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A LITERATURE REVIEW OF COMMON FACTORS AFFECTING LABOR PRODUCTIVITY IN ASIA: 25 YEARS OF INSIGHT

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Abstract. Construction is one of the largest sectors of the Asian economy as it accounts for approximately 14.8% of Asia's GDP. This, together with the fact that labor productivity is a key factor affecting project performance, makes enhancement of productivity a significant contributor to economic growth. Yet, previous studies have not provided a well-defined terminology together with an understanding of the prioritization of factors, which decision-makers need to take into consideration to enhance productivity in a structured manner. A structured literature review has been carried out, focusing on identifying factors affecting labor productivity in Asia, and calculating the aggregated rank. Hypothesis-testing revealed that the ranking could be generalized across the different regions in Asia. A full rank aggregation considering Asia as a whole reveals the five most important factors to be: "Incomplete design", "Skill and experience (of laborers)", "Competency of the project manager", Materials", and "Client and consultants". Today's research on factors affecting labor productivity is fragmented. By making a structured rank aggregation, and comparing findings between studies, a unifying understanding to the relative importance of factors affecting labor productivity has been established. The relative importance gives input to on-site mangers and helps enhancing managerial strategies to improve labor productivity.

Keywords: labor productivity, literature review, rank aggregation, Asia, RRI, construction management, on-site construction.

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1. Introduction

Construction is one of the largest sectors of the Asian economy accounting for approximately 14.8% of Asia's GDP (Crosthwaite, 2000). Moreover, the Asian construction industry accounts for 35% of the global construction sector (Crosthwaite, 2000). This indicates the economic importance of the Asian construction industry. Productivity is a key factor affecting the performance of construction projects. Therefore, the enhancement of productivity in construction projects has a significant contribution to the economic growth of countries. The research conducted by Barbosa et al. (2017) declared that if the global construction productivity were to catch up with the progress made by other sectors during the last two decades or with the overall economy, this could elevate the construction industry's value added by $1.6 trillion a year, and boost the annual world GDP by 2 %. However, previous studies have indicated that the construction industry is a serial productivity underperformer (Nasirzadeh et al., 2022; Zhiqiang et al., 2019; Chalker & Loosemore, 2016; Barbosa et al., 2017). Based on these studies, the construction sector has experienced unsatisfactory levels of productivity in numerous countries. For example, in Turkey, Malaysia, and Singapore, less than a quarter of construction companies have matched the productivity growth reached by the total economies in which they work over the last decade, and most of the projects face time delays and cost overruns (Barbosa et al., 2017).

The productivity of a system is generally defined as the ratio between the output value and the value of input expended to produce that output (Hanna et al., 2005; Johari & Jha, 2020; Alaghbari et al., 2019; Seadon & Tookey, 2019; Gerami Seresht & Fayek, 2018). Regarding the construction industry, productivity refers to the maximization of the output of construction products and services while optimizing utilization of basic resources (i.e., labor, equipment, materials, capital, energy, technology, etc.) (Hamza et al., 2019; McTague & Jergeas, 2002; Attar et al., 2012; Dixit et al., 2017). It is a combination of the inputs or basic resources relative to the output which defines the overall productivity and the production function (Syverson, 2011). Construction productivity is regarded as one of the most important measures that influence the criteria of the overall performance of every construction system; these criteria include cost, duration/schedule, quality, and profit (Cheng et al., 2007; Attar et al., 2012). Higher levels of productivity allow constructors to perform more efficiently through increasing the profitability and competitiveness of construction projects as well as reducing their time and expense (Kisi et al., 2017). Low rates of productivity have always been a significant concern, globally, within the construction industries (Seadon & Tookey, 2019; Enshassi et al., 2007; Hamza et al., 2019). This issue contributes to schedule delays and budget overruns of many construction projects (Sun & Meng, 2009; Hanif et al., 2016; Alaghbari et al., 2019; Lindhard et al., 2020). Considering the essential role of the construction sector in a national economy (Naoum, 2016), poor construction productivity can also cause numerous socio-economic problems (Hamza et al., 2019; Odesola, 2014). Therefore, constant improvement of productivity is an issue of great importance to decision-makers and practitioners in both the construction industry and the government (Hasan et al., 2018).

When comparing the construction industry to other manufacturing sectors, many similarities can be identified, with respect to how to measure productivity and how to obtain and attain a competitive advantage. However, contrary to other manufacturing sector with repetitive production, which often take placed indoors in a very controlled setting, the construction industry is characterized by its one-of-a-kind projects (Molwus et al., 2017), in terms of both project type, design and building organization (Wyke et al., 2023a). Many of the factors affecting productivity in construction are, nonetheless, the same as in other sectors of manufacturing. However, the way they are observed and managed are different, due to the lack of systematic management in the construction industry, and the unique nature of the construction sector compared to other sectors (Zou & Tang, 2012).

Since construction is a labor-intensive industry, productivity is heavily reliant on the performance and effort of the construction crew (Jarkas, 2010; Alaghbari et al., 2019; Heravi & Eslamdoost, 2015; Johari & Jha, 2020). Labor productivity can be defined as the ratio of completed work (output) to expended work hours (input) (Chia et al., 2012). In most countries, nearly 30–50% of the total budget of each construction project is spent on labor costs (Jarkas & Bitar, 2012; McTague & Jergeas, 2002); so, the underperformance of the workforce is detrimental to the project's effectiveness (Hickson & Ellis, 2014). In developing countries where the majority of construction-related tasks are performed manually, the labor productivity is, furthermore, in need of particular attention (Attar et al., 2012; Chaturvedi et al., 2018).

To pursue productivity growth, it is required to evolve an understanding on the determinants underlying labor productivity within the construction industry and identifying which productivity drivers that matter most (Abdel-Wahab & Vogl, 2011; Syverson, 2011; Mojahed & Aghazadeh, 2008). A plethora of research has been conducted to identify factors perceived to influence construction labor productivity in different countries (Singh et al., 2019; Alinaitwe et al., 2007; Robles et al., 2014; Hiyassat et al., 2016; Karthik & Kameswara Rao, 2019, among others). These studies then quantitatively ranked the factors on the basis of their relative importance to prioritize the most influential factors. Using this method, priorities that are given to the factors are based on experience-oriented feedback from various construction practitioners (Durdyev et al., 2018). Existing studies provided cross-country findings and results targeting a specific country or project and were not successful in converging towards a common knowledge of what could be learned by them. This shortcoming in the current literature, therefore, needs to be addressed. As declared by Mojahed and Aghazadeh (2008), comparing key drivers of construction labor productivity across various countries, similarities between major productivity factors in some projects around the world, can be identified. The authors concluded that such similarities are important for increasing construction labor productivity in general. Even though findings from the study by Mojahed and Aghazadeh (2008) found that main determinants of productivity may change depending on a project's conditions, as well as country characteristics and labor demographics, of which similarities can be derived, which can contribute to making improvements on other projects.

Despite the development and maturity of productivity research in the construction industry, the identification and prioritization of factors affecting construction labor productivity tends to be a fragmented study area, where only on a small effort has been made, to generate consensus among the scholarly works.

Two journal papers (Hasan et al., 2018; Hamza et al., 2019) have, recently, thoroughly reviewed the findings across relevant sources of literature to put the factors identified by previous investigations on a shortlist as well as giving a deeper and wider insight into the research efforts conducted until now. However, these two reviews only considered the top five categories of factors indicated by the past research, without taking the weight of the ranked factors, into account, thereby ignoring missing values/factors, and without carrying out a structured rank aggregation to underpin the trustworthiness of the existing findings. The present study, hence, addresses the gap and shortcomings in the existing body of scientific knowledge, by conducting a literature review in which an overall baseline is established, with respect to the relative importance of different factors on construction labor productivity. Because the majority of publications in this field were conducted in the Asian countries (Hasan et al., 2018). This study, therefore, focuses on the geographical Asia, going from the middle east to the pacific ocean and from the Ural mountains to the Indian ocean (Encyclopedia Britannica, 2023).

The main objectives of this study are to firstly, carry out a structured review of the studies published in the past 25 years (1995–2020) in order to identify and group sets of factors influencing construction labor productivity across Asia. Secondly, the study calculates the weight of the ranked factors across selected publications for making comparisons. Thirdly, the a Kruskal-Wallis test on the currently available findings was performed, to highlight if significant differences exist, and fourthly, the study determine the importance of each factor in relation to the other factors through applying the Friedman Rank test.

The main novelty of the present research is how it systematically groups and calculates the relative rank of all factors in each study and aggregate them, whilst the calculation of the relative rank of all factors enabled that the findings could be adjusted for missing values. The systematic approach and the adjustment for missing values increases the trustworthiness of the study, allowing the identification of the most important factors affecting labor productivity, and not solely the factors registered most often, or factors most often found as parts of a top five factor grouping.

The present paper contributes to the scientific body of knowledge, within construction management, by providing construction participants with a unifying understanding of labor productivity factors and their corresponding rank across Asia; through a structured review of scientific literature within the topic, in order to aid the design of more effective managerial strategies to enhance the performance and profitability of both the construction sector and the overall economy of Asian countries. It, furthermore, provides guidance regarding which factors need to be included in future studies, on the path to achieving the optimal labor productivity level.

2. Method and results

This research is based on the findings from a SLR. The SLR method is selected because the number of relevant articles is expected to be low. According to Tranfield et al. (2003), the SLR method is the appropriate strategy for smaller data volumes. The literature review is following the guideline of Randolph (2009) by conducting the SLR as a two-step review: step 1) an electronic search and step 2) search the retrieved articles for relevant references (backward snowballing) and citations (forward snowballing), both is referred to as snowballing (Choong et al., 2014; Wohlin, 2014).

According to Randolph (2009), classic keyword searching (step 1) will identify approximately 10% of the relevant citations, while snowballing (step 2) is the most effective way to identify the remaining 90%. The strengths of snowballing are described and supported by Choong et al. (2014).

Step 1: Like Hohenstein et al. (2014) or Sfakianaki (2019), the literature review took its outset in a "keyword" search at title level. The keyword search identifies the starting set of articles, to ensure a good starting set for the snowball procedure, the instruction of Wohlin (2014) was used as guideline. First, the keywords were selected based on the study's research question. The identified and applied keywords were: "productivity" and "factors". To create a start set of highly relevant and cited papers, only the database of three of the primary publishers, were included in the keyword search. The selected publishers include the most relevant journals covering research in the field of productivity in construction. The included databases were: *Taylor and Francis*; *Emerald Publishing*, and *American Society of Civil Engineers*. The included journals do among others include: *Construction Management and Economics*; *Engineering*, *Construction and Architectural Management*; *International Journal of Construction Management*; *Journal of Construction Engineering and Management*, and *Journal of Management in Engineering*. Finally, a good snowball procedure requires diversity; this was achieved by ensuring that the identified set of articles had a huge diversity in authors. The number of identified papers from the keyword search is shown in Table 1.

Table 1. Article identification phases

Article identification phase	Articles included
Taylor and Francis	313
Emerald Publishing	20
American Society of Civil Engineers	27
Total from search strings	360
After title review of relevance	49
After abstract review of relevance	26

Before the snowball procedure is started, the starting set is reduced to only cover articles that will be included in the study (Wohlin, 2014). Therefore, a set of inclusion criteria are developed. The applied inclusion criteria were: (1) that the articles were peer reviewed journal publications, (2) written in English, (3) that the focus was labor productivity, (4) that factors were identified. First the titles were reviewed to remove most of the not relevant articles, afterwards an in-depth review was conducted by reviewing the abstract in the remaining papers. Based on the inclusion criteria, the number of articles was reduced from 360 to 26 articles, see Table 1. These 26 articles form the starting set to be included in the snowball procedure.

Step 2: The snowball procedure is a method to expand the number of relevant articles from the starting set, and is an approach used by among others De Carvalho et al. (2017) and Sfakianaki (2019). Thus, the snowball procedure takes outset in the starting set of 26 articles identified in step 1. In the snowball procedure, each article is reviewed one by one. The purpose is to identify as many relevant articles as possible. First, until all data is extracted the process will be repeated with the next paper (Wohlin, 2014). The snowball procedure can be divided into backwards and forward snowballing (Wohlin, 2014). Backward snowballing is the process of identifying relevant articles with outset in the reference list, whilst forwards snowballing is the process of identifying relevant articles with outset in the citations.

All the 26 identified papers did undergo first a backwards snowball and then a forward snowball process. In the backward snowballing, the previously mentioned four inclusion criteria were applied at title level. Finally, it was ensured that the reference was not already included. The articles passing the inclusion check were then put aside. In the forward snowballing, citations were identified using Google Scholar. Each citation was at title level checked in accordance with the four inclusion criteria, and as with the backward snowballing it was ensured that the article was not already included. The identified articles were added to the ones put aside. The process was repeated for all 26 articles.

Afterwards the identified papers were reviewed, one at the time, by reading the abstract and looking through the article. When an article passed the review, it did undergo a review of backwards and forward snowballing. The snowballing process was continued until an entire iteration did not reveal any new relevant papers (Wohlin, 2014).

In total, the snowballing procedure identified 61 additional papers, based on title. All identified papers were organized in a Microsoft Excel document to keep track of included and excluded papers. Based on the in-depth review of the articles 28 articles were removed. Thus, in total 33 articles were added to the initial set.

Afterwards, a more detailed review of the remaining papers was conducted, and a new set of inclusion criteria were developed: (1) an actual ranking of the factors should be included, this resulted in the removal of 14 additional papers and (2) the study should originate from Asia, which reduced the number of articles with 16. In the end, 39 papers were selected. A factor to consider in this regard, is that the papers selected in this study, were published over a period ranging from 1995 through 2019, during which macro factors affected the construction industry, such as war, climate changes and global economic instability as well as scarceness of resources, skewing impact of project factors from year to year. This is, nonetheless, the same skewness observed when comparing project factors across regions and countries.

An overview of geographical location of the included studies is shown in Figure 1. The overview revealed that most studies have been carried out in the southern parts of Asia, secondly in Western Asia, followed by South-Eastern Asia.

Table 2 contains the basic characteristics of the identified studies. This includes where the study was conducted, the research method, the number of factors included, and the number of participants.

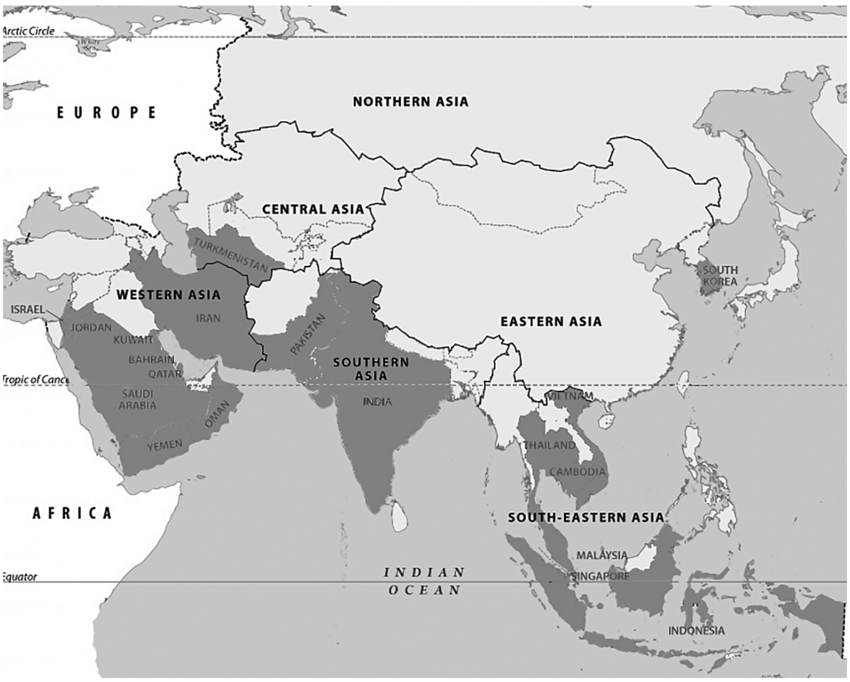

Figure 1. Geographical location of identified studies (dark gray): 1 study from Central Asia (Turkmenistan), 1 study from Eastern Asia (South Korea), 7 studies from Southern Asia (India, Pakistan), 13 studies from South-Eastern Asia (Cambodia, Indonesia, Malaysia, Singapore, Thailand, Vietnam) and 17 studies from West Asia (Bahrain, Iran, Israel, Jordan, Kuwait, Oman, Saudi Arabia, Qatar, Yemen)

Table 2. Basic characteristics of the included studies

Reference	Country	Method	Factors included	Participants
Durdyev et al. (2013)	Turkmenistan	Survey	23	–
Jang et al. (2011)	South Korea	Survey	25	–
Thomas and Sudhakumar (2013)	India	Survey	44	185
Karthik and Kameswara Rao (2019)	India	Survey	38	120
Soham (2013)	India	Survey	27	51
Rao (2015)	India	Survey	15	45
Dixit (2018)	India	Survey	24	140
Thomas (2014)	India	Survey	44	185
Muzamil and Khushid (2014)	Pakistan	Survey	20	164
Durdyev and Ismail (2016)	Malaysia	Survey	39	171
Manoharan (2017)	Malaysia	Survey	19	170
Hwang et al. (2017)	Singapore	Survey	26	32
Tam et al. (2018)	Vietnam	Survey	39	185
Kaming et al. (1997)	Indonesia	Survey	11	243
Soekiman et al. (2011)	Indonesia	Survey	11	63
Hanafi et al. (2010)	Malaysia	Survey	41	43
Muhammad et al. (2015)	Malaysia	Survey	15	44
Pornthepkasemsant and Charoenpornpattana (2019)	Thailand	Survey	16	128
Makulsawatudom et al. (2004)	Thailand	Survey	23	34
Durdyev and Mbachu (2018)	Cambodia	Survey	36	73
Lim and Alum (1995)	Singapore	Survey	17	67
Abdul Kadir et al. (2005)	Malaysia	Survey	50	100
Zakeri et al. (1996)	Iran	Survey	13	141
Islam (2013)	Oman	Survey	25	138
Mahamid (2013a)	Israel	Survey	40	50
Heravi and Eslamdoost (2015)	Iran	Interview	15	85
Ghoddousi et al. (2015)	Iran	Survey	32	60
Bekr (2016)	Jordan	Survey	14	150
Choudhry (2015)	Saudi Arabia	Survey	31	1454
Ghoddousi and Hosseini (2012)	Iran	Survey	31	82
Jarkas et al. (2015)	Oman	Survey	33	132
Hiyassat et al. (2016)	Jordan	Survey	27	90
Alaghbari et al. (2019)	Yemen	Survey	52	91
Mahamid (2013b)	Israel	Survey	31	59
Jarkas et al. (2014)	Qatar	Survey	38	247
Jarkas et al. (2012)	Qatar	Survey	35	84
Jarkas (2015)	Bahrein	Survey	37	59
Jarkas and Bitar (2012)	Kuwait	Survey	45	259
Enshassi et al. (2007)	Israel	Survey	45	76

From Table 2, it is evident that there is a big difference between how many factors were registered. By looking into the factors included in each study, it becomes apparent that there is a considerable variation in a) the number of actual factors included, b) which subjects they cover, and c) the definition, terminology and how they are categorized.

The number of factors included in the studies varied from 11 to 52 sub-factors. To create some order, all factors have been systematically reviewed, and grouped into 33 key sub-factors. A definition to the factors and their content can be found in Table 3. The grouping process was carried out as an iterative process where all factors were mapped and evaluated, and new factors were added when revealed from the studies. However, not all studies covered all sub-factors, and some studies covered the same sub-factor with multiple factors. For instance, storm, wind, rain, heat, and humidity are all covered in the sub-factor weather. Such meaning condensation of the sub-factors was performed for all factors found during the review process, in order to ensure factors with the same semantic meaning and thereby content, were combined in the same category, as well as to ensure comparability between projects from different time periods, regions and countries, despite impact of macro factors, such as war, global economic instability or scarceness of resources. Construction methodologies have additionally changed during the period studied in this research, however, offsetting the effect of macro factors impacting projects. The definitions and content of the sub-factors is shown in Table 3. The condensation and combination of factors was performed based on mapping and discussions between the authors to prevent biased grouping process, as a means for ensuring credibility in the grouping of factors. As most identified factors found in the scientific literature were fairly obvious with respect to how to group multiple factors into one category. Therefore, only a few factors needed extensive discussions to reach consensus regarding their categorization in the author group. A few factors covered more than one-sub-factors; in such cases, the impact has been equally divided between the sub-factors.

Table 3. A short explanation of factor categories and sub-factors

Factor category	Sub-factors	Factors included
Project factors	Contracts and procurement	Procurement method, contract type, contract size and deadline, competition, incentive scheme
	Construction method	Construction method, alternative method
	Subcontracting	Subcontractors, proportion of work subcontracted
	Rework and delay	Rework
	Project characteristics	Size of project, complexity, buildability, design, requirements, type
	Financial capability	Reputation, financial weakness, budget, cash flow, timely payments
	Location	Placement of building, ground conditions
Labor factors	Motivation	Attitude, responsibility, team spirit, morale and discipline
	Skill and experience	Education, training, capability, work experience and errors
	Absenteeism	Regular absenteeism, strikes and labor turnover
	Labor work facilities and satisfaction	Salary, recognition, influence, site facilities and working condition
	Labor shortage	Labor availability
	Labor fatigue	Fatigue, working overtime, no holiday, 7 days a week, health and age
	Crew composition	Composition and size
	Personal issues and disputes	Religion, personal problem, disputes and relationships amongst the labors
Management factors	Supervision	Supervision, interaction, relationship, recruitment and competence
	Planning and sequencing	Planning, sequencing, scheduling, division of work, deadlines and schedule compression
	Competency of project manager	Competence, leadership, management style, empowerment, ethics and decision making
	Poor site condition and layout	Site layout, storage and access
	Inspections	Absenteeism and delay
	Coordination and collaboration	Instructions, information flow, coordination, communication, language barriers, meetings and trust
	Safety and work environment	Safety plans, accidents, safety equipment and work environment (noise, dust, light etc.)
	Congestion and overmanning	Site congestions, overmanning, fluctuations in manning, confined space and interference
Technical factors	Materials	Logistics, availability and quality
	Tools and equipment	Availability, condition, suitability and breakdowns, utilization
	Technology and culture	Application of IT, technological advancements, research, development and culture
	Design changes	Design changes
	Incomplete specification or design	Frequency, response rate, schedule and internal coordination,
	Information	Availability, quality, consistency in contract documents
	Client and consultants	Client interference, approvals and disputes, decision making, competence
External factors	Weather	Heat, cold, rain, wind, humidity, etc.
	Financial stability	Stability of country, inflation, cost of capital, financial crisis, disruption in supply of heat, water, electricity, political stability
	Legislation and permits	Government legislation and inspection, Permits and approvals, bureaucracy

The factors were, additionally, analyzed considering all the included factors and makes a calculation of the impact of each factor by calculating their relative rank (RRI).

In 21 of the studies the sub-factors were given structure by dividing the activities into categories. Again, there was a huge variation in numbers, subjects covered and terminology. For instance, Soekiman et al. (2011) divided the factors into 15 categories. Durdyev and Ismail (2016) divided the factors into two key categories: Internal and External. The internal (productivity at the plant) and external perspective is also applied in different contexts like Syverson (2011) who looked at the overall concepts of productivity and what determines high productivity (Back in our study, four studies used four key categories: Management, Labor, Technical and External (Jarkas et al., 2012, 2015; Alaghbari et al., 2019; Jarkas, 2015). Hwang et al. (2017) expanded the categories to five by adding the category: Project. The present study has adapted these five categories to structure the sub-factors. Table 3 provides the categories, the sub-factors and a short description of each sub-factor of which the first four categories are internal, and the fifth category is external (Syverson, 2011).

Other categories could also have been utilized in this study. However, the five categories were selected by the authors of this paper, as they had previously been selected in other research as worthy categories for summarizing the complexity of construction in terms of clustering factors and because they cover the previous identified basic resources (labor, equipment, materials, capital, energy, technology, etc.). These factors therefore represent the production function in the study (Syverson, 2011).

In order to compare the findings across studies, the numerical representation of the ranks of the included factors has to be independent of the number factors included. In order to do so, a new measure, the relative rank index (RRI), is introduced. The measurements are developed with outset in the RII index which are applied in most of the identified studies, but instead of a relative importance a relative rank is calculated:

The RRI is calculated as:

$$\text{RRI} = \frac{N_{Factors} - Rank}{N_{Factors} - 1}. \quad (1)$$

By calculating the RRI the highest ranked factor will receive the relative rank 1, while the lowest ranked factor will receive the relative rank 0. In cases where studies have multiple factors covering the same sub-factor the RRI has been calculated as the sum of the RRI to each of the factors. In cases where a study uses a factor covering two or more sub-factors, the RRI has been equally divided between the sub-factors.

2.1. Grouping of factors and calculation of RRI

In all the 39 included studies the included factors have been ranked using the RRI. The RRI is a measurement that can be compared across the studies because it expresses the importance of the sub-factor without considering the number of included factors. Table 4 contain an example of the calculated RRI. The example focuses on the project related factors to Mahamid (2013a, 2013b).

In all studies the complete list of ranks has been included. Thus, based on the complete list of ranks, each study's factors have been grouped into sub-factors and the RRI has been calculated. The RRI levels from the 39 studies are shown in Figure 2, where the blue line indicates the mean value.

2.2. Aggregation of ranks

In order to create a common baseline to the factors affecting productivity in construction, the findings from the 39 studies have been tested for significant differences. The studies have been grouped into three main groups; studies conducted in West Asia containing 17 studies; studies conducted in South-East Asia containing 13 and studies covering the remaining regions in Asia (Central, East and South) this includes the last 9 studies.

Initially a Kruskal-Wallis test have been carried out. In the Kruskal-Wallis test, independent variables are tested for significant differences. The test is carried out for each sub-factor and the findings are shown in the following 5 tables. The test result reveals that no significant difference is found between 3 of the 5 categories for 31 of the 33 sub-factors. The two sub-factors revealing significant differences are "Absenteeism" (in the Labor factor category) and "Planning and scheduling" (in the Management factor category). An in-depth analysis reveals that for "Absenteeism" the significant difference is located between "West Asia" and "Central, East and South Asia". For "Planning and Scheduling" the significant difference is located between "South-East Asia" and "Central, East and South Asia". Thus, no differences are found between the sub-factors when comparing West Asia and South-East Asia.

Table 4. The project factors from Mahamid (2013a, 2013b), divided into subcategories. Rank represents the factors direct rank and can be found directly in the article

Reference: (Mahamid, 2013a, 2013b)	Contracts and procurement	Construction method	Subcontracting	Rework and delay	Project characteristics	Financial capability	Location
Rank(s)	12	32, 38	39	9	31	7, 18, 20	24, 25, 33, 37
Frequency	1	2	1	1	1	3	4
Summed RRI	.718	.256	.026	.795	.231	1.923	1.051

In conclusion, the findings for the 31 sub-factors can be directly generalized, while the last two sub-factors can be generalized with care, taking in mind that region-specific aspects can affect the importance.

In order to determine the importance of the different sub-factors, the factors are ranked by applying the Friedman rank test. The rank test is based on the summed rank of each sub-factor cleared for the effect of missing values. In the Friedman Rank test, the ranks are calculated and compared to each study and a significance level is calculated. The significance level indicates whether the ranked factors are significantly different or not. The sub-factors are ranked both with regards to the factor category and between all factors. The calculated Friedman ranks can designate distinct ranks to factors having nearly identical values.

Table 5 shows the result from the Kruskal-Wallis test and the Friedman's Rank test on Project related sub-factors.

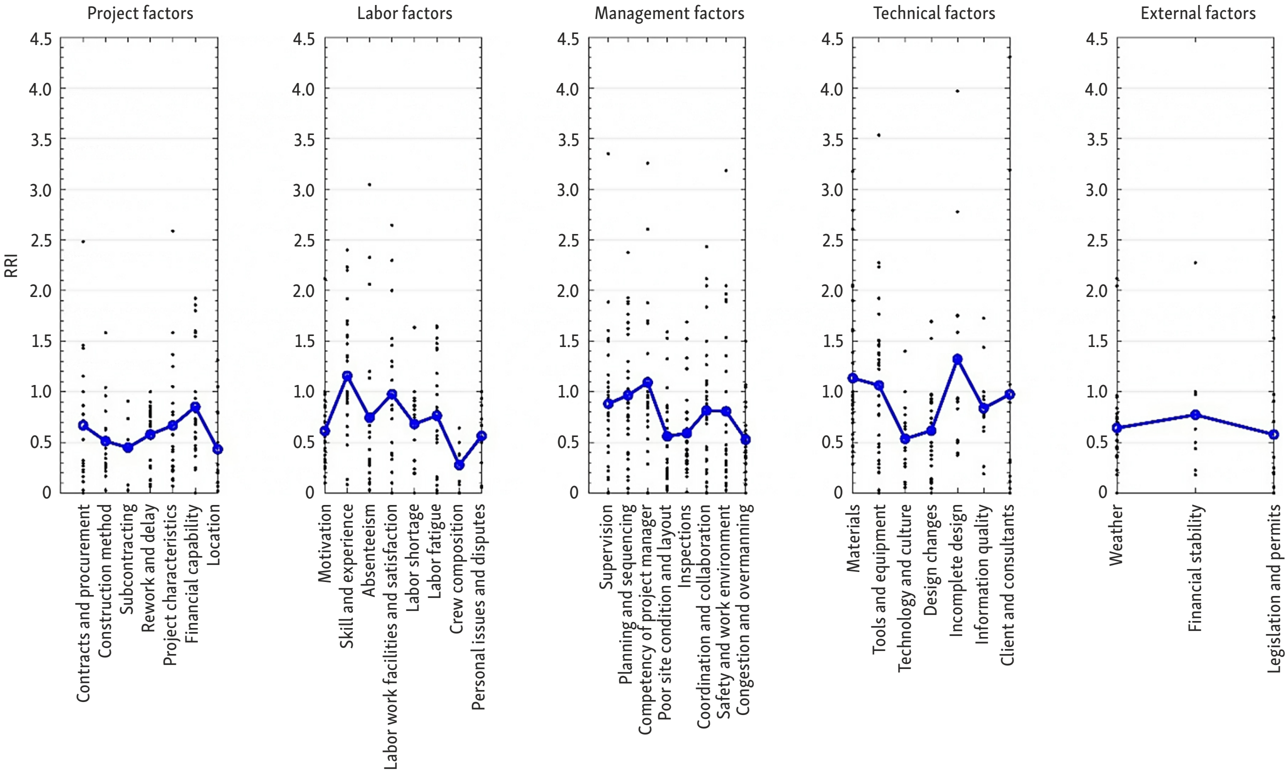

Figure 2. Grouping of factors

Table 5. Comparing significant differences between groups and ranking the different Project related sub-factors

	Contracts and procurement		Construction method		Subcontracting		Rework and delay		Project characteristics		Financial capability		Location	
	N	R	N	R	N	R	N	R	N	R	N	R	N	R
Summed Rank (for Asia)	27	12.039	23	9.748	7	3.141	30	16.208	34	14.031	38	22.146	21	6.055
Times included (out of 39)		17		18		6		27		20		25		13
Kruskal-Wallis test for differences in distributions between parts of Asia (West, South-East and rest)														
p-value		.052		.176		.317		.400		.152		.504		.463
Rank only between project factors														
Friedman Rank test (sig = .000)		4.64		3.56		3.05		4.32		4.45		5.64		2.33
Friedman corresponding rank		2		5		6		4		3		1		7
Rank between all factors														
Friedman Rank test (sig. =.000)		15.81		10.99		8.89		14.49		15.36		20.31		8.50
Friedman corresponding rank		18		30		31		21		19		11		32

Note: Rank adjusted for missing values.

Table 6 shows the result from the Kruskal-Wallis test and the Friedman's Rank test, related to the Labor related sub-factors.

Table 7 shows the result from the Kruskal-Wallis test and the Friedman's Rank test, related to the Management related sub-factors.

Table 6. Comparing significant differences between groups and ranking the different Labor related sub-factors

Reference	Motivation		Skill and experience		Absenteeism		Labor work facilities and satisfaction		Labor shortage		Labor fatigue		Crew composition		Personal issues and disputes	
	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R
Summed Rank (for Asia)	31	15.332	62	38.239	42	17.858	52	21.494	21	12.273	44	18.352	8	2.217	15	6.211
How often included (out of 39)		25		33		24		22		18		24		8		11
Kruskal-Wallis test for differences in distributions between parts of Asia (West, South-East and rest)																
p-value		.463		.319		.015*		.273		.272		.483		.303		.147
Pairwise comparison																
West vs. South-East						*.237*										
West vs. Rest						*.015**										
South-East vs. Rest						*.268*										
Rank only between labor factors																
Friedman Rank test (sig. =.000)		3.72		6.77		4.68		5.78		4.64		5.05		1.79		3.56
Friedman corresponding rank		6		1		4		2		5		3		8		7
Rank between all factors																
Friedman Rank test (sig. =.000)		14.26		25.99		16.54		22.72		17.68		18.69		5.13		13.06
Friedman corresponding rank		23		2		17		6		15		13		33		26

Note: *Significantly different at the 95% confidence level.

Table 7. Comparing significant differences between groups and ranking the different Management related sub-factors

Reference	Supervision		Planning and sequencing		Competency of project manager		Poor site condition and layout		Inspections		Coordination and collaboration		Safety and work environment		Congestion and overmanning	
	N	R	N	R	N	R	N	R	N	R	N	R	N	R	N	R
Summed Rank (for Asia)	44	25.586	58	31.868	41	27.302	39	15.672	43	17.142	58	28.531	59	23.404	43	14.23
How often included (out of 39)		29		33		25		28		29		35		29		27
Kruskal-Wallis test for differences in distributions between parts of Asia (West, South-East and rest)																
p-value		.777		.004*		.409		.279		.089		.840		.118		.137
Pairwise comparison																
West vs. South-East				*.760*												
West vs. Rest				*.005**												
South-East vs. Rest				*.037**												
Rank only between management factors																
Friedman Rank test (sig =.000)		5.05		5.36		6.09		3.46		3.78		4.88		4.37		3.00
Friedman corresponding rank		3		2		1		7		6		4		5		8
Rank between all factors																
Friedman Rank test (sig. =.000)		20.42		21.62		25.08		12.50		13.22		17.95		16.91		11.51
Friedman corresponding rank		10		9		3		27		25		14		16		29

Note: *Significantly different at the 95% confidence level.

Table 8. Comparing for significant differences between groups and ranking the different Technical related sub-factors

Reference	Materials		Tools and equipment		Technology and culture		Design changes		Incomplete design		Information quality		Client and consultants	
	N	R	N	R	N	R	N	R	N	R	N	R	N	R
Summed Rank (for Asia)	44	25.586	58	31.868	41	27.302	39	15.672	43	17.142	57	37.198	59	23.404
How often included (out of 39)		34		31		16		26		15		16		11
Kruskal-Wallis test for differences in distributions between parts of Asia (West, South-East and rest)														
p-value		.710		.414		.635		.776		.579		.820		.824
Rank only between technical factors														
Friedman Rank test (sig. =.000)		4.94		4.65		2.13		2.51		5.79		3.56		4.41
Friedman corresponding rank		2		3		7		6		1		5		4
Rank between all factors														
Friedman Rank test (sig. =.000)		24.85		22.33		11.68		14.42		27.81		21.78		22.82
Friedman corresponding rank		4		7		28		22		1		8		5

Table 9. Comparing significant differences between groups and ranking the different External related sub-factors

Reference	Weather		Financial stability		Legislation and permits	
	N	R	N	R	N	R
Summed Rank (for Asia)	40	17.995	17	7.730	23	7.514
How often included (out of 39)		28		10		13
Kruskal-Wallis test for differences in distributions between parts of Asia (West, South-East and rest)						
p-value		.860		.511		.172
Rank only between external factors						
Friedman Rank test (sig =.000)		1.81		2.63		1.56
Friedman corresponding rank		2		1		3
Rank between all factors						
Friedman Rank test (sig. =.000)		14.69		19.47		13.54
Friedman corresponding rank		20		12		24

Table 8 shows the result from the Kruskal-Wallis test and the Friedman's Rank test, related to the Technical related sub-factors.

Table 9 shows the result from the Kruskal-Wallis test and the Friedman's Rank test, related to the External sub-factors.

3. Discussion

Based on the search results, our findings revealed 39 articles that have been carried to identify factors affecting labor productivity across Asia. Although leading determinants of labor productivity may vary depending on the specific project's or country's conditions, some similarities could also be identified in the factors that contribute to making improvements in general (Mojahed & Aghazadeh, 2008; Heravi & Eslamdoost, 2015). Despite the differences, a Kruskal-Wallis test confirmed that the studies are overall comparable. The present paper has created a common understanding of labor productivity factors and their corresponding rank within the Asian construction industry. Considering the information given by Tables 5 to 9, the top five factors constraining labor productivity across Asia are: 1) Incomplete design; 2) Labor: skill and experience; 3) Competency of a project manager; 4) Materials; 5) Client and consultants.

What distinguishes the technique, followed by this research, from the two previous literature reviews (Hasan et al., 2018; Hamza et al., 2019) with the similar purpose of identifying factors affecting construction productivity is that the present study considers not only the top five but all the included factors and makes a calculation of the impact of each factor by calculating their relative rank (RRI). Including the impact of all factors has made it possible to, in the rank aggregation, to impute missing values/factors to make sure that the highest-ranked factors are not just the ones included most often. Non-imputed data would lead to, materials being considered as the most important factor which corresponds to the top category in the work of Hasan et al. (2018).

The analysis revealed a significant variation to the included factors and the terminology. This research has grouped these factors into 33 factors. These factors can be used as baseline factors for measuring labor productivity and, help organize future studies in examining these factors. The most frequent factors based on the current literature are Materials, Coordination and Collaboration, Labor: skill and experience, Planning and Sequencing, as well as Tools and Equipment. The least frequent factors are Subcontracting, Crew composition, Financial stability, Client and Consultants, Labor: personal issues and disputes. It is evident that whilst some factors are critically significant for labor productivity in Asia, they have rarely been included in the past research. This is the case for, e.g., the client and consultant factor. Future studies in this field should, therefore, provide a deeper insight into the most influential factors impeding construction labor productivity in Asia in terms of their causes and management solutions to upgrade, especially those which have been rarely included in the available publications (see Tables 4 to 8). Moreover, some parameters are more relevant in some countries than others; for instance, financial stability has been mostly explored in Malaysia.

Detailed elaborations on the top five factors identified by the present study and their management solutions are presented in the following sub-sections.

3.1. Incomplete specifications or design

A specification or a design being incomplete entail that some parts are missing or some parts are not finished. Missing and incomplete specifications or designs entails that crucial information is missing that tells the contractor how to perform the job, when the contractor is scheduled to complete the job. Therefore, incomplete, ambiguous, or outdated design documents and technical specifications disrupt project rhythm and prolong construction duration. This also creates consecutive dilemmas for foremen and site supervisors and imposes overtime on the crew (Zakeri et al., 1996). It is mainly because the workforce has to stop or slow down ongoing activities until designers respond to requests for information or clarifications, and face rework in case of revisions (Jarkas, 2015). In addition, excessive allocations of time, payments, and site resources also lead to dissatisfaction of the management team and demotivation of laborers (Jarkas et al., 2014; Thomas, 2014). According to the publications reviewed in this paper, issues such as delay in availability of design documents at the worksite, errors/omissions in design information or specifications, poor concepts and details, complex or impractical design, slow response to requests for information, low-quality or illegible drawings, incompatible drawings or specifications, and uncoordinated disciplines and drawings result in a considerable decline in labor productivity levels. A significant problem that prevents construction drawings from being timely available on site is delays in issuing them by consultants (Hanafi et al., 2010; Abdul Kadir et al., 2005). Late issuance of information is often interrelated to coordination problems among designers and contractors, which hinders the work progress (Abdul Kadir et al., 2005). Some other significant reasons that cause improper designs are either employing inexperienced or irresponsible designers who fail to apply buildability principles or imposing insufficient design schedules and low design fees upon designers by clients (Islam, 2013; Jarkas et al., 2014, 2015; Jarkas, 2015). The view of exerting pressure on designers to reduce design time and budget was denominated by Jarkas et al. (2012) as a 'false economy', since directing more efforts on the design than on the building phase provide more opportunities to considerably lower the overall project expenditures.

With this said, the management of drawings and specifications is an area of research that deserves immediate attention. For example, Abdul Kadir et al. (2005) proposed one management solution to resolve poor coordination and promote interaction amongst designers, clients, contractors and managers. The authors suggested that site meetings should be held between the project team on a regular basis during the design stage to clarify any unsettled issues and prevent delayed issuance of design documents. Another step in the right direction is improving the buildability level of designs, which can be accomplished through raising the designers' awareness of the considerable positive effect of this notion on the performance and productivity of the workforce (Jarkas & Bitar, 2012). Such an effort can be further enriched by encouraging procurement contracts or project delivery methods, which allow the contribution of contractors during the design phase of projects and thus facilitate sharing the construction experience at an early stage so that the associated benefits can be reaped during the execution phase. Additionally, establishing a formal buildability assessment application by policymakers has been considered as another strategy to ensure compliance with the minimum requirements of buildability practices (Jarkas et al., 2012, 2015). Jarkas et al. (2014) also emphasized the need for highly competent construction managers who would be able to prepare a comprehensive 'request for information' list at a primary phase of the project to prevent occasional requests along the execution phase. Other research has, identified lack of documentation of a design's intent and a design's rationale, as a limitation, due to not understanding design management's impact on productivity (Peña-Mora et al., 1993; Wyke et al., 2023a, 2023b). Hence, further development of design knowledge management and buildability competences, will be a step in the right direction in improving construction labor productivity.

3.2. Labor: skill and experience

Labor is essential when talking about productivity in Construction. Labor is one of the basic resources that serves as an input for creating the output (Hanna et al., 2005). Thus, an increased efficiency of the labor entails a lower consumption of labor hours and thus higher productivity. Moreover, construction is considered a labor-intensive industry. Thus, the cost, schedule, and quality outputs of every construction project relies heavily on the labor and their performance (Jang et al., 2011). The performance of the workforce depends on their skills, which expresses the labors' ability to perform their job, and their experience, which expresses the progress of getting the skill, obtained by performing similar tasks or by education. This is why the construction industry, as well as this present study, have an intensive focus on labor productivity (Neve et al., 2020). Low-skilled and untrained workers are often characterized with poor or unsatisfactory outputs, which may lead to extensive and costly reworks on construction sites; therefore, low productivity level is incurred (Durdyev & Ismail, 2016). This issue is also stated as a cause of frustration and demotivation to site managers (Jarkas et al., 2014). In contrast, experience enhances both the intellectual and physical capabilities of the labor force to effectively cope with task-related challenges (Durdyev et al., 2013; Manoharan, 2017). Most of the time, developing countries have difficulties finding experienced local staff due to this group's high tendency to migrate to other countries in search of more lucrative job opportunities. Conversely, the industry has to rely on either foreign operatives or self-employed individuals who are mostly inexperienced and untrained (Durdyev et al., 2013; Mahamid, 2013a, 2013b; Manoharan, 2017; Kaming et al., 1997). In such situations where there is a dire shortage of skilled local craftsmen in the market while the level of skill and experience of foreign workforce is also insufficient, contractors are compelled to recruit less-qualified/unqualified manpower deteriorating labor productivity (Karthik & Kameswara Rao, 2019). The provisional nature of foreign recruitments results in frequent craftsmen turnover and lower productivity when during the learning curve of newer employees (Thomas & Sudhakumar, 2013), due to both lack in skills and competences of the focal recruit, in addition to limited productivity as a result of the recruit needing to integrate in a new work environment, a new culture, and even new tools and materials. This also imposes extra work to the supervision team because they constantly have to give instructions to the workers on site and carefully monitor their outputs (Islam, 2013; Hwang et al., 2017). Another contributor to the workforce incapability in these regions is the lack of professional training courses and skill development programs to be attended by the workforce and help them execute construction activities based on modern practices (Muzamil & Khushid, 2014). The majority of novice workers acquire skills informally, following on-the-job training over time (Bekr, 2016). Past research attributed this issue to a shortfall on the management side that usually takes a short-term view of labor training because of the workload and its fluctuation, depending on the economic conditions and demand for construction (Jarkas et al., 2012; Jarkas, 2015). Besides, the industry also fails in providing skillful craftsmen with specific knowledge and experience to handle more complicated or less-conventional construction operations (e.g., prefabrication, green building) than traditional ones, which give rise to productivity problems (Durdyev & Ismail, 2016; Hwang et al., 2017; Hanafi et al., 2010), however, cultural differences might also be a affecting factor limiting productivity, even when recruiting from neighboring countries, or regions within the same country.

Considering the direct impact of these rampant issues on labor productivity, the development of workforce knowledge and skillfulness deserves the attention of both governments and construction companies in developing countries (Pornthepkasemsant & Charoenpornpattana, 2019; Jang et al., 2011; Ghoddousi et al., 2015). To this end, Pornthepkasemsant and Charoenpornpattana (2019) have introduced a tripartite labor skill management strategy: 1) describing planning level, 2) defined and managed level, and 3) continuous level.

1) Planning level, includes one criterion, namely, job training. The governments should conduct ongoing training programs (e.g., workshops, apprenticeships, etc.) in collaboration with higher education institutions to upgrade the skill level of the workforce (Durdyev & Ismail, 2016; Mahamid, 2013a, 2013b). The number of trade schools that concentrate on educating construction tradesmen should also be increased (Enshassi et al., 2007).
2) Defined and managed level, contains two criteria, which are labor incentives and performance review. Authorities should promote new policies and programs for encouraging skilled native laborers based overseas to come back home as well as attracting skilled foreign workforce to the market (Durdyev & Ismail, 2016). Long-term employment and relaxation of residence permits have been considered as motivating forces for craftsmen (Durdyev et al., 2013; Pornthepkasemsant & Charoenpornpattana, 2019). Moreover, policymakers should contribute to establishing a high-quality recruitment screening process to ensure that selected recruits have the necessary qualifications. Such regulation can, furthermore, result in a considerable saving in time, efforts, and costs associated with the workforce training (Jarkas et al., 2014).
3) Continuous level, consists of three criteria: job training program planning, human resource recruitment planning, and new technology. This level takes a long-term effort on construction companies' part to further enhance the competence of their employees. In terms of novel technology, worker input has to be enriched by applying technologies which are valuable and suitable for the local resources and skills (Durdyev & Ismail, 2016).

3.3. Competency of project manager

Project managers are the front-line personnel with the overall duty to organize, implement, supervise, direct, and deliver the construction projects. Thus, the competence of the project manager is crucial important as it expresses his or her ability to perform the job. Project managers competences are composed of several roles where the most important abilities with regards to ensuring project success is the project managers communication, commitment, and leadership capabilities (Alvarenga et al., 2020). The competences of the project manager directly contribute to approximately 30–50% of a project success (Hwang et al., 2017). Nonetheless, it is observed that incompetent managers are operating with low productivity levels (Jarkas et al., 2014). This issue attributes to the shortage of managers who possess leadership characteristics in the local construction sector and the managers' weakness in handling the work challenges on an individual level (Ghoddousi & Hosseini, 2012; Jarkas et al., 2012). Besides, lack of empowerment, unethical behavior and decision-making of managers, and improper management styles also result in poor worker's performance and productivity in the construction projects (Karthik & Kameswara Rao, 2019; Ghoddousi et al., 2015; Durdyev & Ismail, 2016). Managers with a low level of knowledge, managerial skills, and experience definitely make numerous management mistakes, giving rise to non-value-added activities, which will finally impede the work progress and its productivity (Durdyev & Ismail, 2016). In further details, incoordination among the parties, poor workforce training, failure in early detection of drawing errors, failure in addressing technical inquiries of craftsmen, inappropriate utilization of site resources, defective work or rework, employee demotivation, unrealistic expectation of labors, negative attitudes of workforce, unsuitable relationship between the management and the crew, interrupting ongoing operations, frequent disrupting field supervisions, unorganized rest breaks, and abuse of time schedule have been stated as the major consequences of poor competency of construction managers (Ghoddousi & Hosseini, 2012; Mahamid, 2013a, 2013b; Bekr, 2016; Jarkas & Bitar, 2012).

To promote labor productivity, construction companies have to develop managers' leadership capabilities by establishing long term and short-term training programs (Bekr, 2016). Government policies should also emphasize formal education to upgrade construction parties' technical and managerial skills (Mahamid, 2013a). Another recommendation is to encourage managers to focus on improving their behavioral competencies rather than technical abilities. By doing so, effective communication and multi-organizational teamwork can be incurred (Durdyev & Ismail, 2016). Moreover, promoting managers' ethical behavior is positively associated with employee commitment and job satisfaction (Ghoddousi et al., 2015). With this said, the improvement of labor productivity can be facilitated through more appropriate leadership styles that encourage interpersonal communication between construction managers and personnel (Ghoddousi et al., 2015; Durdyev & Ismail, 2016), as well as having a better foundation for decision making such as access to design knowledge, bridging the gap between how to solve the identified issues with incomplete specifications or design, and increasing the competency of project managers.

3.4. Materials

Materials are the parts which are needed to perform a specific activity. Material unavailability is therefore a hindrance to complete the work when planned. Problems with material unavailability at the worksite generally arises from inefficient material planning and management, and can lead to idling manpower, since the crew has to temporarily postpone the work planned regarding these activities whilst waiting for materials (Thomas & Sudhakumar, 2013; Manoharan, 2017). Besides, such interruption at work is a key detriment to the sequence and progress of interrelated construction activities (Abdul Kadir et al., 2005) and, diminish craftsmen's motivation and performance (Hanafi et al., 2010; Jarkas et al., 2014). It is notable that material shortage is sometimes caused by the negligence and sabotage of project managers who are employed on a contract basis to intentionally extend the contract period (Abdul Kadir et al., 2005). Poor coordination among project site, office, and suppliers, excessive paperwork for material requisition, ignoring the lead time in material procurement, lack of materials in the market, or non-payment to vendors may also cause delays in material supplies to the project site (Abdul Kadir et al., 2005; Thomas & Sudhakumar, 2013; Zakeri et al., 1996; Ghoddousi & Hosseini, 2012; Makulsawatudom et al., 2004). In Singapore, however, early delivery of materials has been problematic as well. This issue arises from the lack of adequate storage spaces that causes multiple handling of materials and so, loss of person-hours (Lim & Alum, 1995). Besides, the unsuitability of material storage location contributes to the increase in project duration, because workers spend extra time for transporting or double handling of materials from a distant location to the desired place (Muzamil & Khushid, 2014; Karthik & Kameswara Rao, 2019). On the other hand, difficulties in transportation and/or handling materials on the worksites are detrimental issues which not only lead to high wastage, but could also threaten the safety of laborers (Zakeri et al., 1996; Kaming et al., 1997). Additionally, other detriments such as lack of a properly defined work plan, incomplete or unclear design documents, changes in drawings or specifications, misuse of materials to specifications, execution errors, and working overtime due to unrealistic scheduling increase the demands for materials to support extra work imposed, which result in loss and waste of materials (Zakeri et al., 1996; Hanafi et al., 2010; Islam, 2013; Karthik & Kameswara Rao, 2019; Hwang et al., 2017).

Two studies conducted in Malaysia (Durdyev & Ismail, 2016; Abdul Kadir et al., 2005) revealed that the construction productivity was negatively affected by some external constraints related to the capabilities of complementary industries, including inadequate supply of construction materials in the local market and inflation/fluctuations in material prices being imported. While acknowledging the impact of economic problems, the materials shortage in this country is sometimes associated with artificial shortages created by the suppliers who choose to export them abroad for extra profit (Abdul Kadir et al., 2005). In countries such as Palestine and Yemen, material shortage in the local market was mainly attributed to the tough political situation restricting product import (Mahamid, 2013a; Enshassi et al., 2007; Durdyev & Ismail, 2016). Addressing this issue, more investment in the production of quality local materials is required to reduce the industry's growing reliance on imported materials (Durdyev & Ismail, 2016; Mahamid, 2013). Quality materials are a prerequisite for providing satisfactory work and task success (Karthik & Kameswara Rao, 2019; Enshassi et al., 2007). Therefore, low-quality materials delivered to the site are usually rejected by site managers, which lead to idle time of labors and cost overruns. The study in Iran attributed this problem to the deliberate dishonesty of suppliers in providing cheaper defective materials (Zakeri et al., 1996).

Existing scholarly works represent some opportunities for improvement in materials component and thereby, labor productivity. To upgrade the obsolete techniques that are used for on-site material transportation and handling in countries like India and Iran, changes in material innovation using efficient technologies (e.g., automated materials tracking, modernized material transport and distribution systems, etc.) has been recommended, which can significantly increase labor productivity (Grau et al., 2009; Thomas, 2014). Some studies have targeted the detriment of poor material planning and proposed the adoption of an adequate schedule for material procurement and supply in each specific project taking the variables of time, quality, storage location and space into account (Enshassi et al., 2007; Ghoddousi & Hosseini, 2012; Bekr, 2016). This schedule should be set at the earliest stage of the management plan with particular attention to long-lead items (Jarkas et al., 2012, 2014). Another study presented by Abdul Kadir et al. (2005) emphasizes the key role of governments in encouraging proactive policies and practices to restrict the export of materials and control their prices. According to Tam et al. (2018), the origin and qualification of raw materials need also to be confirmed by organizations. The novel approach followed by Pornthepkasemsant and Charoenpornpattana (2019), was developing and validating a maturity model leading to the improvement of the productivity-related work system in Thailand. Three levels of material management have been proposed in their model, namely, materials planning level, defined and managed level, and continuous improvement level. These levels emphasize on making a detailed plan for all the materials, checking the quality of materials and protecting them from damage and pilferage with proper storage, and procurement of resources, respectively. In addition, to maintaining an integrated supply chain, better *cash flow management* by contractors is also needed, especially for those contractors facing financial limitations (Ghoddousi et al., 2015; Mahamid, 2013a, 2013b). However, in countries such as Kuwait and Qatar with financially strong contractors, *cash-flow is not a common obstacle for* material procurement (Jarkas & Bitar, 2012). In these countries, a major shortage of material supply is due to the rapid pace of development, as the demand for materials is much higher than their availability in the local market. Such countries need to increase the investment on the domestic production of quality materials (Jarkas et al., 2012, 2014).

3.5. Client and consultants

The client, which is the person who receives and pays for the project, while the clients' consultants are simply giving advice and in many cases responsibility for leading the project. Disputes and litigation conflict with the clients or the client consultants, are often caused by either contractual or speculative issues both caused by incompleteness or ambiguities in the contract and tender materials and specifications (Cheung & Pang, 2013). Thus, it is strongly related to the key factor: Incomplete specifications or design. Disputes can in extreme cases result in the client stopping the payments or the contractor stopping the work and leaving the site. Major disputes might even affect the behavior of both parties in some cases even the morale of the workers and thus, impairs their performance and productivity (Thomas & Sudhakumar, 2013). Ambiguities in the tender document can lead to mismatched goals between the expectations of the clients and the contractor, bot regarding to regarding project duration project quality and project cost (Lim & Alum, 1995; Rao, 2015; Jarkas, 2015; Larsen et al., 2018). The high-handed behavior of some owners' representatives aggravates such work tensions (Lim & Alum, 1995). Another contributor to disputes between project participants is frequent requests for revision of design and drawings and delays in decision-making by either the clients or the consultants that usually impose extra work or rework on contractors and staff and, prevent timely completion of the project (Thomas, 2014; Durdyev & Ismail, 2016; Lim & Alum, 1995). One major reason behind owners' late decision-making is that the *approval process* for *construction* projects is hierarchical and prolonged (Jarkas et al., 2014). Sometimes, claims by contractors to the clients for excess payments due to variations in either design or unforeseen circumstances (e.g., unusual weather or ground conditions) may not be issued on time (Durdyev & Mbachu, 2018; Durdyev & Ismail, 2016); which can hinder the payment to employees and suppliers and, severely affect labors' motivation and vendors' credibility (Abdul Kadir et al., 2005).

To resolve the above-mentioned conflicts at the construction workplace, the interaction among the clients/owners and the project consultants should be enhanced from the earliest phase of projects (Thomas, 2014). Furthermore, an increased effort is needed to ensure that the contractual documents are transparent and unambiguous. Finally, the impacts of unforeseen circumstances must be well articulated in project planning and cost estimating stages and clearly stated in the contract to establish an acceptable basis for variation claims (Durdyev & Mbachu, 2018).

4. Limitations

The present research has tried to make a consensus regarding the key factors affecting construction labor productivity across specific regions in Asia. Thus, the study identifies the average most important factors based on aggregated values. Several limitations exist, first of all the study acknowledges but does not consider country characteristics and differences in demographic factors which might have an effect regarding key factors in the individual country. Also, the study acknowledges that the included studies are most often not based on nationally representative samples and does therefore not necessarily reflect the overall national key factors. Despite these limitations and due to the fact that the study is focused on aggregated averages of 39 different studies involving at least 5500 respondents (one study did not state the number of respondents), the presented key factors are not expected to be susceptible to selection bias.

5. Conclusions

A structured literature review has been carried out focusing on aggregating the ranks of factors affecting labor productivity in specific regions in Asia, namely West Asia, South-East Asia and a conglomerate of the remaining regions of Central, East and South Asia. The review represented the regions by 17, 13 and 9 papers, respectively, and a total of 39 papers were thusly included in the identification of ranked factors. The review yielded the identification of 33 region-wise, ranked sub-factors, each pertaining to one of 5 more general factor categories. The identified and ranked factors were made comparable by utilizing the novel RRI. In addition, the review revealed that previous studies have been inconsistent in the use of terminology and also in the number of considered factors.

Hypothesis testing based on the Kruskal-Wallis test revealed no statistically significant differences between the region-wise sub-factor rankings for 31 out of 33 identified ranked factors at a 95% confidence level. The only significant differences in ranks were identified for the sub-factors "Absenteeism" and "Planning and scheduling", both between the regions West Asia and Central, East and South Asia. Thus, no differences were found between the sub-factors when comparing West Asia and South-East Asia. In conclusion, the findings for 31 of the considered 33 sub-factors were directly generalized, whilst the remaining two sub-factors had to be generalized with care, bearing in mind that region-specific aspects can affect the importance.

A key reason for why the grouping is necessary is, to allow project managers to have an overall and more general understanding for where to start, when improving a process or planning a new construction project, whilst at the same time, allowing an understanding of what each category consists of, which creates a structured foundation for improvement planning, as well as a to do list, of factors to consider, in planning and project management.

On the basis of the established generalizability of the identified sub-factors, a rank aggregation was carried out by applying the Friedman rank test to the RRI of the sub-factors. The ranking yielded that the sub-factors "Incomplete design", "Skill and experience (of laborers)", "Competency of project manager", "Materials" and "Client and consultants" were found as the five most important sub-factors affecting productivity in Asia. Thus, managing these five factors the best way possible are the key to achieving higher labor productivity levels in on-site construction.

The main contributions of the present study are: 1) establishing that the region-wise ranking of factors affecting productivity in different regions of Asia can be generalized to be valid for the region as a whole, and 2) providing construction professionals with a prioritized list of terminologically well-defined factors affecting productivity, which facilitate a structured approach to productivity enhancements.

The study furthermore allows countries in Asia without available data, with respect to productivity on construction projects, to attain an understanding of what to look for and what to focus on, when planning productivity improvements. As differences between projects within a country is also expected for many construction projects, the generalized grouping of factors, can similarly be used to plan where to begin and what to focus on, with respect to productivity improvements.

Notations

Variables and functions

Rank – is the rank of the factor in the examined study.

$N_{Factors}$ – is the total number of ranked factors in the examined study.

Abbreviations

RRI – Relative Rank Index.

SLR – Systemic Literature Review.

GDP – Gross Domestic Product.

Author contributions

SS and NS worked together on writing the introduction and discussion, where NS had the primary responsibility for the introduction and SS had the primary responsibility of the discussion. SL carried out the SLR and the data-analysis, moreover he wrote the method and result section. SW was in charge of the review process, and finally, FN had the responsibility of coordinating and supervising the work.

Disclosure statement

The authors do not have any competing financial, professional, or personal interests from other parties.

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