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FACTORS INFLUENCING PRODUCTIVITY IN CONSTRUCTION

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Over the past three decades, the Kingdom of Saudi Arabia (KSA) has witnessed a significant increase in new building projects and construction industry activity. The KSA construction industry is expected to continue developing and growing at a significant rate in the coming decades. However, several serious issues currently face the construction industry, in particular low productivity, which have contributed to poor outcomes where projects have been delayed or postponed. This paper discusses the major factors influencing productivity in the KSA construction industry. A questionnaire survey using a 5-point Likert scale was used to measure the importance of these factors. It was administered to 176 respondents from Grades 1, 2 and 3 construction companies, which are registered in the Contractors Classification Agency under the Ministry of Municipal and Rural Affairs (MMRA). The questionnaire included five major factors identified from the literature review: managerial, labor-related, materials, tools and equipment, financial, and project-related. Using descriptive statistical analyses, it was found that the most important factors influencing construction productivity were financial factors, including issues such as the limited financial liquidity of the company, payment delays by owners, and limited cash flow. The next main influential factor was project-related, followed by factors related to materials and equipment, labor-related factors, and administrative and managerial factors.

Keywords: Saudi Arabia, Project delays, Project management, Building, Labor, Financial, Managerial, Productivity improvement.

1 INTRODUCTION

Construction industry productivity is one of the most significant and key drivers leading economic production activities (Pekuri *et al.* 2011) and is a major source of competitive advantage (Grossman 1993). Despite this, achievement of greater productivity in the construction industry has been growing slowly for some time and has left much room for improvement (Pekuri *et al.* 2011).

In the Kingdom of Saudi Arabia (KSA), new construction is currently undergoing a boom. The estimated value of planned and under-construction projects has been totaled at more than $800 billion (Worldfolio 2015); it is expected that the KSA construction industry will continue to

develop and grow at a significant rate in the coming decades. Despite considerable technological advances globally over the last decade, only limited improvements in productivity have been noted in the KSA construction industry (Al-Otaibi 2011).

The aim of this paper is to determine the factors affecting and influencing productivity in the KSA construction industry. The paper begins with a brief literature review on productivity in the construction industry, focusing on the factors affecting productivity and productivity in the KSA construction industry. It is then followed by a discussion of the research methods used in this study. Subsequently, the results are described and discussed, and conclusions are presented.

2 LITERATURE REVIEW

The most commonly used general definition of productivity as the output products divided by the inputs was given by Tran and Tookey (2011). Many researchers agree that productivity is one of the essential variables through which economic production activities are evaluated and regulated (Pekuri *et al.* 2011). Several researchers have also emphasized that, to achieve and maintain a competitive edge, an industry needs to increase its knowledge of how to improve its productivity (Soekiman *et al.* 2011).

While poor labor productivity is one of the most difficult problems faced by the construction industry, it is particularly the case in developing countries (Mahamid *et al.* 2013), and limited research has addressed this topic (Albogamy *et al.* 2012). Previous studies have identified factors affecting productivity in the construction industry in many developing countries, including, amongst others, lack of skilled labor and experience, non-payment to suppliers, jobsite conditions, and financial issues (Ghoddousi and Hosseini 2012, Jarkas and Bitar 2011). While there is wide variation in these factors across countries, many face similar issues, such as communication problems, tools and materials, and unskilled supervision. According to many studies (Kuroshi and Lawal 2014, Mahamid *et al.* 2013), the factors affecting productivity in the construction industry have been classified into five categories: (1) managerial, (2) labor-related, (3) materials, tools and equipment, (4) financial, and (5) project related.

Over the last three decades, the building and construction boom in the KSA has attracted builders and professionals from around the world. According to the KSA Ministry of Planning, by the end of each national development plan, the construction industry had contributed 30–40% of the non-oil productive sector (Al-Kharashi and Skitmore 2009). Despite the construction boom and strong government support, the KSA construction industry has suffered from a long period of low productivity, hindered projects, frequent delays, and budget deficits, with many of these issues having led to project cancellations (Al-Kharashi and Skitmore 2009, Mahamid *et al.* 2013). KSA's lower productivity has been mainly attributed to factors that affect the work performance of the labor force (Al-Kharashi and Skitmore 2009, Alhaqbani 2013). In 2014, 40% of construction projects failed to complete on time (Al-Kharashi and Skitmore 2009, Albogamy *et al.* 2012). However, there is a lack of studies on productivity in the KSA construction industry that address these issues. Therefore, this study aims to identify the factors that affect productivity in the KSA construction industry.

3 METHODS

3.1 Measurement Instrument

A questionnaire or survey has been one of the most common methods employed in recent years in construction research (Fellows and Liu 2015). This study used the Productivity Questionnaire (PQ) to evaluate the barriers to productivity improvement in the construction industry in the

KSA. This 51 item questionnaire used a five-point Likert scale from one (*Not an important barrier at all*) to five (*Extremely important barrier*) to measure productivity growth trends and the associated barriers in the context of the KSA construction industry. The developed measurement instrument was completed online by the individually by each participant.

The PQ was designed by the authors on the basis of the existing literature and interviews of 13 experts with more than ten years' experience in the KSA construction industry. The data from the interviews assisted the development of valid items for the PQ, covering the major aspects of productivity growth and the associated barriers in the KSA context. A pilot study of the PQ was conducted in accordance with Fink's (2003) recommendations, and involved ten constructors from the KSA construction industry who did not participate in the interviews. This was aimed at refining the items, determining the typical time required to complete the online survey, and resolving any remaining completion issues.

3.2 Participants

There were 555 construction companies registered with the Contractor Classification Agency at Grade 1 (>USD75 million), Grade 2 (>USD20 million), and Grade 3 (>USD6 million), under the Ministry of Municipal and Rural Affairs (MMRA), KSA. All these companies were contacted by email and were invited to participate in the study by asking their employees to complete the online survey. There were 176 online responses from individual participants, with 79.0% of participants coming from Grade 1 construction companies, 13.1% and 6.8% from Grade 2 and Grade 3 respectively, and two missing values.

3.3 Statistical Methodology

This study involved a preliminary investigation of the data obtained from the online survey with the sample of 176 participants. Therefore, the adopted statistical methodology primarily encompassed exploratory statistical methods such as Principal Component Analysis (PCA) (Field 2013, Stevens 2012), Cronbach's alpha analysis (Cortina 1993, Cronbach 1951), and simple correlations between different variables and principal components.

The Kaiser criterion (Stevens 2012) was used in the PCA to identify principal components (new orthogonal variables) that were given by linear combinations of the original PQ items with their respective PCA weights. These linear combinations were truncated, with only the items having PCA loadings greater than 0.5 (the conventional cut-off) being retained (Field 2013, Stevens 2012). The principal components were subsequently considered as constructs related to productivity barriers; they were regarded as new numerical variables, characterized by their scores that were determined as simple averages of the questionnaire items involved in the truncated linear combinations. Cronbach's alpha was then calculated for the determined constructs in order to ensure their internal consistency. Simple Spearman's correlations between the constructs and other involved variables were used to establish any possible relationships between these variables/constructs. Spearman's correlations were used instead of Pearson's correlations due to the typically abnormal distribution of the obtained data.

4 RESULTS AND DISCUSSION

The conducted PCA (including the scree plot) demonstrated that there were five principal components satisfying the Kaiser criterion (with eigenvalues greater than one). These components together explained around 75% of the total variance of the model (with the first principal component accounting for around 46% of the total variance). These five principal

components corresponded to the five expected constructs (different groups of items) in the survey instrument: labor-related, administrative and managerial, materials and equipment, financial, and project related. This finding is in line with the previous literature outcomes highlighting the same or similar constructs as the most important for productivity growth in the construction industries in a variety of developing countries including the KSA (Albogamy *et al.* 2012, Mahamid *et al.* 2013). However, a significant distinction and advantage of the current paper is that it has used PCA as a tool for identification of the constructs. Previous analytical efforts were mostly based on the very basic methods of summary statistics such as severity and importance indices (Albogamy *et al.* 2012), mean ratings (Kuroshi and Lawal 2014), an importance index that was simply an averaged of the responses (Mahamid *et al.* 2013), or a critical factor index that was calculated by multiplying all the raw rankings (Jarkas and Bitar 2011). The use of the PCA statistical methodology in the current study provided the required mathematical justification for the identified constructs and their relevance to productivity growth.

The internal consistency of the PQ constructs were examined using Cronbach's alpha analysis, which are shown in Table 1 indicating good internal consistency for each construct (Cortina 1993, Cronbach 1951).

Table 1. Cronbach's alpha, mean values, and their standard deviations for the five determined constructs.

Constructs	**M (SD) (N =166)**	**α (N =51)**
Labor-related	3.46 (1.03)	0.937
Administrative and Managerial	3.32 (1.06)	0.959
Materials and Equipment	3.61 (1.12)	0.936
Financial	4.01 (1.08)	0.960
Project-related	3.83 (1.11)	0.933

The outcomes of the simple correlation analysis using Spearman's correlation coefficients R are presented in Tables 2 and 3. Contrary to previous research efforts, which were primarily focused on the comparative characterization of separate questionnaire items (Albogamy *et al.* 2012, Kuroshi and Lawal 2014, Mahamid *et al.* 2013), the correlations in Tables 2 and 3 determine and characterize relationships between the productivity barriers determined as statistical constructs involving multiple relevant survey items. This enabled the identification and illustration of a more general picture of productivity trends and interactions between the barriers.

It can be seen that the administration and management productivity growth barrier did not correlate with either the experience of the respondents or the contractor grades (Table 2). It can thus be understood that, within the limits of the conducted analysis, all study participants considered the administration and management barrier approximately equally, irrespective of experience or contractor grade. The lowest mean value for the administrative and managerial construct (Table 1) also indicated that the associated barriers were perceived as the least important by all study participants, whereas the financial barrier appeared to be of the greatest importance.

Table 2. Spearman's correlation coefficients between the five productivity growth barriers and contractor experience and grade.

Construct		Experience	Contractor Grade
Labor-related	*R*	.165	-.097
	p-value	.057	.202
Administration and Managerial	*R*	.046	.038
	p-value	.595	.622
Materials and Equipment	*R*	.18*	-.12
	p-value	.035	.113
Financial	*R*	.29**	-.23**
	p-value	.001	.002
Project-related	*R*	.24**	-.18*
	p-value	.006	.018

Note: Asterisks indicate the level of statistical significance: (*) $0.01 \leq p < 0.05$; (**) $0.001 \leq p < 0.01$.

Table 3. Spearman's correlation coefficients between the five productivity growth barriers.

Construct		Labor-related	Administration & Managerial	Materials & Equipment	Financial	Project-related
Labor-related	*R*	1	.705***	.669***	.433***	.369***
	p-value		< .001	< .001	<. 001	<. 001
Administration and Managerial	*R*	.71***	1	.60***	.24**	.27***
	p-value	< .001		< .001	.001	< .001
Materials and Equipment	*R*	.67***	.60***	1	.66***	.56***
	p-value	< .001	< .001		< .001	< .001
Financial	*R*	.43***	.24**	.66***	1	.61***
	p-value	< .001	.001	< .001		< .001
Project-related	*R*	.37***	.27***	.56***	.61***	1
	p-value	< .001	< .001	< .001	< .001	

Note: Asterisks indicate the level of statistical significance: (***) $p < 0.001$; (**) $0.001 \leq p < 0.01$.

Participants with greater experience demonstrated a significant increase in their perception of the importance of the materials and equipment, financial, and project-related barriers (Table 2). On the contrary, as the size of the company (contractor grade) increases concerns weaken about these barriers (see the respective negative correlation coefficients in Table 2). This could be because larger companies generally have better capabilities and arrangements in terms of materials and equipment, financial services, and project evaluation/design.

The correlations between the considered productivity growth barriers in the construction industry in the KSA appear to be highly significant and positive (Table 3). These constructs are thus closely related to each other demonstrating the universal nature of the perceptions of productivity barriers in the KSA construction industry, something that has not been discussed previously in the literature. The pairs of constructs that particularly strongly correlate with each other include (Table 3): labor and administration; labor and materials; administration and materials; financial and materials; financial and project, etc. It is possible that the constructs in these pairs are dependent on each other. This might lead to useful practical recommendations for increasing productivity, e.g. through identifying and removing any independent barriers. At the same time, further research will be needed to determine any causal relationships between the correlated constructs (barriers), and to develop specific recommendations for productivity improvement.

5 CONCLUSION

This study has demonstrated that financial barriers are likely to be the most important in terms of influencing productivity in the KSA construction industry. Furthermore, these barriers appeared to be more important for lower grade contractors which demonstrate the practical importance of the proper management of financial issues in the construction industry. Materials and equipment barriers and project-related barriers were found to be the next most important group of factors, whereas labor-related barriers and administration and managerial barriers could be considered to be the least important in the KSA context.

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