Sub-Sahara African Academic Research Publications
September, 2022, Editions

JBER
Journal of Biodiversity and Environmental Research
Vol.25, No.4, ISSN 2211-8735

EFFECTIVENESS OF QUALITY CONTROL TECHNIQUES IN BUILDING PRODUCTION IN FCT, ABUJA, NIGERIA

NAFISA ABUBAKAR BARAU[1], UMAR AUWAL[2], ABDULLAHI ISA BUNU[1], DANIEL RAYMOND[2]

[1]Department of Technical Education, Aminu Saleh College of Education Azare, P.M.B. 044, Katagun LGA, Bauchi State, Nigeria, [2]Department of Estate Management and Valuation, Faculty of Environmental Technology, Abubakar Tafawa Balewa University (ATBU), Bauchi, P.M.B. 0248, Bauchi State, Nigeria

ABSTRACT

Most construction firms face many difficulties and problems due to the ineffectiveness of the quality management model, such as errors, delay, degradation, compromised quality and cost overrun, etc. in complementing their projects worldwide. The study aims to assess the effectiveness of quality control techniques in building production in terms of planning and control in Abuja, Nigeria, one hundred and seventy-five (175) sets of questionnaires were administered to practicing financially up to date Professionals in the Construction Industry within the study area through proportionate stratified random sampling. The survey records about 97.7% useful response rate. Descriptive statistics was used to analyse the data. Findings revealed that, the assessment of effectiveness of quality control techniques in building production in terms of planning and control resulted to a concise indication of cost of quality with the highest level of effectiveness and constructability of design assessment with the least. Based on these findings, it is recommended that all the quality control techniques in use should be put to practice rather than just a few, and should easily be accessible to ensure effectiveness in building production across all companies in the study area.

Keywords: Construction, Quality Control, Building Defects, Total Quality Management

Introduction

Quality control in the production process of construction deals with the complete execution of quality strategies by ensuring that control measures are fully adhered to in the production process to assess production. An important issue relating to design and construction management is quality sustenance in the construction industry (Rani, 2018). A high rate of building defects has significantly changed the public's dependence on buying or investing in housing. This makes it essential to build-up a quality control

system to keep the building and allow for decreasing building defects (Ali & Wen, 2011). It assumes that quality control requires checking products to identify flaws, malfunctions, and reporting to management to facilitate or refuse the consumer's use of the product. A building repair project requires immense knowledge to be skilfully supervised: knowledge of building parts and systems, building practices and techniques in various aspects of construction, as well as the usability of current building practices and challenge-mitigation strategies. Also, cost and cost dimension control and expansive social skills are criteria for productive project management operation. The issue of quality control in construction projects should not be exaggerated because construction facilities are the largest in the development plan and economic growth of any country (Farooqui, Masood & Aziz, 2008).

The construction sector is universally perceived as a fundamental industry on which a country's development progress relies. The progress of a nation and its growth status is typically defined by the existence of its physical infrastructure and construction projects placed in place (Wasiu, Aliyu & Modupe, 2012). Quality development can trace its roots back to medieval Europe, wherein the late thirteenth century, workers began to sort themselves into unions called societies to achieve a common goal (American Quality Society, 2010). Manufacturing in the industrialised world, in general, follow this craftsmanship model till the mid – nineteen fifties when the plant method, with its focus on product inspection, began in Great Britain and metamorphosed into the Industrial Revolution in the early 1800s and thus transformed the definition of production. In the early twentieth century, manufacturers started to integrate quality review into processes as a general standard. Quality became an essential component of the war effort towards the beginning of World War II as an item produced in one of the states required to work efficiently with things brought from different locations, thereby helping to eventually implement sampling techniques for investigation helped by the introduction of military-specification guidelines and training courses (American Society for Quality, 2010).

The American Society for Quality (2010) takes note of the years since the turn of the 20th century that have transformed quality beyond Absolute Quality. New quality systems have arisen, and quality has moved into service, healthcare, engineering, education, construction, and government sectors beyond engineering. In the recent past, there has been a general decrease in the output of the construction industry, possibly affected by the on-going rate of collapsed buildings, the prevalence of deserted construction sites, and generally low quality of completed projects, abandoned construction projects. Tan and Abdul-Rahman (2011) therefore, felt that a construction company that seeks to address itself in the current construction market, trend, and scope, which is highly challenging and demanding, needs quality management. The practice of quality control can help limit material wastage, time delays, facility deterioration, output product quality, and cost overrun (Ashokkumar, 2014) and can be used to maintain the requirements and basic needs of customers (Hoonakker et al.,

2010). Al-Ani & Al-Adhmani (2011) argued that quality management is necessary for the management system to be taken into account by construction companies to increase their efficiency standards. Still, in its most real sense, building companies do not practice quality management in its most fundamental sense.

Numerous studies were carried out on the quality control, quality management, in building production management, such as Yada & Yadeta (2016) investigated the factors affecting the performance of construction projects; Adam (2012) identified challenges facing quality control in construction industry; Neyestani (2016) assess the effectiveness of quality management system (QSM) on construction projects; Lounshine (2006) evaluated quality and safety management in construction; Shehu & Ijego (2014) identified quality control mechanisms in building production management in Nigeria; Agbenyega (2014) assessed quality management practices of building construction companies; Flett (2001) determined the role of quality in the management of projects; Tanko (2017) processed stakeholders assessment of constraints to project delivery in the Nigerian construction industry; Oteju (2014) evaluated the management and control of product quality; Olalekan (2010) assessed total quality management in Nigerian SME companies; Arditi and Gunaydin (1997) evaluated comprehensive quality management in construction process, and Salter (1993) assessed total quality management and applications to the construction industry.

However, none of the previous researches has tremendously and robustly carried out findings on Effectiveness of Quality Control Techniques in Building Production in terms of planning and control, thus giving due diligence to technological, environmental, personnel, and project-related challenges of management. Therefore, this study intends to bridge the above gap by identifying the techniques used for quality control in building production and investigating the effectiveness of the quality control techniques on building production in Abuja municipal area council, Federal Capital Territory.

Review of Related Literature

Quality Control

Stevenson, Hojati and Cao (2007) define 'Quality Control' as a mechanism by which a company attempts to ensure that product quality is improved or maintained and that defects or defects are reduced or contained to the best of its capacity. Quality management allows the organization to create an atmosphere in which flawlessness is sought by both leadership and employees (Goetsch & Davis, 2014). This is accomplished through training staff, making product quality milestones, and testing products to check for statistically significant variations. The establishment of well-defined standards is a significant part of quality control. This control helps to institutionalize both production and reactions to quality issues. Limiting the space for errors by determining which manufacturing tasks are to be performed by which workers and, in turn, reducing the chance for workers to engage in operations in which they do not have adequate expertise (Kerzner & Kerzner, 2017). Quality Management Systems, (2013) believed that quality

control is the method of determining whether specific requirements are met by construction projects. Health is a primary objective of quality management. In addition, quality control is also primarily intended to ensure the safety and sustainability of buildings (Trienekens & Zuurbier, 2008).

The ISO definition also states that the operational techniques and activities that are used to meet quality or product requirements are quality control (Dale & Plunkett, 2017). This description could infer that a quality control operation could be any behavior, whether serving the enhancement, control, implementation, or affirmation (Montgomery, 2007). What the definition neglects to tell us is that controls regulate efficiency. They foresee improvement, and it guides quality output when linked to the quality and avoids unnecessary changes in quality models (Mitra, 2016). Quality control has continued to be a process for ensuring or maintaining standards and not for creating them. Via a method of work assessment, estimate, and review, guidelines are maintained such that only certain goods or services that emanate from the method follow the guidelines. Quality management subsequently counteracts adverse shifts in the quality of the product or service being supplied (Mitra, 2016). Quality control may be applied to specific products, to processes which produce the products, or to the production of the entire business by measuring the general quality performance of the company (Montgomery, 2007). It is deemed that quality assurance seeks prevention and quality control discovery but a control introduced to distinguish failure before it happens ensures prevention such as decreasing the tolerance line to well within the acceptable specification limits (Kapur & Pecht, 2014). So quality control can anticipate failure. Assurance is a forecast and the implications of an examination while the result or expectation is produced by control. The object is not changed by Quality Assurance, but Quality Control does. Harris and McCaffer (2001) characterised quality control as a set of operations or techniques whose purpose is to ensure that all quality criteria are being met and maintained. To accomplish an objective, how processes are controlled and performance problems are eradicated. Scatterfield (2005), as such, said quality control is fundamentally essential to a profitable construction project and ought to be complied upon throughout a project life from inception and design to execution and completion. Inspection in the middle of construction, after the project is executed, will anticipate costly repairs. To analyze, report, and provide solutions to inadequacies in development, the auditor, engineer, contractor, financial, regulatory body, and framework staff must function in harmony (Deming, 2018).

Quality Improvement

The Heath Establishment (2009) said there is no single meaning of quality improvement or enhancement, and no single approach has all the earmarks of more effective over the other. Notwithstanding, various definitions depict quality enhancement as a systematic methodology that utilises explicit strategies to enhance quality. The most critical component in a fruitful and maintained enhancement is how the change is presented and

actualised. According to ISO 9000:2000, Quality improvement is Part of quality management inclined towards increasing the knowledge of enhancing quality requirements (Moosa & Sajid, 2010). Empirical investigations on quality management in construction have revealed that numerous quality improvement practices are common among non-residential developers and builders. Most of these practices have been collectively summarised under a useful management concept termed "Total Quality Management" or TQM (Shofoluwe et al., 2012).

Quality Management Systems in Construction

Some of the perceived quality management standards include; The ISO9000 series, Complete Quality Management, Quality Control, Quality Assurance, Malcolm Baldridge Standard (MBS) and BS 5750 of the British Standard Institute (BSI), European Construction Institute (ECI), which developed the (ECI) Matrix in 1993 (Kado, 2011). The fundamental task of rules and regulations is to safeguard the well-being and protection of the people. According to the ASCE Handbook (2012), compliance with benchmarks should be a problem tackled right from the beginning of the project endeavour. Reworking plans and control measures could lead to considerable costs and postponement or delay without an early diagnosis of the appropriate codes and standards. Before conceptualizing the design plan, the architect must be knowledgeable about the provisions of codes and standards because the building codes directly control the minimum requirements of essential components of a construction project and are significantly more prohibitive for the quality of the finished product. Kubal (1994) argues that building process management regulations are far stricter than in most manufacturing and service industries. Stasiowski & Burstein (1994) underscore that quality structure starts with sound designing and logical principles which must fulfil the requirements of applicable codes and benchmarks, yet the proprietor's project obligations. The regulations and guidelines allude to the lowest specifications. Proprietors, though, may have particular criteria. Table 1 demonstrates the continuing growth and transformation of quality enhancement, which has been categorized over the years by various writers and researchers

ISO 9001 Quality Management Practices

The British Standards Institute (BSI) (2008) has described the efficient implementation of Quality Management Practices (QMP), as partnered in the applicable ISO 9001 standard, as requiring effective preparation, activity, and examination, as well as continuous improvement of the system at all levels of company effectiveness, as the degree to which planned activities are recognized, and planned results are recognized. In order to be seen to have been effectively or fruitfully implemented, the term "effectiveness" is incredibly unique to the implementation of the quality management system, as organizations that adopt a QMP must fulfil their predefined quality criteria and specified quality goals without any shortcomings (Willar, 2012). Effective

implementation of a Quality Management System (QMS) and the assurance of quality values or a high-level concept of quality, whether by the operation of a QMS-ISO 9001 or the application of a TQM approach, will theoretically provide the requisite benefits, even in the most competitive building environments.

Curt (2005) pointed out that the system for quality control tracks and analyses the quality of the built project and predicts quality issues and problems. Typical quality controls include quality management tests: number of conducted, recurrence and percentage passed or failed, number of non-compliance problems, number of demands for improvement and root causes, rework cost, number of exceptional cases at turnover and quality cost (ii) quality assurance cost (resource cost): cost of quality assurance as a percentage of construction cost, cost of quality and cost of quality Lepartobiko (2012) found that by analysing and wiping out the factors that cause poor project results, quality can be guaranteed. Jha & Jha (2006) claimed that the skills of the project manager and top management support are found to have a major effect on improving the quality of a construction project. The lack of familiarity with the contractor topped the quality-related cause of project failure. Ling & Bui (2010) said that the main enhancers leading to project completion are the participation of international experts in the project, the project's review by government authorities, and very close monitoring when new construction techniques are used. The lack of reliable data on soil, weather, and traffic conditions is a factor that contributes to poor results.

Methodology

Quantitative method was used as research design in both data collection and analysis stages. The target population for this study are the Architects, Quantity Surveyors, Civil Engineers, Mechanical Engineers, Electrical Engineers, and Builders (Professionals) involved in construction industries day-to-day production process in Abuja municipal area council. The research used Krejcie and Morgan (1970) table to arrive at a sample size of 175 professional within the building parlance from a sample frame of 317. The study adopted the proportionate stratified sampling technique. For this research, 175 numbers of questionnaires were administered for possible chances to the professional practicing and financially registered. Of which 37 were Architects 36 were Quantity Surveyors, 38 were Civil Engineers, 26 were Mechanical Engineers, 9 were Electrical Engineers and 29 are Builders. (Keyton, 2014). The instrument that was used in this study is self-administered questionnaire. SPSS version 23 was used to test the relationship among the variable in the research. Also, it was used to test the reliability of the instrument. After careful scrutiny in pretesting, the questionnaires were distributed to sample respondents 40 for the pilot test in order to test a reliability of the instruments

Analysis and Discussion of Result

One hundred and seventy-five (175) sets of questionnaires were administered to practicing financially up to date Professionals in the Construction Industry within the

study area. A total number of one hundred and seventy-one (171) questionnaires with 97.7 % response rate were retrieved. A total number of 169 were used in the analyses after which 2 were removed as incomplete ones and data screening for outliers. The overall response rate after data screening was 96.6%.

Demography

The demographic information of the respondents was collected. The frequency and percentage analysis were carried out and the results presented to explore the respondents' profile.

Table 1: Demography Results

S/N	*Variables*	*Options*	*Frequency*	*Percentages*
1.	**Gender**	Male	69	40.8
		Female	100	59.2
2.	**Age**	Under 30 years	32	18.9
		30 to 60 years	126	74.6
		Above 60 years	11	6.5
3.	**Profession**	Architects	35	20.7
		Quantity Surveyor	36	21.3
		Civil Engineer	47	27.8
		Electrical Engineer	13	7.7
		Mechanical Engineer	11	6.5
		Builder	27	16.0
4.	Educational Qualification	Diploma	16	9.5
		Degree	94	55.6
		Master degree and above	59	34.9
5.	Type of Organization:	Client	20	11.8
		Consultants	30	17.8
		Contractors	29	17.2
		Private	55	32.5
		Public	35	20.7
6.	Company size (number of employees):	Small (1-4)	56	33.1
		Medium (5-20)	101	59.8
		Large (more than 20)	12	7.1
7.	Number of your years of experience:	Less than 5 years	20	11.8
		5-15years	81	47.9
		Above 15years	68	40.2

Table 1 depict that 59.2% were females, while 40.8% were males. This explains the extent to which female traditionally predominate most respondents or professionals in the construction industries in the study area. The analysis of the gender of the respondent was carried out to provide contextual information of the gender distribution of the respondent within the study area. The age range shows that 18.9% are under thirty years and 74.6% of the respondents fall within the range of 30-60 years and 6.5% are above 60 years of age, respectively, hence, 30-60 years indicates the predominance of professionals in the construction industries than over the middle-aged life span. Regarding the profession of the players in the industries which clearly show that 20.7% are architects, 21.3% are quantity surveyors, 27.8 are civil engineers, 7.7% are electric engineers, 6.5% are mechanical engineers and 16.0% are builders. Professionals educational backgrounds, most of the respondents were well educated; where 9.5% are diploma holders, 55.6% are degree holders, 34.9% have masters and above, while in aspect of the organization types 11.8% are client based, 17.8% are consultants, 17.2% are contractors inclined, 32.5% are privately run and 20.7 are public construction firms or client, Company size (number of employees): Small (1-4) has 33.1%, Medium (5-20) are 59.8% and Large (more than 20) are 7.1% which incidentally relates that the medium size construction companies constitute majority in the study area, lastly considering the Number of your years of experience: 11.8% are Less than 5 years, 47.9% has 5-15years experience and 40.2% has experience of 15years and above which obviously shows that the most of the professional experience fall within 5-15years.

RQ1: *What are the techniques used for quality control in building production in the study area?*

Descriptive statistics based on mean ranking was carried out to explore the techniques used for quality control in building production in Abuja Nigeria. Hence, the results showed the ranking, mean and standard deviation for each item in Table 2 below:

Table 2: **Techniques used for quality control in building production in Abuja Nigeria**

SN	*Techniques used for quality control*	*Mean*	*Std. Deviation*	*Rank*
1	Work Breakdown Structure (WBS)	4.06	0.943	Highly Used
2	Gantt chart	3.99	0.890	Used
3	Sensitivity Analysis	3.82	0.917	Used
4	PRINCE 2	3.81	0.926	Used
5	Cost Benefit Analysis (CBA)	3.80	0.978	Used
6	Statistical Methods	3.76	1.031	Used
7	Contractor Performance	3.75	1.028	Used
8	Customer Service	3.73	1.095	Used
9	Supplier Involvement	3.71	1.077	Used
10	Cost of Quality	3.70	1.095	Used

11	Graphical Evaluation and Review Technique (GERT)	3.64	1.032	Fairly Used
12	Constructability of Design assessment	3.64	1.167	Fairly Used
13	Critical Path Method	3.60	1.081	Less Used
14	Programme Evaluation and Review Technique (PERT)	3.58	1.188	Less Used
15	Construction Industry-Specific Factor	3.57	1.153	Less Used
16	Use of Drawings and Specifications tools	3.56	1.138	Less Used

From Table 2, the data displays that the mean value ranged from a highly used mean value of 4.06 to the less used mean value of 3.56. It can be perceived from the Table 4 that Work Breakdown Structure (WBS) has the highest mean value of 4.06; hence ranked 1st – highly used, followed by Gantt chart with a high mean value of 3.99 and used, Sensitivity Analysis, with a high mean value of 3.82 and used, PRINCE 2 with a high mean value of 3.81 and used, Cost Benefit Analysis (CBA) has a high mean value of 3.80 and used, Statistical Methods with a high mean value of 3.76 and used, Customer Service with a high mean value of 3.73 and used, Supplier Involvement with a high mean value of 3.71 and used, Cost of Quality with a high mean value of 3.70 and used, Graphical Evaluation and Review Technique (GERT) with a fairly used mean value of 3..64, Constructability of Design assessment with a fairly used mean value of 3.64, Critical Path Method was less used with mean value of 3.60, Programme Evaluation and Review Technique (PERT) was less used with a mean value of 3.58, Construction Industry-Specific Factor was less used with the mean of 3.57 and Use of Drawings and Specifications tools was less used with a mean value of 3.56. The analysis from the Table 4 shows that the major techniques used for quality control in building production in Abuja Nigeria are Work Breakdown Structure (WBS) highly used, while Gantt chart, Prince 2, Sensitivity analysis, Cost benefit analysis, Graphical evaluation and review technique, Critical path method, Programme evaluation and review technique, Statistical method, and Cost of quality were used and the remaining were less used.

RQ2: *What is the effectiveness of the quality control techniques in terms of planning and control in the study area*?

Descriptive statistics based on mean ranking was conducted to explore what is the effectiveness of the quality control techniques in terms of planning and control in the study area. The results showed the ranking, mean and standard deviation for each item in Table 3

Table 3: **Effectiveness of the quality control techniques in terms of planning and control in Abuja Nigeria**

SN	*Quality control techniques*	*Mean*	*Std. Deviation*	*Rank*
1	Cost of Quality	4.26	0.888	Very Effective
2	Work Breakdown Structure (WBS)	4.05	0.811	Effective

3	Supplier Involvement	3.92	0.751	Effective
4	Gantt chart	3.91	0.773	Effective
5	PRINCE 2	3.85	0.886	Effective
6	Cost Benefit Analysis (CBA)	3.74	0.965	Effective
7	Customer Service	3.74	0.847	Effective
8	Sensitivity Analysis	3.72	0.914	Effective
9	Statistical Methods	3.71	1.088	Effective
10	Graphical Evaluation and Review Technique (GERT)	3.70	0.956	Effective
11	Contractor Performance	3.60	0.854	Effective
12	Critical Path Method	3.57	1.084	Fairly Effective
13	Programme Evaluation and Review Technique (PERT)	3.55	1.052	Fairly Effective
14	Use of Drawings and Specifications tools	3.39	1.007	Fairly Effective
15	Construction Industry-Specific Factor	3.38	1.018	Fairly Effective
16	Constructability of Design assessment	3.24	1.280	Fairly Effective

From Table 3, the data displays that the mean value ranged from a very effective mean value of 4.26 to the fairly effective mean value of 3.24. It can be perceived from Table 5 that Cost of Quality has the rank very effective mean value of 4.26 and ranked highest, followed by Work Breakdown Structure (WBS) as effective with a mean value of 4.05, Supplier Involvement was effective with a mean value of 3.92, Gantt chart was effective with a mean value of 3.91, PRINCE 2 was effective and has a mean value of 3.85, Cost Benefit Analysis (CBA) was effective, with a mean value of 3.74, Customer Service was effective with a mean value of 3.74, Sensitivity Analysis was effective with a mean value of 3.72, Statistical Methods was effective with the mean of 3.71, Graphical Evaluation and Review Technique (GERT) was effective with the mean of 3.70 Contractor Performance was effective with the mean of 3.60, Critical Path Method was fairly effective with a mean of 3.57, Programme Evaluation and Review Technique (PERT) was fairly effective with a mean of 3.55, Use of Drawings and Specifications tools was fairly effective with a mean of 3.39, Construction Industry-Specific Factor was fairly effective with a mean of 3.38 and Constructability of Design assessment was fairly effective with a mean of 3.24 the analysis from the Table shows it ranked lowest. The effectiveness of the quality control techniques in terms of planning and control in the study area is very effective in Cost of Quality and least in Constructability of Design Assessment and is fairly effective.

Conclusion and Recommendation

Conclusively, the study has ascertained the techniques of quality control adopted by professionals in building production in terms of planning and control in the study area.

The study has also ascertained the effectiveness of quality control techniques in building production in terms of planning and control aspects of management in Abuja. Lastly, the study has ascertained the challenges of quality control techniques in building production in terms of planning and control in Abuja with inclination to environmental, technological, personnel and project related challenges respectively

In view of the Findings made and Conclusion drawn from the study, it is recommended that all the quality control techniques in use should be put to practice rather than just a few, and should easily be accessible to ensure effectiveness in building production across all companies in the study area. So also, the gap for further study should create a data base for information and communication challenges of quality control techniques from lowest to highest as negative factors should have negative highest value respectively. Lastly, Construction consultants, contractors both private and public should imbibe quality control habits through training, workshops, seminars, symposium, etc to aid effective and efficient productivity

Reference

Abdelsalam, H. M., & Gad, M. M. (2009). Cost of quality in Dubai: An analytical case study of residential construction projects. *International journal of project management*, *27*(5), 501-511.

Abdulsalam, A. Z. (2016). Assessment of Quality Management Practices of Building Construction Firms in Abuja, Nigeria, being a Master's thesis submitted to Department of Building, Faculty of Environmental Design, Ahmadu Bello University, Zaria, Nigeria.

Agbenyega, I. (2014). *Quality management practices of building construction firms in Ghana* (Doctoral dissertation).

Asim, M., U.Z Zaman, S., & Zarif, T. (2013). Implementation of total quality management in construction industry: A Pakistan perspective. *Journal of Management and Social Sciences*, *9*(1), 24-39.

Atkinson, R., Crawford, L., & Ward, S. (2006). Fundamental uncertainties in projects and the scope of project management. *International journal of project management*, *24*(8), 687-698.

Ayanda, A. M., & Laraba, A. S. (2011). Small and medium scale enterprises as a survival strategy for employment generation in Nigeria. *Journal of sustainable development*, *4*(1), 200.

Azhar, S., Khalfan, M., & Maqsood, T. (2015). Building information modelling (BIM): now and beyond. *Construction Economics and Building*, *12*(4), 15-28.

Bamisile, A. (2004). *Building production management*, Lagos-Nigeria, Foresight Press Ltd,

Barton, D. (2017). *Literacy: An introduction to the ecology of written language*. John Wiley & Sons.

Bauer, H. H., Falk, T., & Hammerschmidt, M. (2006). eTransQual: A transaction process-based approach for capturing service quality in online shopping. *Journal of Business Research*, *59*(7), 866-875.

Besterfield, D. H. (2004). *Quality control*. Pearson Education India.

Buskirk, G. L. (1976). *The dissemination and utilization of network based management systems in public school districts in Ohio and geographically contiguous states* (Doctoral dissertation, The Ohio State University).

Callahan, J. L., Almstrom, C. M., Swift, J. K., Borja, S. E., & Heath, C. J. (2009). Exploring the contribution of supervisors to intervention outcomes. *Training and Education in Professional Psychology*, *3*(2), 72.

Chakos, A., Schulz, P., & Tobin, L. T. (2002). Making it work in Berkeley: Investing in community sustainability. *Natural hazards review*, *3*(2), 55-67.

Chin, C. M. M., Yap, E. H., & Spowage, A. C. (2010). Reviewing leading project management practices. *PM World Today*, *12*(11), 1-18.

Csele'nyi, J, Ille's B.: Planning and controlling of material flow systems. Textbook, Miskolci Egyetemi Kiado', 2006

Cummings, T. G., & Worley, C. G. (2014). *Organization development and change*. Cengage learning.

Deloitte. Industry 4.0 – Challenges and Solutions for the digital transformation and technologies, Deloitte, http://www2.deloitte.com/(2014)

DelNibletto, P., Editor – Computer Dealer News, Canada, IT Channel Community, 2018
Deming, W. E. (2018). *Out of the Crisis*. MIT press.
Denscombe, M. (2014). *The good research guide: for small-scale social research projects*. McGraw-Hill Education (UK).
Dick, J., Hull, E., & Jackson, K. (2017). *Requirements engineering*. Springer.
Eastman, C., Teicholz, P., Sacks, R., & Liston, K. (2011). *BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors*. John Wiley & Sons.
European Environments Agency, State and Synthesis 20.1.11, http://www.eea.europa.eu
Forbes, L. H., & Ahmed, S. M. (2010). *Modern construction: lean project delivery and integrated practices*. Crc Press.
Frank, R. H., & Cook, P. J. (2010). *The winner-take-all society: Why the few at the top get so much more than the rest of us*. Random House.
Gaikwad, L. M., Teli, S. N., Majali, V. S., & Bhushi, U. M. (2016). An application of six sigma to reduce supplier quality cost. *Journal of The Institution of Engineers (India): Series C*, *97*(1), 93-107.
Gillen, M., Goldenhar, L. M., Hecker, S., & Schneider, S. (2014). Safety culture and climate in construction: bridging the gap between research and practice. *Omni*, *2013*.
GIRI, M. (2014). Total quality management (TQM) implementation in construction firm. A literature review and analysis.
Giunipero, L., Handfield, R. B., & Eltantawy, R. (2006). Supply management's evolution: key skill sets for the supply manager of the future. *International Journal of Operations & Production Management*, *26*(7), 822-844.
Goetsch, D. L., & Davis, S. B. (2014). *Quality management for organizational excellence*. Upper Saddle River, NJ: pearson.
Grondzik, W. T., & Kwok, A. G. (2014). *Mechanical and electrical equipment for buildings*. John Wiley & Sons.
Hallowell, M. R., Hinze, J. W., Baud, K. C., & Wehle, A. (2013). Proactive construction safety control: Measuring, monitoring, and responding to safety leading indicators. *Journal of Construction Engineering and Management*, *139*(10), 04013010.
Halpin, D. W., Lucko, G., & Senior, B. A. (2017). *Construction management*. John Wiley & Sons.
Harrison, F., & Lock, D. (2017). *Advanced project management: a structured approach*. Routledge.
Hertzum, M., & Pejtersen, A. M. (2000). The information-seeking practices of engineers: searching for documents as well as for people. *Information Processing*