project Risk Analysis and Assessment Implications for Project Clients and Project Managers*. Heron Quay, London: Thomas Telford Publishing.

Tillotson, J., Espitalier-Noel, P., & Huddleston, D. (2002). New design approaches to counteract change costs and impacts on schedules. *Future Fab International, 13*.

Tongco, M. D. C. (2007). Purposive sampling as a tool for informant selection. Ethnobotany Research and Applications, *5*, 147-158.

Totterdill, B. W. (2006). *FIDIC Users' Guide: A Practical Guide to the 1999 Red and Yellow Books*. Heron Quay, London: Thomas Telford Publishing.

Tumi, S. A. H., Omran, A., & Pakir, A. H. K. (2009). Causes of delay in construction industry in Libya. *Proceedings of the International Conference on Economics and Administration* (pp. 265-272). Faculty of Administration and Business, University of Bucharest, Romania.

U.S. Cost [Computer software]. (2010). Success design exchange. Retrieved from RIB U.S. Cost website: http://www.uscost.com/designexchange.asp.

US Green Building Council. (2008). Green building facts. Retrieved from US Green Building Council website: www.usgbc.org/ShowFile.aspx.

Vico, C., Guerra, P., Robles, H., Vila, J., & Anllo-Vento, L. (2010). Affective processing of loved faces: Contributions from peripheral and central electrophysiology. *Neuropsychologia, 48*(10), 2894-2902.

Vinzi, V. E., Chin, W. W., Henseler, J., & Wang, H. (Eds.). (2010). *Handbook of Partial Least Squares: Concepts, Methods and Applications*. Heidelberg: Springer Science & Business Media.

Walliman, N. (2005). *Your Research Project: A Step-By-Step Guide For The First-Time Researcher (2nd ed.)*. London: Sage.

Wambeke, B. W., Hsiang, S. M., & Liu, M. (2011). Causes of variation in construction project task starting times and duration. *Journal of Construction Engineering and Management*, *137*(9), 663-677.

Weinert, L. S. (2010). International Association of Diabetes and Pregnancy Study Groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. *Diabetes Care*, *33*(7), e97-e97.

Weitz, C. M. (2016). *The proliferance of BIM adoption amongst clients for the minimization of variance orders relevant to the South African building industry* (master's dissertation). University of the Witwatersrand, Johannesburg, South Africa.

Wetzels, M., Odekerken-Schröder, G., & Van Oppen, C. (2009). Using PLS path modeling for assessing hierarchical construct models: Guidelines and empirical illustration. *MIS Quarterly*, *33*(1), 177-195.

Won, J., & Cheng, J. C. (2017). Identifying potential opportunities of building information modeling for construction and demolition waste management and minimization. *Automation in Construction*, *79*, 3-18.

Woo, J., Wilsmann, J., & Kang, D. (2010). Use of as-built building information modeling. *Proceedings of the 2010 Construction Research Congress* (pp. 538-548), Banff, Alberta, Canada

Yin, R. K. (2003). *Case Study Research: Design and Methods. Applied Social Research Methods Series* (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc.

Yogeswaran, K., Kumaraswamy, M. M., & Miller, D. R. (1998). Claims for extensions of time in civil engineering projects. *Construction Management & Economics*, *16*(3), 283-293.

Z. Zahrizan, Z., Nasly Mohamed Ali, Ahmad Tarmizi Haron, Amanda Marshall-Ponting, & Zuhairi Abd Hamid. (2013). Exploring the adoption of Building Information Modelling (BIM) in the Malaysian construction industry: A qualitative approach. *International Journal of Research in Engineering and Technology, 2*(8), 384-395.

Zeitoun, A. A., & Oberlender, G. D. (1993). *Early Warning Signs of Project Changes*. Austin, TX: Construction Industry Institute.

Zuppa, D., Issa, R. R., & Suermann, P. C. (2009). BIM's impact on the success measures of construction projects. *Proceedings of the 2009 ASCE International Workshop on Computing in Civil Engineering* (pp. 503-512). Austin, Texas.