CONSTRUCTION MANAGEMENT PRACTICES INFLUENCING PRODUCTIVITY IN BUILDING PROJECTS

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ABSTRACT

The adverse effects of management related problems affecting productivity in construction projects can be reduced by implementing best management practices that are suitable for a specific project type. Previous studies identified the best practices for infrastructure and industrial projects. However, these practices could not directly be used for building projects as the management practices might vary from project to project and from country to country. Moreover, a little research has been conducted on what the best practices might be in the context of building projects in Victoria, Australia. Face-to-face in-depth interviews were conducted with nineteen experienced professionals in the construction industry and forty-seven context specific best practices for building projects such as long lead materials identification, machinery productivity analysis, short interval planning, incentive programs, dynamic site layout plan and safety policy are identified. The study revealed that some best practices that are applicable to infrastructure and industrial projects are not suitable for building projects. Therefore, implementation of the best practices identified in other contexts could not improve productivity in building projects and principal contractors involved in building construction should adopt context-specific practices to enhance the productivity of their projects.

Keywords: *Australia; Best Practices; Building Projects; Management Practices; Productivity.*

1. INTRODUCTION

Construction productivity improvement is essential for economic growth of a country. Productivity growth is also important for increasing the profit margin of contractors. Previous studies confirmed that management practices and technology are among the most important factors that have the potential to increase productivity in construction projects (Rojas and Aramvareekul, 2003). For principal contractors involved in the management of many subcontractors, the implementation of best management practices plays a vital role than the use of technology in delivering building projects within the contract time. The Victorian state construction industry is characterised by numerous subcontractors and a few principal contractors (Australian Bureau of Statistics, 2016). Multi-storey building projects in the state are managed by a principal contractor that engages various subcontractors. Thus, the use the best practices can help principal contractors to manage their subcontractors and to hand over their projects within agreed time framework. Moreover, the implementation of best practices can reduce the adverse effects of the construction productivity problems such as shortage of materials, equipment and tools; rework; breakdown of machinery; disruption of utilities; changes in design and specifications; turnover; and accidents (Makulsawatudom *et al*., 2004; Rivas *et al*., 2011; Ghoddousi and Hosseini, 2012; Hughes and Thorpe, 2014).

A review of the literature shows that management practices having the potential to improve the productivity of construction projects can be classified into six categories: materials management, equipment and tools management, execution approach, human resource management, construction methods, and safety and health practices (CII, 2013b; CII, 2013a; Nasir, 2013; Caldas *et al*., 2014). However, as these practices are identified for industrial and infrastructure projects, they might not be best practices for building projects. Moreover, since projects are unique in nature management practices that are considered best in other countries might not be best in Australia. Furthermore, there is a little research

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done on what the best management practices could be for building projects. Therefore, the objective of this research is to identify the best construction management practices that have the potential to improve productivity in building projects in the context of Victoria, Australia.

2. LITERATURE REVIEW

Best practices are defined as the most efficient ways of doing something (Helms, 2006). In construction industry context, the best practices are processes that lead to enhanced project performance when they are executed effectively (CII, 2016). Productivity is the ratio of output to input (Park *et al*., 2005). In this study, output represents the value of a completed building project in dollars and input refers to the project duration in days. Materials management, equipment and tools management, execution approach, human resource management, construction methods, and health and safety practices are reviewed in this section.

Previous researchers suggested numerous materials management practices that have the potential to improve productivity in construction projects. Bell and Stukhart (1987) suggested the implementation of efficient materials management practices such as materials planning to enhance productivity. Olomolaiye *et al*. (1987) recommended regular review of the principal contractors' cash to ensure a continuous supply of materials. Lim and Alum (1995) suggested the use of just-in-time materials delivery techniques in urban Singapore. Arditi and Mochtar (1996) found that improvement in procurement practices could lead to enhanced project productivity. Abdul *et al*. (2005) mentioned the influence of the planning of critical materials on productivity. Makulsawatudom *et al*. (2004) proposed careful inspection of the construction materials as one of the areas where productivity improvement could be obtained in the construction industry of Thailand. Moreover, the authors emphasized the importance of initiation of materials management meetings as a means to improve coordination between head office and site team. Jergeas (2009) suggested that the availability of both critical and non-critical materials should be ensured to improve productivity in oil and gas capital projects in Alberta, Canada. Grau *et al.* (2009) assessed the impact of materials tracking technologies on crafts' productivity and quantified the impact of automating, identifying and localizing engineered components on productivity in industrial projects. The results of the study indicated that materials tracking technologies can significantly improve productivity. Nasir (2013) investigated the importance of construction materials procurement team and preservation of materials in construction sites to increase productivity in infrastructure projects. Caldas *et al*. (2014) identified monitoring materials status database as the best productivity practice for industrial projects. Some of the above materials management practices might not be applicable for building projects in the context of the Victorian building industry as the majority of principal contractors are not directly involved in purchasing construction materials.

Productivity improvement can also be achieved by implementing good equipment and tools management practices. Wheeldon (2012) mentioned effective tools management systems such as the use of tools tracking technology and regular inventory of tools to enhance productivity. Arditi and Mochtar (1996) identified maintenance of machinery as one of the possible areas where productivity gain could be obtained in the construction industry of Indonesia. Stewart (2002b) suggested that to fulfil the short term equipment demand, renting is the preferred procurement option. Stewart (2002a) recommended leasing option when there are many construction projects in an industry. Marquez and Herguedas (2004) described that good record keeping helps contractors to analyse the performance of the equipment and to take corrective actions. Wireman (2005) justified the benefit of training the machinery operators in improving productivity and saving costs. Prasertrungruang and Hadikusumo (2007) suggested adopting of suitable construction equipment acquisition strategies such as renting, leasing and buying based on project scope and construction markets. Procurement procedures and plans for equipment and tools were found to be the best practices in improving roductivity in industrial projects (CII, 2013a). Conducting onsite tool maintenance was found to be one of the best practices for infrastructure projects (Nasir, 2013). The author also described that identifying tools which need maintenance, planning the time when they will be repaired, and assigning qualified personnel are important tool management practices. In the context of Victoria, since principal contractors sublet most of the construction works, some of the equipment and tools management practices might not be important to improve the productivity of building projects.

The preparation of detailed project execution plan is another potential area for productivity improvement. According to PMI (2013), a project plan is a formal and approved document used to guide project execution and control. It is used to document any assumptions and decisions about a project, facilitate communication among stakeholders, and document approved scope, cost and schedule baselines. Hadavi and Krizek (1993) concluded that higher construction productivity is obtained by implementing short-interval goals instead of long-interval goals. Arditi and Mochtar (1996) suggested that the use of the construction management (CM) project delivery system is significant to increase productivity. Jergeas (2009) found that defining clearly the scope of a project and reducing conflicting issues among contract documents are good practices to enhance project performance. CII (2013a) identified Construction Work Packaging (CWP) as the best practice for industrial projects. Construction Work Package (CWP) is an executable construction deliverable which defines a specific scope of work in detail including its budget and schedule (COAA, 2013b). COAA (2013a) recommended the assignment of a dedicated planner to improve construction productivity. Nasir (2013) suggested identification of permitting requirements and alignment of utilities such as water and power as the potential areas for productivity improvement in infrastructure projects. Caldas *et al*. (2014) identified the utilization of software in generating work packages and in developing 3D models as one of the best productivity practices for industrial projects. El-Gohary and Aziz (2014) suggested that increasing the constructability level of design is the first step in improving productivity in the construction industry of Egypt. In the Victorian construction industry, as there are numerous regulatory requirements for building projects, preparation of detailed project execution plan might be important. For instance, the practice of the identification of the type of permits could be significant for principal contractors. Thus, the implementation of some of the above practices might help the contractors to improve productivity in their building projects.

The use of good human resource management practices could also lead to improvement of construction projects' productivity. Maloney (1983) mentioned that team building practice is one of the approaches which enhance the forces acting to increase the productivity of the labour. Liberda *et al*. (2003) suggested emphasizing on team building or crew composition as important human resource management practice. Fagbenle *et al*. (2004) concluded that the productive time of bricklayers who received non-financial incentive was improved significantly. Kazaz and Ulubeyli (2007) mentioned that incentive payments, the adequacy of the workers' payment as compared to others' who are working on similar projects, the effectiveness of the remuneration on time and the arrangement of social activities are the most important factors that could increase workers' motivation. Wang *et al.* (2010)found that training for craftsmen increased construction productivity by 5%, and decreased absenteeism as well as turnover by 2.5% and 10% respectively. Hewage *et al.* (2011) concluded that the construction productivity might not be improved by only working hard and fast. According to the author, the companies should also develop the social skills of their workers. Tabassi *et al*. (2012) described that a well-organized human resource development program is an essential strategy for construction firms as human capital plays a significant role in the success of an organization. According to Hong *et al*. (2012), effective human resource management practices such as employee empowerment, training and development, appraisal system, and compensation are the principal factors for employee retention. Nasir (2013) identified the clarification of the responsibilities of employees as one of the best practices for improving productivity in infrastructure projects. Caldas *et al*. (2014) concluded that maintaining the stability of the organizational structure is the best management practice for industrial projects. Some of the human resource management practices mentioned above might not be applicable for principal contractors in Victoria. For instance, crew composition for each trade of work might not be important for principal contractors involved in managing the works of subcontractors.

Construction methods related practices are also identified as the critical factors that could enhance productivity in the construction projects. According to PMI (2013), project management methods are defined as a system of practices, techniques, procedures, and rules used by those who work in the discipline. Dynamicsite layout which refers to a sequence of layouts, each is used for a discrete time interval or certain project phase, and together covering the entire duration of a construction project is one of the techniques for productivity enhancement (Tommelein and Zouein, 1993). Arditi and Mochtar (1996) found that integration of management functions could increase construction productivity. The use of Critical Path Method (CPM) in controlling and integrating various schedules is significant for monitoring project performance (Neil and Knudsen, 1990). The project schedule controlling technique

include the methods used in measuring work progress such as units completed, incremental milestone, start/finish, and manager or supervisor judgment (Attalla, 1997). The technique also includes analysing, reporting and corrective action approach. Zhang *et al*. (1999) developed a computer model to optimize the location of a group of tower cranes. Hanna *et al*. (2008) suggested that the use of second shift schedule is effective as compared to overtime and overmanning in reducing the project duration. Nasir (2013) found that project start-up, project completion, traffic control and site security plans are the best practices for enhancing productivity in infrastructure projects. Investigation of new technologies for construction methods is recommended as one of the mechanisms to increase construction productivity (CII, 2013a). Caldas *et al*. (2014) suggested that the implementation of the integrated schedule is the best management practice for improving the productivity in industrial projects. In cities such as Melbourne, Australia, building construction projects are carried out in confined spaces. Thus, some of the above-mentioned practices such as machinery positioning strategy might be important to enhance productivity in building projects.

Finally, health and safety practices could also improve productivity in construction projects. Sawacha *et al.* (1999) found that organizational policy on safety is the most significant factor that could influence the safety performance of construction projects in the UK. Hinze and Wilson (2000) confirmed that conducting alcohol and substance abuse program is one of the mechanisms to achieve zero accidents on construction projects. Dai *et al*. (2009) mentioned the impact of health and safety training on productivity. Jergeas (2009) found that neat and clean work environment and safety training are essential to ensure safety and productivity in construction projects. Preparation of the workplace health and safety (WHS) management plan according to the relevant code of practices is essential for productivity and safety of construction workers (Safe Work Australia, 2012). Safe work method statements (SWMS) or job safety analysis for each task is the practice that could ensure the safety of workers and leads to enhanced productivity. According to Safe Work Australia, SWMS sets out the tasks in a logical sequence, identifies the potential hazards and describes the measures to control them (Safe Work Australia, 2012). The occurrence of accidents in building projects in Victoria could lead to the closure of the site and productivity could be influenced. Thus, adopting best practices for safety and health might help principal contractors to increase their projects' productivity.

3. RESEARCH METHODOLOGY

Interviews were used to investigate the context-specific best management practices since they could vary from country to country and from project to project. Constructivist paradigm is adopted as there is no single best management practice that is accepted universally. Different construction industries have their own best practices which can be investigated by collecting qualitative data that helps to understand how each practice is implemented, why some of the practices are not suitable in some industries and other related issues. Accordingly, in-depth face to face interviews which took an average of one and half hours were conducted with nineteen professionals having construction industry experience ranging from five to forty years in Australia. The participants have been working as a general manager, construction manager, project manager, project coordinator, project engineer, site engineer, contract administrator, supervisor and cost manager. Semi-structured interview questions were prepared for sixty-nine management practices which were identified from the literature. The questions include: Does the practice exist? How do local contractors practice it? Is this practice best in improving the productivity of building projects? What other practices enhance the productivity of building projects? The interviews were audiotaped, transcribed and analyzed. Data analysis reached a saturation point and best practices for building projects were identified. Saturation refers to the point where a new respondent provides a similar reason for accepting or rejecting a particular management practice.

According to Rose *et al.* (2015), qualitative data analysis consists of three concurrent flows of activity: data reduction, data display, and conclusion drawing. Data reduction is a form of analysis that sharpens, sorts, focuses, discards, and organizes data in such a way that final conclusions can be drawn (Miles and Huberman, 1994). Writing summaries, coding, and making clusters are common methods used in the data reduction process. The latter two methods of reducing the collected data are more suitable when the research is entirely inductive nature.In this research context, writing a summary is used as it is suitable to sum up the responses of the interviewees regarding a particular management practice. The reduced data is

displayed using matrices, graphs, charts and networks (Miles and Huberman, 1994; Rose *et al*., 2015). In this study, matrix technique is used as it is convenient to exhibit the summaries of the responses in matrix boxes. Once the data is displayed, theconclusion from qualitative data is drawn by noticing the patterns of similarities and differences between categories and/or processes, clustering, making contrasts and comparisons and noting relations between concepts (Rose *et al*., 2015). According to the author, the final three approaches are more appropriate if the researcher attempts to develop a theory from qualitative data only. However, in this research context, qualitative data was collected to be used as an input to the quantitative research and the first strategy that is noticing the pattern of similarity between the interviewees' responses about a specific construction management practice is used to drawn a conclusion.

An Excel spreadsheet in the form of a matrix was prepared to match the responses of an expert and management practices (refer Table 1). A summary of what each respondent has described about a particular management practice was written in boxes and a conclusion was drawn. Similar iterative procedures of qualitative data analysis such as transcribing, summarizing and concluding were used for all the interview results. The succeeding interview was not conducted until the previous one was analysed using the three procedures. The similarity between the successive summaries was identified to find a saturation point. After analysing the outcome of the fifteenth interviewee, similar explanations for the management practices were observed. Although the saturation point is reached at fifteenth interviewee, additional interviews were conducted until the nineteenth participant for the sake of confirmation. Finally, the practices that were described as suitable were included in the list of best practices for building projects. For the sake of brevity, all the data is not included in this paper. Sample data analysis for the practice "machinery positioning strategy" is indicated in Table 1 below. In the Table, the last two respondents R_{18} and R_{19} described that construction machinery positioning strategy is a best practice and explained similar factors such as the weight of materials, the floor area of a building, and the presence of nearby objects to determine the optimal location of a crane. Similar reasons were providedafter the fifteenth participant, and the practice was concluded as applicable for building projects in Victoria, Australia. By using similar techniques, forty-sevencontext-specific best management practices were identified and twenty-two practices are excluded from the list of the best practices.

Table 1: Interview Data Analysis Template

Construction Management Practices	**Respondents (R)**								
	R_1		**…**	**R_{17}**	**Respondent(R_{18})**		**Respondent(R_{19})**		**Final Conclusion**
	S	**C**	**S**	**C**	**Summary(S)**	**Conclusion(C)**	**Summary**	**Conclusion**	
52. Construction Machinery Positioning Strategy					"We sit down and work through a site layout details.It is interrelated with many things such as traffic control plan; access points; the way materials could easily get into the site; the size or the footprint of the job; crane types and number requirements; and the location of the cranes and other issues.We locate cranes for the maximum flexibility; we position them to get as much coverage as we can. Thus, integrating and developing a strategy for positioning cranes is critical for productivity."	The practice is applicable	"The critical machinein our site is a crane, and its location is planned by considering the weight to be loaded, the street, distance of placement and the nearby buildings. The crane needs to reach the street; it needs to reach the heaviest lift; it needs to reach the entire site. There might be another building that is taller than the building under construction, and the crane should not hit that building. All these factors are taken into account when positioning a crane and it is a best practice."	The practice is applicable	**The practice is applicable**

4. RESULTS AND DISCUSSION

4.1. MATERIALS MANAGEMENT PRACTICES

Six best practices for construction materials are identified. These include procurement procedures and plans for materials, long-lead materials identification, monitoring materials status database, materials delivery schedule, material inspection process, and material inspection team. However, practices such as procurement team, on-site materials tracking technology, and post receipt preservation and maintenance are considered to be not significant to improve the productivity of building projects in Victoria.

The interviewees described that formation of a procurement team is entirely the responsibility of subcontractors and the practices is not significant for principal contractors. This could be due to the characteristics of the Victorian construction industry which is dominated by a few large contractors and numerous small companies that could supply and install construction materials. According to Australian Bureau of Statistics (ABS), at the end of 2015 financial year, the proportion of companies involved in building construction were 99.15% for firms employing 0-19 workers, 0.78% for firms employing 20-199 workers, and 0.06% for firms employing over 200 workers (Australian Bureau of Statistics, 2016).

On-site materials tracking technology is not considered as a best practice for building projects. There are different reasons provided by the respondents. The first one is that construction materials are not usually stored on building project sites due toshortage of storage spaces in the cities such as Melbourne, Australia. The materials are brought to the sites when they are required and placed near their installation areas. The other reason is to reduce the damagedue to multiple handling. The respondents described that they preferred to bring materials one day before their installation date. Thus, the tracking system is not required as the materials are not kept on building sites and the probability of missing their location is low.

Preservation and maintenance of materials are not considered as the best practices for construction materials in the context of building projects in Victoria. The participants described that it is the last option to choose this management practice. They explained that the practice is recommended for projects that have sufficient on-site storage spaces. However, as most building projects in cities such as Melbourne are carried out in restricted spaces the practice is not suitable to increase productivity. Some respondents also described that contractors could incur additional cost due to the loss of productivity if they implement this practice.

4.2. EQUIPMENT AND TOOLS MANAGEMENT PRACTICES

Three best practices for construction equipment and tools are identified. Procurement procedures and plans for construction equipment, construction equipment productivity analysis, and construction equipment maintenance are found to be applicable for building projects. However, tools related practices such as site tools management strategy, tools tracking systems and on-site tools maintenance are not considered as best practices.

The interview results indicate that tools management practices have less importance for building projects from principal contractors' point of view. This could be due to the nature of the industry in which smaller firms execute activities that involve tools. According to Australian Bureau of Statistics, 78% of the building construction works are executed by small and medium firms (Australian Bureau of Statistics, 2013). The principal contractors employ a few laborers and purchase a fewtools. The interview participants described that they do not usually employ skilled workers such as carpenters, plumbers, electricians, plasterers and other tradesmen. They have a few laborers that do ancillary works such as cleaning the site for the sake of safety and other minor works that could not be subcontracted. According to the interview, on some projects, from a total of two hundred skilled and unskilled labourers only twenty of them belong to a principal contractor. The number of the principal contractors' labourers could be as low as five based on the scope of the building projects. Thus, there is no need to implement management practices which are related to tools.

4.3. EXECUTION APPROACHES

Ten best practices for project execution approaches are found for building projects. These are short interval planning, well-defined scope of work, use of software for planning, dedicated planner, construction work packages, design readiness for construction, utilities alignment, contract strategies, model development, and permitting requirements.

The interview results revealed that the decision to prepare short interval plan is important for productivity. The plan shows the details of daily activities and the resources required for their execution. Some respondents described that short interval plan helps to focus on specific tasks that should be executed on a specific date. Furthermore, the respondents discussed that a well-defined scope of works which has references to drawings, specification, and other contact documents also has a positive impact on productivity. Some of the interviewees suggested the preparation of templates for the scope of works based on the previous work experience.

The employment of dedicated planner also has a positive influence on the productivity of building projects. However, the level of complexity and scope of a project determine the need to assign a dedicated planner. Some respondents explained that certain construction companies assign a dedicated planner for large projects such as hospital buildings. Others described that a project manager is responsible for planning tasks and dedicated planner is not required for small building projects. However, all interviewees explained that dedicated planners have sufficient productivity data which helps them to prepare better construction schedules. Thus, assignment of the dedicated planner is considered in a list of best practices.

Reviewing designs for construction purpose is found as one of the potential areas where productivity gain can be obtained. Interview participants described that for some items, how much time it takes to install can be more important than the actual cost of the material. They suggested that if principal contractors focus on design management and conduct constructability reviews, extra costs will be minimized and productivity can be improved. Utility alignment is also becoming an important practice for building construction projects in Victoria, Australia. According to the interviewees, utility adjustment is a significantissue because of the restrictions set by local authorities in connecting to old networks such as water, electric, sewer and other infrastructures. Contractors operating in the City of Melbourne are required to prepare Construction Management Plan that addresses issues such as public safety, amenity, and site security; operating hours; noise and vibration controls; air and dust management; storm water and sediment control; waste and materials re-use and traffic management (City of Melbourne, 2005). Before commencement of any construction activity, the plan should be approved. Thus, the practice of identification of regulatory requirements is important for building contractors to reduce initial project delay.

4.4. HUMAN RESOURCE MANAGEMENT PRACTICES

The finding of this study revealed that crew composition, skills assessment and evaluation, employees training,career developmen, non-financial incentive program, financial incentives programs, social activities, maintain stability of organization structure, clear delegation of responsibility, retention plan for experienced personnel, and exit interviews are the best productivity practices for building projects.

Interviewees explained that since most principal contractors do not employ skilled labourers focusing on the composition of crews for different trades of works is not significant. However, the formation of good management crew which comprises of project manager, site manager, supervisors and others is important for principal contractors. Some respondents described that certain construction companies include the name of key personnel in the subcontract agreements. Skill assessment and evaluation is another important element that could influence productivity in building projects. Some of the interview participants described that before the commencement of any construction activity, a project manager should organize the project crew by assessing the skills and experience of the employees. They suggested that the project managers should be able to understand the strength and weakness of the crew members. Some interviewee explained that the site staff could also be assigned directly from a head office. Respondents described that the principal contractor’s project manager or other project team member

could check the skill and experience of a particular subcontractor. These can be done by requesting the recommendation letters from the previous employers and assessing other evidence such as pictures of the previously completed projects.

Employee training is also an important practice for building projects. Some respondents described that there are various changes such as new safety and health regulations in the construction industry and workers should be trained before starting to work in construction projects. Others added that employees can acquire technical skillsthrough practice, but they need to get training since legislations and regulations could change from time to time. Thus, training is considered as an important practice in the context of building projects in Victoria. The interview participants discussed that maintaining the stability of the organizational structure of a project is also an essential practice. They explained that unstable project organization could lead to loss of knowledge about a specific project. Therefore, controlling the staff turnover by using different motivation techniques is essential.

4.5. CONSTRUCTION METHODS

Ten elements under construction methods category are identified as best practices for construction methods to enhance productivity in building projects. These are integrated schedule, work schedule strategies, schedule execution and management, dynamic site layout plan, traffic control plan, site security plan, machinery positioning strategy, project start-up plan, project completion plan, innovations and new technologies.

Construction schedule which integrates works, materials, equipment and financial schedules has a positive impact on the productivity of building projects. Integration of the program is essential to monitor the material delivery, to evaluate the type of equipment to be used for a particular task, to assign the number and type of crew, and to organize any information that is required for execution of an activity in one place. Interview participants described that if more information is gathered in one place, the project team will have a better chance of understanding the project details. The research participants also explained that best-performing contractors link all the schedules together. These contractors integrate procurement, long lead materials delivery schedule and project status to the main work schedule. Developing working hours strategy is another important management practice that influences productivity. There are various working hour restrictions imposed by the authorities in Victoria and contractors are required to develop a strategy to reduce project delay. For instance, the Environment Protection Authority of Victoria (EPA) has a guideline to control noise from building projects. Accordingly, the normal work hours are restricted to 7:00am to 6:00pm during weekdays and 7:00am to 1:00pm on Saturdays (EPA, 2016).

Dynamic site layout plan is found to be one of the best practices for construction methods. Some of the participants described that although the practice of adopting dynamic site layout is necessary, it should be planned ahead to be effective. They explained that experienced contractors include their site logistics plan in a tender document. The proposed changes in the site layout plan are communicated to the prospective subcontractors. Construction machinery positioning strategy is another important practice that influences productivity in building projects. According to the interview results, the location of the critical machine or crane is determined by considering the major factors such as the maximum weight of an object to be lifted; distance from the street and nearby properties; and the floor area of a building. Some interviewees described that the crane needs to reach the street; it should lift the heaviest material; it has to cover the entire site; it should not hit the existing building or other property while maneuvering. Thus, careful analysis of the position of a crane using either 2D drawings or 3D models is an important practice to conduct the constructionworks smoothly.

4.6. HEALTH AND SAFETY

Based on discussion with interviewees, formal health and safety policy, task safety analysis, housekeeping, hazards analysis, zero accident techniques, health and safety training programs, and toolbox safety meetings are found to be the best practices for health and safety in building projects in Victoria. However, substance abuse program is not considered as a best practice. All respondents

described that drug testing program is not practiced in most projects. Some participants suggested that for building construction sites, it is not necessary to have drug and alcohol testing policy as the program is not included in the employment agreement.

Safe Work Method Statement (SWMS) is found to be the best practice for safety and health in building projects. Interview participants described that SWMS is prepared by conducting safety analysis for a particular task. Accordingly, the task is broken down into manageable activities; potential hazards are identified; controlling techniques for minimizing or elimination of the risks are proposed and the responsible person is assigned. Moreover, preparation of SWMS is a regulatory requirement in the Victorian construction industry. According to Occupational Health and Safety Regulations 2007, any contractor must not perform high-risk construction works unless a safe work method statement is prepared and the works should be executed according to the statement. The regulation stipulates that if there is non-compliance with SWMS, the contractor must stop the work immediately which leads to loss of productivity. Moreover, the interviewees described that safety training needs to be carried out as regulations might change and employees need to be updated with the latest information. According to Work Safe Victoria, all persons performing construction works require proof that they had completed construction induction training regarding occupational health and safety issues in construction projects (Work Safe Victoria, 2016). Thus, preparation of clear safe work method statement is an important practice for principal contractors in Victoria. Toolbox safety meeting is also found to be the best practice for safety and health. Some respondents described that the meetings are typically conducted regularly in the presence of subcontractors' employees. Other interviewees explained that on some building projects the meeting is not scheduled. It is conducted when executing risky tasks such as lifting heavy precast panels and erecting of tower cranes. However, there is a short daily pre-start meeting and employees are briefed about the nature of activities on a particular day.

5. CONCLUSION

From the findings of this study, it is concluded that building projects have their own specific best management practices. Forty-seven context-specific best practices that are categorized under materials management, tools and equipment management, execution approach, human resource management (HRM), construction methods, and health and safety are identified for building projects in Victoria, Australia. Most of the tools and equipment practices that are obtained from the literature are not suitable for building projects where as the majority of the practices under HRM categories are found to be applicable in the context of Victoria. This study contributes to the body of knowledge by identifying and verifying best management practices for building projects from the perspectives of principal contractors. Based on the finding of this research, the authors are investigating the relationship between productivity and management practices using quantitative data. Researchers in other countries can prioritize the best practices for building projects in a different environment based on the findings of this study. Best practices from subcontractors' perspectives need further research as this study focuses on principal contractors' management practices only. Finally, the principal contractors in Victoria, Australia can implement the identified practices to improve productivity in their building projects.

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