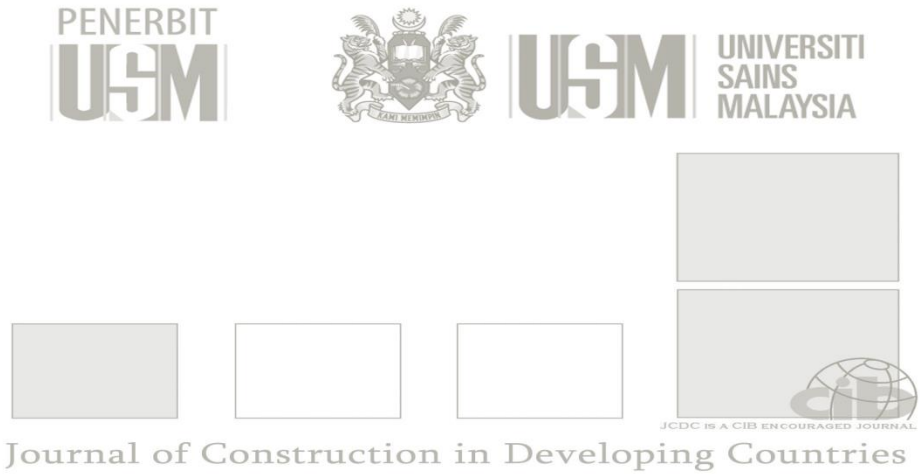

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A meta-analysis of factors affecting construction labour productivity in the Middle East

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ABSTRACT: Despite the importance of the construction sector to economic development, labour productivity in construction is lower than productivity in many sectors. Construction productivity has declined continuously for decades, particularly in developing countries. The challenges of low productivity in construction is considered a chronic problem. This has engendered the concern of construction stakeholders to address the myriad of challenges undermining labour productivity growth. This study conducted a meta-data analysis of factors affecting construction labour productivity growth in the Middle East. A systematic review of the existing construction labour productivity studies was presented. Ten Middle East studies were selected for a meta-data analysis. The key factors affecting construction labour productivity in the region were identified, and quantitative data of the selected studies were synthesized. Effect summaries derived from the analysis revealed delay in responding to requests for information, inadequate workers supervision, a shortage of skilled labour, extent of change orders, and clarity of technical specifications as the major factors affecting productivity. The study is limited to journal articles published from 2000-2020 in the Scopus database. Contractors in the Middle East can adopt the interventions of the study to evolve productivity growth policies for their organisations.

Keywords: Construction, Labour, Meta-analysis, Middle East, Productivity

Introduction

The large number of research geared towards understanding productivity has generated diverse perspectives that has led to a wide range of definitions of productivity (Nasir et al., 2014). Productivity is relevant to every sector; thereby contributes to diverse knowledge and perceptions to its meaning. In the construction sector, productivity is understood as the units of work produced per man-hour (Ouga et al., 2020). The concept is usually expressed at the activity, project, and industry levels (Yi and Chan 2014), which are respectively concerned with productivity on construction tasks, construction projects, and the industry long-term productivity trends (Shan et al., 2016; Zhao and Dungan 2014; Vogl and Abdel-Wahab 2015; Borg and Song 2015). Due to the growing knowledge that the construction sector considerably contributes to a booming economy, more than ever, productivity growth is becoming more important to the industry's stakeholders and policymakers (Fadejeva and Melihovs, 2010). This engenders several interventions from construction

stakeholders towards ensuring labour productivity in construction continues to grow (Vogl and Abde-Wahab, 2015). Regrettably, labour productivity in construction is lower than productivity in many sectors, particularly in developing countries (Neve et al., 2020). Although, several research projects have been conducted to address this challenge (Olomolaiye et al., 1987; Kaming *et al.*, 1997; Alinaitwe et al., 2007), the construction industry has continued to be confronted with the issue of low productivity. Yap et al. (2019) express the problem of productivity in the construction industry as being 'chronic'. There are review based studies on factors affecting construction labour productivity (CLP) (e.g., Naoum, 2016 and Hasan et al., 2018). However, these studies were conducted qualitatively leaving possibilities for subjectivity (Hosseini, et al., 2018; Adebowale and Agumba, 2022). Meta-data analysis provides a quantitative integration of data from different studies. The analysis would largely address the bias in review based studies of CLP research field. The method will offer a quantitative measurement and analysis of data to achieve a more realistic and scientific precision of factors affecting labour productivity in construction operations. Meta-data analysis has been applied to diverse domains in construction. These include: delays in construction (Sanni-Anibire et al., 2020), health and safety (Alruqi et al., 2018), and Building Information Modelling (Noor and Yi, 2018). There are evidences in literature that the Middle East is one of the regions with the highest number of publications in CLP research field. This foregoing suggests the importance of CLP to the economic development of the region. The Middle East countries include: Bahrain, Cyprus, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Palestine, Qatar, Saudi Arabia, the Syrian Arab Republic, Turkey, United Arab Emirates and Yemen. These countries share common ethnic groups, geographic features, religious beliefs, and political history. Given the proliferation of CLP studies in the region, the aggregation of factors affecting CLP in the Middle East will provide a more comprehensive understanding of factors affecting CLP than a single study specific to a country. The meta-data analysis approach has the advantage of transparency in extracting and analysing knowledge to enhance accurate decision making and policy formulation (Borenstein et al. 2009). The objective of this study is to present a systematic review of factors affecting CLP in the construction industry. Studies that are specific to the Middle East will further be extracted for a meta-data analysis. Subsequent sections present an overview of the CLP challenges, a review of existing CLP studies, research method, discussions, conclusion and implication of the research.

Overview of the CLP challenges

Construction organisations in many countries are greatly concerned about their low level of productivity (Jarkas et al., 2015). There is a surfeit of evidence that productivity is a critical challenge confronting the construction industry in many countries (Jalal and Shoar, 2019). This is because high or low productivity is critical to construction projects success (Adebowale and Agumba, 2022). Contractors' competitiveness is considerably dependent on their productivity (Kazaz and Ulubeyli, 2007). Arising from low productivity of many contractors,

cost and time overruns are frequent on most construction projects (Ghoddousi et al., 2015). Pawanhari and Gupta (2016) posit that prevalent cost and time overruns in the construction industry are indicators of productivity problem. Low productivity of craftsmen is considered as one of the most daunting problems of contractors, especially those in developing countries (Kaming et al., 1997). Current construction productivity issue is also associated with disputes and abandonment of construction projects (Pawanhari and Gupta, 2016). These have jointly or separately resulted in negative influences on construction project performance, project stakeholders, and the business of construction (Hasan et al., 2018). According to Alinaitwe et al. (2007), improving construction productivity will contribute to eliminating these challenges. Evaluating factors that influence productivity are critical issues faced by construction managers (Naoum, 2016). The first step in finding opportunities for improvement in labour productivity is to identify what factors are affecting it (Adebowale and Agumba, 2022). After identifying the factors, managers can effectively act upon them to lower costs, enhance scheduling, and eventually obtain a more accurate productivity prediction when estimating construction costs (Rivas et al., 2011).

Existing CLP studies

This section reviews the existing literature on factors affecting CLP to obtain necessary evidence in the research area. Existing CLP studies have primarily used empirical research methods to identify factors that affect construction productivity. Five research approaches highlighted by Fellows and Liu (2003) include: experiment, survey, action research, ethnographic research, and case study. According to Hasan et al. (2018), experiments on factors influencing CLP would be costly as it will take a long time to produce useful results. Generalizable results cannot be achieved with case studies, as different projects face different problems (Alinaitwe et al., 2007). Therefore, questionnaires are predominantly the data collection tool of choice in CLP research. The methods commonly used by researchers to identify the factors influencing CLP include: identification of a variety of factors based primarily on a review of the existing literature, focus group discussion, interviews or case studies, pilot tests of research questionnaires to identify salient factors influencing CLP, rank factors based on relative importance index, and survey results are often validated through focus groups discussion, interviews or case studies. Few studies preferred focus groups to identifying factors influencing CLP (Dai et al., 2007), while most authors relied solely on a review of the existing literature to facilitate the identification of factors (Jarkas and Bitar, 2012; Jarkas et al., 2012). More thorough factors are gathered by requesting contributions of the industry practitioners (Jarkas, 2015). The results are more robust and relevant in their national context, since local productivity factors are identified on the basis of focus group meetings and contributions from the industry practitioners (Hasan et al., 2018). Rather than identifying local productivity factors through focus group meetings and input from industry professionals, most studies extract factors that influence CLP through a literature review, which may constitute bias in these studies. The number of productivity factors

selected for CLP research varied between studies in developed and developing countries. Afolabi et al. (2018) selected 17 factors in Nigeria, Jarkas et al. (2015) selected 33 factors in Oman, Jalal and Shoar (2019) analyzed 60 factors in Iran (see Table 2), and Dai and Goodrum (2011) identified a complete list of 85 factors in the United States (see Table 1). In each study, the list of the most influential factors was identified and reported. CLP studies are distributed in industrialized and developing countries. India, the US, Australia and the UK are leading countries in terms of publications in the field of CLP research. The factors identified in different studies vary widely due to the specifications and conditions with each construction project. Structured questionnaires were used primarily to collect data for the CLP studies. Scholars have mostly sought the perceptions of project managers and craftsmen (Thomas and Sudhakumar, 2013), whereas a number of researchers obtained the perceptions of senior industry professionals such as directors and senior executives.

Table 1: **A review of factors affecting CLP in developed countries**

Author	Year	Country	No. of factors	Major finding
Hanna and Heale	1994	Canada	30	Foreman supervision, availability of working drawings task sequencing, equipment breakdown, and non-availability of construction equipment
Kazaz and Ulubeyli	2006	Turkey	9	Working at similar activities, design complexity, error tolerance, weather conditions, and disruptions.
Chan and Kaka	2007	United Kingdom	59	Poor supervision, simplicity of building design, level of site experience, information flow, and communication with sub-contractors.
Kazaz et al.	2008	Turkey	37	Quality of site management, material management, systematic flow of work, supervision, and site layout.
Mojahed and Aghazadeh	2008	USA	5	Skills and experience of workforce, management, job planning, workers motivation and material availability.
Dai et al.	2009	USA	57	Construction equipment, project management, craft workers' qualifications, training, and foreman competency.
Valverde-Gascuena et al.	2010	Spain	11	Faulty works, overcrowded work areas, crew interference, lack of on-site cleanliness, and equipment unavailability.
Dai and Goodrum	2011	USA	85	Errors on the drawings, late response to drawing related questions, project management pays monetary bonuses for good performance, inadequate information from supervisors, lack of health and safety training on projects.
Durdyev and Mbachu	2011	New Zealand	55	Reworks, level of skill and experience of the workforce, adequacy of method of construction, buildability issues, and inadequate supervision and coordination.
Rivas et al.	2011	Chile	15	Lack of on-time delivery of materials, insufficient number of tools, problem associated with availability of sufficient trucks

				for moving materials or tools, rework arising from client's change orders, and interference among crews.
Robles et al.	2014	Spain	35	Shortage or late supply of materials, clarity of the drawings and project documents, clear and daily task assignment, tools or equipment shortages, and level of skill and experience.
Loosemore	2014	Australia	9	Relationship management, tender practices, project documentation and control, project management and supervision, and planning.
Hwang et al.	2017	Singapore	26	Workers' experience, technology, design changes, workers' skill level, and planning and sequencing of work.

Although studies show that different groups of study participants have general perceptions of the factors that influence CLP, there are still some differences in perception. Chan and Kaka (2007) highlight the differences in perception between managers and workers about the factors that influence CLP. Managers have been found to place more emphasis on resource planning, while resource use is more important to workers. Similarly, Dai et al. (2007) state that foremen give greater importance to factors related to project management and technical drawings, whereas factors related to construction materials are considered more important for artisans. Spanish-speaking workers considered factors related to supervisor, safety, and work management as most important in increasing productivity, while English-speaking craftsmen preferred factors related to engineering drawing management (Dai and Goodrum, 2011). Ghoddousi et al. (2015) examined the perceptions of executive directors of construction organizations in their study. The study found some inconsistencies with the results of previous studies, possibly because executive directors are not directly involved in construction operations, and as a result, there is a lack of awareness of site-related challenges hampering construction operations. On the contrary, Thomas and Sudhakumar (2013) found no significant differences in perception between project managers, superiors, and artisans. Most research to date has identified factors that affect productivity from the contractor's point of view. Hasan et al. (2018) recommended the need to revisit the existing studies, while taking the perceptions of various stakeholders into account.

Table 2: **A review of factors affecting CLP in developing countries**

Author	Year	Country	No. of factors	Major finding
Alinaitwe et al.	2002	Uganda	36	Incompetent supervisors; lack of skills from the workers; rework; lack of tools/equipment; and poor construction methods.
Makulsawatudom et al.	2004	Thailand	23	Lack of materials, incomplete drawings, incompetent supervisors, lack of tools and equipment, and absenteeism.
Kadir et al.	2005	Malaysia	50	Material shortage at site; non-payment to suppliers causing the stoppage of material delivery to site; change order by consultants; late issuance of construction drawing by

				consultants; and incapability of contractors' site management to organise site activities.
Enshassi et al	2007	Palestine	45	Material shortages, lack of labour experience, lack of labour surveillance, misunderstanding between labour and superintendents, and drawings and specifications alteration during execution.
Rivas et al.	2011	Chile	38	Materials, tools, rework, equipment, truck availability, and the workers' motivational dynamics.
Ghoddousi and Husseini	2012	Iran	31	Utilizing the traditional construction methods instead of modern technology; site manager is not experienced to handle challenges that arise in the field, lack of proper tools and equipment on-site, operatives do not possess skills and experience to perform the task, and site manager does not have the ability in training workers to perform their jobs properly.
Jarkas and Bitar	2012	Kuwait	45	Clarity of technical specifications, the extent of variation/change orders during execution, coordination level among design disciplines, lack of workers supervision, and proportion of work subcontracted.
Attar et al.	2012	India	15	Lack of material, delay in arrival of materials, unclear instruction to workers, workers strikes, and financial difficulties of the owner.
Mahamid	2013	Saudi Arabia	31	Rework, lack of cooperation and communication between construction parties, financial status of the owner, lack of labor experience, and lack in materials.
ElGohary and Aziz	2014	Egypt	30	Workers experience and skill, incentive programs, availability of materials and their ease of handling, leadership and competency of construction management, competency of workers supervision.
Jarkas et al.	2014	Qatar	38	Lack of financial incentive schemes; slow decision-making process by owners; remuneration scale; delay in responding to requests; and shortage of skilled workforce.
Odesola and Idoro	2014	Nigeria	15	Craft workers' pride in their work, lack of skills of the worker, rework, incompetent supervisors, and workers personal problems/poor economic condition of workers.
Jarkas	2015	Bahrain	37	Workers' skills, coordination among design disciplines, lack of workers supervision, errors and omissions in design drawings, and delay in responding to requests for information.
Jarkas et al.	2015	Oman	33	Errors and omission in design drawings, change to orders during execution, delay in responding to requests for information, lack of workers supervision, clarity of project specifications.
Hiyassat et al.	2016	Jordan	9	Planning, worker–management relationship, education and experience, climate, and technology and equipment.
Afolabi et al.	2018	Nigeria	17	Availability of equipment and material, supervision, payment method, welfare on site, and weather conditions.

Alaghbari et al	2019	Yemen	40	Labour's experience and skill, availability of materials in site, leadership and efficiency in site management, availability of materials in the market, and Political and security situation.
Hai and Tam	2019	Vietnam	43	Experiences of workers, workers discipline, types of salary payment, quality of building materials, and ability to organize production.
Jalal and Shoar	2019	Iran	60	Fatigue, lack of workers motivation, lack of skill, schedule delay, and inflation in the cost of execution.
Adebowale and Smallwood	2020	South Africa	42	Inadequate workers' skills, defective workmanship, awarding contracts to lowest bidders, industrial action resulting from political activities, and inadequate project planning.
Al-Rubaye et al.	2020	Iraq	21	Management of the construction site, difficulty of entering or accessing the construction site because it requires entry and exit permissions, work progress schedule that ensures the flow of work, the financial situation of the contractor, and effect of Land acquisition

Identifying the main factors that influence CLP is essential to increase productivity in the construction industry (Ghoddousi and Hosseini, 2012). If the factors influencing CLP are unknown, efforts to improve productivity will certainly not produce the desired result. Tables 1 and 2 summarize the results of existing studies during the last 26 years (1994-2020). Given that construction projects are labour intensive and influenced by internal and external environments, construction productivity in developed and developing countries is influenced by many factors. However, scrutinizing previous research suggests that some factors are more recurring than others (Hasan et al., 2018).

Research method

The research process entailed a systematic review of global CLP research and a meta-data analysis of factors influencing CLP in the Middle East. A literature search was conducted using the systematic approach of the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) protocol guidelines. PRISMA offers evidence-based results and improves the quality of review reports through a transparent literature selection process (Alaloul et al., 2021). The study was designed to search the largest single database in construction. The Scopus database represents the database with the largest number of publications in the field of construction. Hence, the database was preferred. Some of the construction research that have explored the Scopus database include: Hosseini et al. (2018); Olawumi and Chan (2018); Vigneshkumar and Salve (2020); Yi and Chan (2014). The search was carried out with the following search strings: "Factors Affecting Construction Productivity" OR "Factors Affecting Construction Labour Productivity" OR "Factors Influencing Construction Productivity" in 'articles title' of the Scopus database. The search took into account research projects conducted in the Middle East countries from 2000-2020. The underlying reason for limiting

sampled articles to documents published from 2000-2020 is to obtain contemporary issues confronting labour productivity in the Middle East. Over the years, the construction industry has evolved in the areas of technology, procurement, management, and innovation. Therefore, it becomes essential to focus on recent articles that address current issues. The Scopus database yielded seventy-three research articles. After this outcome, the database was filtered to obtain the most relevant research articles. There were sixty-five research articles that specifically investigated factors affecting CLP. The articles were relevant and considered for a systematic review. Relevant studies were distributed across different regions such as Africa, the Middle East, Europe, and Asia. Given that the objective of this study is to analyse the predominant factors that influence CLP in the Middle East, only ten studies met the selection criteria and therefore considered for meta-data analysis. The selection criteria include: research conducted in the Middle East, research conducted in the last twenty years (2000-2020), one article from each country, and Relative Importance Index (RII) values for meta-data analysis. The selected ten Middle East studies reported several factors influencing CLP. However, some of these factors were only reported in one or two studies. To obtain highly relevant factors, only factors featuring in minimum of three articles were considered. The 35 factors that were reported in minimum of three articles are presented in Table 6. Subsequently, the RII values of the factors were extracted for analysis. The meta-data analysis includes the formulation of research questions. This study sought to answer the "what factors influence CLP in the Middle East?" A meta-analysis was carried out systematically with a set of results, based on quantitative analyses. Statistical combination of data from a number of studies can estimate underlying effects more accurately than a single study. Therefore, analysis in this study overcomes the limitations of small sample sizes by extrapolating a larger population of ten CLP studies. Factors influencing CLP were grouped into four categories, which include: management, technological, human/worker, and external factors. The grouping is consistent with Alaghbari et al. (2019); Jarkas and Bitar (2012); Sangole and Ranit (2013).

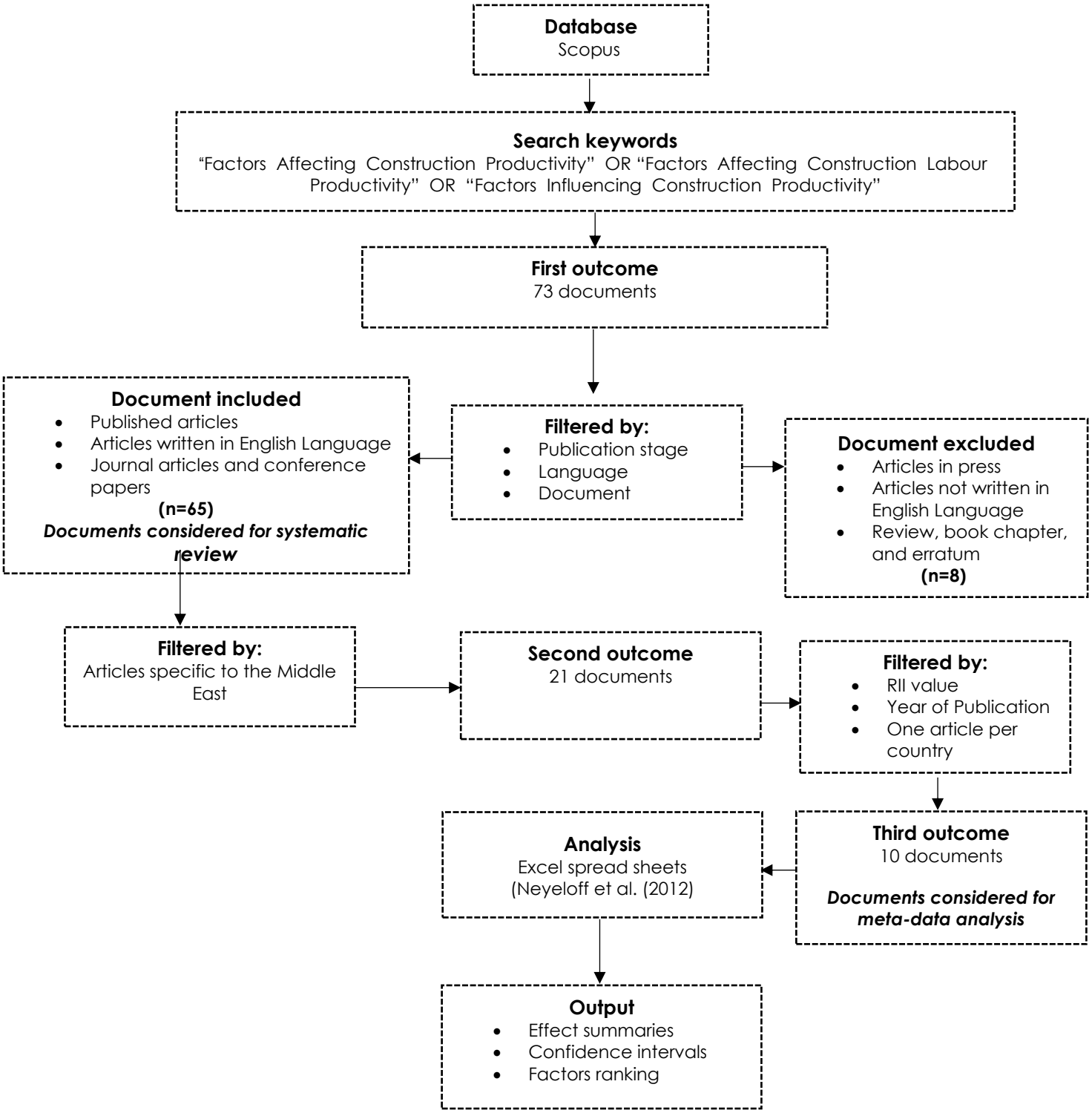

Figure 1: Research process

The outcome of a meta-analysis is the 'effect' summary (Neyeloff et al. 2012). The chosen model was determined by calculating the effect summary. The heterogeneity of the studies affects different populations in the selected studies. A fixed or random model could be selected depending on the homogeneity or heterogeneity of the sources. A fixed model assumes that

differences in studies are due to sampling errors, while a random model takes into account and addresses differences in the sample population (Neyeloff et al., 2012). The foregoing supports the adequacy of the random model to the heterogeneity of the sources. Furthermore, Sanni-Anibire et al. (2020) reported on the suitability of the randomized model for studies with heterogeneous sources. The random model requires the combination of sample size and effect size. The effect size is the RII values of the selected articles. Taking into account the size of the sample and the size of the effect, Neyeloff et al. (2012) recommended the formulas presented in Table 3 for computing effect summary.

Table 3: Effect summary computation

S/N	Parameter	Abbreviation	Equation
1	Standard error	*SE*	$\frac{\mathrm{es}}{\sqrt{\mathrm{es} * \mathrm{n}}}$
2	Variance	*Var*	SE^2
3	Individual study weight	*w*	$\frac{1}{SE^2}$
4	Cochran's statics	Q	$\sum(\mathrm{w} * \mathrm{es}^2) - \frac{\sum(\mathrm{w} * \mathrm{es})^2}{\sum \mathrm{w}}$
5	Modification constant	*v*	$\frac{\mathrm{Q} - (\mathrm{k} - 1)}{\sum \mathrm{w} - \left(\frac{\sum \mathrm{w}^2}{\sum \mathrm{w}}\right)}$
6	Modified study weight	W_v	$\frac{1}{(\mathrm{SE}^2 + \mathrm{v})}$
7	Effect summary	es	$\frac{\sum(\mathrm{w_v} * \mathrm{es})}{\sum \mathrm{w_v}}$
8	Standard error for effect summary	$\mathrm{SE_{es}}$	$\sqrt{\sum \frac{1}{\mathrm{w_v}}}$

Discussion

Many studies preferred to use RII to rank the severity of factors affecting CLP in the Middle East. However, some of the research adopted other statistical tools. For example, Jalal et al. (2019) adopted effect rate to classify factor affecting CLP in their study.

Table 4: Countries represented

Country	No. of articles
Iran	4
Egypt	3
Vietnam	3
Saudi Arabia	2
Bahrain, Iraq, Jordan, Kuwait, Malaysia, Oman, Palestine, Qatar, Yemen.	1 each
Total	**21**

Hai and Tam (2019) adopted impact index approach to rank the level of impact of factors. These studies and some of the research conducted in Iran - Jalal and Shoar (2019); Ghoddousi and Hosseini (2012); Rad and Kim (2018); the only study conducted in Iraq - Al-Rubaye and Mahjoob (2020); Saudi Arabia - Almathami et al (2017); and Vietnam - Hai and Tam (2019) were exempted from analysis due to the lack of common analysis denominator.
RII computation proposed by Dey et al. (2017) was adopted in this study.

Table 5: Selected Middle East based studies for meta-data analysis

S/N	Author	Year	Country	No of factors identified	No of citation (October 01 2021)
1	Kadir et al.	2005	Malaysia	50	403
2	Enshassi et al.	2007	Palestine	45	458
3	Jarkas et al.	2012	Kuwait	45	378
4	Jarkas et al.	2013	Qatar	38	56
5	Mahamid	2013	Saudi Arabia	31	104
6	Hafez et al.	2014	Egypt	27	56
7	Jarkas	2015	Bahrain	37	77
8	Jarkas et al.	2015	Oman	33	61
9	Alaghbari et al.	2019	Yemen	52	80
10	Toan et al.	2020	Vietnam	45	3

$$RII = \frac{\sum w}{(A*N)}$$

Where:

$\sum w$ = Weighting given to each factor by respond;
A = Highest weight, and
N = Total number of respondents.

The values of RII and population (N) of the ten studies selected are presented in Table 6. Literature has identified many factors that constitute impediment to CLP in the Middle East. From the selected studies, the average number of factors affecting CLP is 40.3 (see Table 5). Some factors are repeatedly identified in the studies. The entire factors identified by these studies were scrutinised, where 35 factors were determined to be commonly studied by minimum of three studies.

Table 6: RII values obtained from selected studies for meta-data analysis

S/N	Factors negatively affecting CLP	Kadir et al. et al 2005 N = 100	Enshassi et al. 2007 N = 105	Jarkas et al. 2012 N = 180	Jarkas et al. 2013 N = 350	Maha mid 2013 N = 59	Hafez et al. 2014 N = 55	Jarkas, 2015 N = 59	Jarkas et al. 2015 N = 132	Alaghbari et al. 2019 N = 91	Toan et al. 2020 N = 56
1	Design complexity	0.711	-	0.796	0.412	-	0.727	0.567	0.612	0.848	-
2	Coordination among design disciplines	0.810	-	0.826	0.613	-	0.731	0.876	0.854	-	-
3	Clarity of technical specifications	-		0.843	0.786	-	0.793	0.619	0.862	0.844	-
4	Extent of change orders	0.848	0.800	0.837	0.771	-	0.724	0.625	0.896	0.850	0.786
5	Lack of incentive schemes	-	-	0.786	0.864	-	-	0.803	-	0.724	0.736
6	Proportion of work subcontracted	-	-	0.806	-	-	0.766	0.711	-	-	-
7	Construction method	-	0.621	0.524	-	0.444	0.756	0.748	0.806	-	0.765
8	Inspection delay	-	0.776	-	0.435	-	-	0.703	-	-	-
9	Inadequate workers supervision	-	0.719	0.817		-	0.840	0.861	0.867	0.836	0.775
10	Rework	0.772	0.750	0.667	0.738	0.786	0.738	0.822	0.838	-	0.736
11	Quality and availability of drawings	0.848	-	-	0.753		-	0.672	0.781	-	0.736
12	Material shortage at project site	0.912	0.895	0.529	0.801	0.709	0.720	0.761	0.776	0.878	0.768
13	Absenteeism	0.712	0.718	-	-	0.471	-	-	-	-	0.739
14	Inclement weather conditions	0.730	0.640	0.759	0.712	0.400	0.796	0.786	0.832	0.760	0.736
15	Problem of communication	-	-	0.521	0.723	0.780		0.555		0.814	0.696
16	Poor workers' motivation	-	0.690	0.694		0.573	0.833	0.719	0.739		0.718
17	A shortage of skilled labour	-	0.842	0.594	0.809	0.736	0.869	0.893	0.813	0.886	0.764
18	Working overtime	-	0.624	0.648	0.403		0.811	0.809	0.846	0.720	0.704
19	Unavailability of suitable tools and equipment	0.812	0.753	0.505	-	0.704	-	0.494		0.840	0.729
20	Working within a confined space	0.736	0.703	0.547	-	0.488	0.633	0.685	0.769	-	0.707
21	Inadequate training	-	0.503	0.498	0.375	-	-	-		-	-
22	Payment delay	-	0.787	0.524	-	-	0.876	0.778	0.758	-	0.782
23	Physical fatigue	-	-	0.570	-	-	0.760	0.733	0.827	-	-
24	Poor site management	0.840	-	0.490	0.563	0.664		-		0.876	0.743
25	Unrealistic deadline for project completion	0.756	-	0.551	0.547	-	0.680	0.757	0.802	0.790	-
26	Accident	0.764	0.724	0.516	0.351	0.553	0.695	0.602	0.713	-	0.771
27	Stringent inspections	-		0.770	0.574	-	0.748	0.814	0.752	-	-
28	Economic conditions	0.712			-	-		-	-	0.842	0.779
29	Unsuitability of storage location	-	0.692	0.676	-	0.617	0.735	-	-	-	-
30	Government policies	0.766	0.608		-	-	-	-	-	-	0.721
31	Project location	0.626		0.640	0.387	0.437	-	-	-	0.790	0.714
32	Lack of labour recognition programs	-	0.618	0.437	0.488		-	-	-	-	0.675
33	Remuneration scale	-	-		0.828	0.607	-	-	-	0.780	-
34	Delay in responding to requests for information	-	-	0.767	0.822	-	-	0.830	0.878	-	-
35	Type of project	-	-	-	0.479	-	-	-	-	0.640	0.650

The selected Middle East based research articles were printed and the factors in each article were thoroughly examined. Subsequently, inclusion criteria for any factor to be considered for analysis was determined. To obtain factors that are relevant to productivity in the Middle East and not just to a specific country, factors that featured in one or two countries were considered less significant to the region and therefore discarded. For example, errors and omissions in design and drawings was identified in Bahrain (Jarkas, 2015) and Oman (Jarkas et al., 2015). Also, poor leadership of construction managers was identified in Kuwait (Jarkas et al., 2012) and Egypt (Hafez et al., 2014). Therefore, factors that are reported in minimum of three countries and their corresponding RII are presented in Table 7. Spread sheets prepared by Neyeloff et al. (2012), which is useful for determining confidence intervals and effect summaries of quantitative data was utilized for the meta-data analysis. The outcomes of the effect summaries and confidence intervals of 95% derived from the meta-data analysis are presented in Table 7. Overall ranking of the 35 factors is presented and also the ranking within the four classified groups. The results indicate that the five most significant factors affecting CLP include: Man. 20: delay in responding to requests for information, Man. 11: inadequate workers supervision, Lab. 1: a shortage of skilled labour, Man. 17: extent of change orders, and Tec. 4: clarity of technical specifications. The five least significant factors in their order of significance include: Man 12: accident, Tec. 5: type of project, Man. 1: lack of labour recognition programs, Ext. 4: project location, and Man. 5: inadequate training. The mean values of the effect summaries calculated according to the four categories shows that workers related factors are the most significant group affecting CLP. However, some previous studies - Alaghbari et al. (2019); Jarkas and Bitar (2012) and Sangole and Ranit (2013) found technological factors as the most significant group affecting CLP. Examining the top ten critical factors affecting CLP in developing countries and the Middle East, three factors, which include: a shortage of workers skills, lack of incentive programs, and inadequate supervision were found to be consistent in the studies from the Middle East and other developing countries. This suggests some level of commonalities in challenges confronting developing countries and the Middle East. Across studies, external groups were reported as the least significant factors, which is also consistent with the findings of this study. The most significant factors undermining CLP in the Middle East include: delay in responding to requests for information, inadequate workers supervision, a shortage of skilled labour, extent of change orders, and clarity of technical specifications. In terms of factors classification, workers and management related challenges are predominant factors that affect CLP in the Middle East, whereas external related factors have minimal influence.

Discussion of the key findings

This section presents a discussion of the most significant factors affecting CLP in the Middle East. The results were compared to the major findings in other developed and developing countries. Delay in responding to requests for information was a major barrier to site productivity in Kuwait, Qatar, Bahrain, and Oman. Based upon the perceptions of respondents surveyed in these

countries, delay in responding to requests for information was ranked 10th, 25th, 22nd, and 19th as factor affection CLP. Although, this factor was not ranked one of the top five factors affecting CLP in these countries, its high mean score values (MSVs) however suggested that it is a major barrier to CLP in the four countries. Similar finding was obtained in a study conducted by Dai and Goodrum (2011) in the United States. The study reported late response to drawing related information as one of the major challenges that was contributing to low productivity on construction jobsites. Challenges associated with workers supervision have been largely reported in most of the studies in the Middle East, which suggests that supervision is a major issue preventing productivity growth in the region. Among the ten Middle East countries, only studies conducted in three countries (Malaysia, Saudi, and Qatar) have not reported inadequate workers supervision as a challenge to CLP. Except in Qatar, where inadequate workers supervision was ranked 22nd, the factor achieved high ranking in Bahrain (1st), Palestine (2nd), Yemen and Vietnam (3rd), and Kuwait and Egypt (4th). The high ranking and MSVs of inadequate workers supervision across different Middle East countries underscore the significance of workers supervision challenges in the region. The findings of previous studies confirm that developed and developing countries alike are confronted with the problem of supervision on jobsites. In developed countries, the factor was reportedly a major barrier to productivity growth in Canada (Hanna and Heale, 1994), UK (Chan and Kaka, 2007), Turkey (Kazaz et al., 2008), US (Dai and Goodrum, 2011), New Zealand (Durdyev and Mbachu, 2011), Australia (Loosemore et al., 2014). Besides the identified countries in the Middle East, Uganda (Alinaitwe 2002), Thailand (Makulsawatudom et al., 2004), and Nigeria (Afolabi et al., 2018) are developing countries from other regions that are reportedly affected by inadequate supervision. Similar to most developing countries, skill shortage is one of the major challenges to productivity performance in the Middle East countries. Nine countries, with the exception of Malaysia reported a shortage of skilled labour as one of the factors affecting construction productivity. The problem of skilled labour is critical to construction productivity of the region as the factor was ranked as the most significant factor affecting construction productivity in Bahrain, Kuwait, and Yemen. Similarly, a shortage of skilled labour was determined to be the second most significant construction productivity influencing factor in Palestine and Egypt. In Saudi Arabia and Qatar, the factor was ranked the fourth and fifth most significant factor affecting construction productivity. Similar to supervision problem, shortage of skill in construction have been largely reported in developed and countries. The finding is consistent with Majahed and Aghazadeh (2008) - US, Durdyev and Mbachu (2011) - New Zealand, Robles et al. (2014) - Spain, Hwang et al. (2017) - Singapore, Alinaitwe et al. (2002) - Uganga, Odesola and Idoro (2014) - Nigeria. Change orders contribute to delay and sometimes rework during construction project deliveries. Change orders, which are largely associated with clients and their professionals, have been one of the major obstacles to construction project deliveries. The prevalence of change orders is also evident in data gathered from the ten Middle East countries. Only a study

conducted in Saudi Arabia did not report change orders as a challenge to construction productivity. Extent of change orders have achieved a high MSVs in Oman (MSVs=0.896), Yemen (MSVs=0.850), Malaysia (MSVs=0.848), Kuwait (MSVs=0.837), and Palestine (MSVs=0.800). These indicate that measures that mitigate extent of change orders in the Middle East countries will significantly contribute to CLP growth in the region. Change orders as one of the major barriers to productivity growth in the Middle East is consistent with the findings of studies conducted in Chile (Rivas et al., 2011) and Singapore (Hwang et al., 2017). Clarity of technical specifications was reported as a barrier to construction productivity growth. Complexity and ambiguity of design information have been recurring in productivity studies. Six studies conducted in the Middle East reported this factor as a challenge to construction productivity but Oman (MSVs=0.862), Yemen (MSVs=0.844), and Kuwait (MSVs=0.843) achieved a high MSVs which suggests the importance of the factor to CLP improvement. Table 7 presents confidence intervals of 95%, indicating a 95% possibility that the effect summary falls within the range indicated.

Table 7: Results from meta-data analysis (effect summary, confidence interval and ranking)

S/N		Factors affecting CLP	Effect summary	Confidence interval (95%CI)	Overall	Within group
Management group	0.708	-	2	-	-	-
1	Man. 1	Lack of labour recognition programs	0.555	0.605-0.505	33	19
2	Man. 2	Unsuitability of storage location	0.680	0.730-0.630	25	15
3	Man. 3	Stringent inspections	0.732	0.782-0.682	15	10
4	Man. 4	Unrealistic deadline for project completion	0.698	0.748-0.648	19	11
5	Man.5	Inadequate training	0.459	0.509-0.409	35	20
6	Man. 6	Material shortage at project site	0.775	0.825-0.725	9	6
7	Man. 7	Unavailability of suitable tools and equipment	0.691	0.741-0.641	23	14
8	Man. 8	Payment delay	0.751	0.801-0.701	13	8
9	Man. 9	Poor site management	0.696	0.746-0.646	21	12
10	Man. 10	Proportion of work subcontracted	0.761	0.811-0.711	10	7
11	Man. 11	Inadequate workers supervision	0.816	0.866-0.766	2	2
12	Man. 12	Accident	0.632	0.682-0.582	31	18
13	Man. 13	Lack of incentive schemes	0.783	0.833-0.733	7	5
14	Man. 14	Inspection delay	0.638	0.688-0.588	30	17
15	Man. 15	Working overtime	0.696	0.746-0.646	21	12
16	Man. 16	Coordination among design disciplines	0.785	0.835-0.735	6	4
17	Man. 17	Extent of change orders	0.793	0.843-0.743	4	3
18	Man. 18	Working within a confined space	0.659	0.709-0.609	29	16
19	Man. 19	Remuneration scale	0.738	0.788-0.688	14	9
20	Man. 20	Delay in responding to requests for information	0.824	0.874-0.774	1	1
Workers group	0.723	-	1	-	-	-
1	Lab. 1	A shortage of skilled labour	0.801	0.851-0.751	3	1
2	Lab. 2	Physical fatigue	0.723	0.773-0.673	16	3
3	Lab. 3	Rework	0.761	0.811-0.711	10	2
4	Lab. 4	Poor workers' motivation	0.709	0.759-0.659	18	4
5	Lab. 5	Problem of communication	0.682	0.732-0.632	24	5
6	Lab. 6	Absenteeism	0.660	0.710-0.610	28	6
Technological group	0.695	-	3	-	-	-
1	Tec. 1	Construction method	0.666	0.716-0.616	27	4
2	Tec. 2	Quality and availability of drawings	0.758	0.808-0.708	12	2
3	Tec. 3	Design complexity	0.668	0.718-0.618	26	3
4	Tec. 4	Clarity of technical specifications	0.791	0.841-0.741	5	1
5	Tec. 5	Type of project	0.590	0.640-0.540	32	5
External group	0.687	-	4	-	-	-
1	Ext 1.	Inclement weather conditions	0.715	0.765-0.665	17	2
2	Ext. 2	Government policies	0.698	0.748-0.648	19	3
3	Ext. 3	Economic conditions	0.778	0.828-0.728	8	1
4	Ext. 4	Project location	0.555	0.605-0.505	33	4

The results of this study have lent insight into commonalities in the challenges confronting contractors in the Middle East and other developing countries. Problems associated with management resonate across the Middle East countries. Adopting strategic management and emerging technologies could meaningfully improve productivity performance in the Middle East countries. The strategic management should adopt a systemic approach to the entire processes involved in construction project deliveries. Skill development for new innovations would contribute to promoting the implementation of emerging technologies that would enhance productivity of construction organisations in the region. Given the outcome of this study, Figure 2 presents a framework for CLP growth in the Middle East. The framework can further be unpacked by future studies.

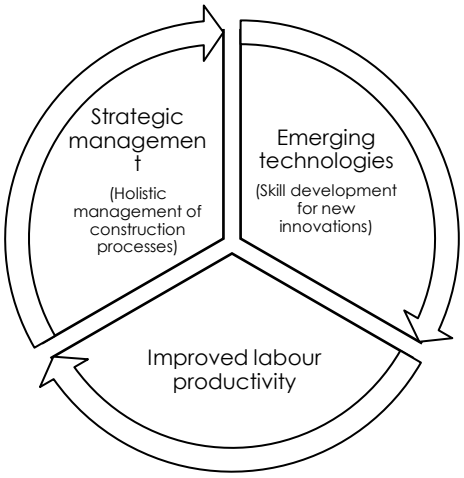

Figure 2: Construction productivity growth framework

Conclusion and implication

Volumes of CLP studies have achieved the objective of determining the important factors influencing labour productivity in the construction industry. The findings of the existing studies indicate that factors affecting CLP in different countries and regions differ from one other. Scholars who have identified factors affecting CLP are largely subjective in their judgement. Some authors have identified as much as 85 factors, whereas some studies have focused only on 9 factors. To our knowledge, a meta-data analysis study that is focused on factors affecting CLP in the Middle East is still lacking. More generally, CLP research field is also deficient of a meta-data analysis. Few research articles that review the existing literature relative to factors affecting CLP were qualitative in nature. A systematic review has the potential to provide evidence-based answers to research questions.

Results of the meta-data analysis were presented in the form of effect summaries and 95% confidence intervals. The study found delay in responding to requests for information, inadequate workers supervision, a shortage of skilled labour, extent of change orders, and clarity of technical specifications as the major factors affecting CLP in the Middle East. The results indicate that factors affecting CLP in the Middle East, especially problems associated with workers supervision and a shortage of skilled labour are largely consistent with the findings of several studies conducted in developing countries. According to classification of factors, workers and management related challenges are the predominant factors affecting CLP in the region. The study's implications for professional practice entails the adoption of the study's key findings to evolve measures to improve productivity growth of contractors in the Middle East. The construction industry in the Middle East must begin to increasingly embrace strategic management and advanced technologies to promote productivity growth. For the industry to achieve sustainable productivity growth in the region, Building Information Modelling, Internet of Thing, Virtual Reality, Augmented Reality, Sustainable Construction Practices, Construction Project

Management Software and other innovative technologies are essential. Digitalizing construction operation in the Middle East would help to radically reduce rework, improve communication of design intent, and ultimately engender productivity growth. Similar studies are recommended for other regions such as Asia, Africa, and Europe that have attracted special attention of researchers in CLP research field. Such studies could compare the results obtained in this study with those from other regions. Although the Scopus database is the largest single database in the field of construction, a single database constitutes a limitation to the research problem. Consequently, future studies should consider more databases to ensure a more robust research approach.

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Conflicts of interest
The authors have no competing interests to declare.

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