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Labor Productivity in the Construction Industry -Factors Influencing the Spanish Construction Labor Productivity-

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***Abstract*—**This research paper aims to identify, analyze and rank factors affecting labor productivity in Spain with respect to their relative importance. Using a selected set of 35 factors, a structured questionnaire survey was utilized as the method to collect data from companies. Target population is comprised by a random representative sample of practitioners related with the Spanish construction industry. Findings reveal the top five ranked factors are as follows: (1) shortage or late supply of materials; (2) clarity of the drawings and project documents; (3) clear and daily task assignment; (4) tools or equipment shortages; (5) level of skill and experience of laborers. Additionally, this research also pretends to provide simple and comprehensive recommendations so that they could be implemented by construction managers for an effective management of construction labor forces.

***Keywords*—**Construction management, Factors, Improvement, Labor productivity, Lean construction.

I. Introduction

NOWADAYS, although Spain is still suffering the effects of the economic crisis, its economy begins to show signs of recovery. However, severe cuts during the last years had been made in public works investment in order to control public finances. The public bidding volume has been in constant decrease since 2008 when it reached almost 45,000 m €, to 10,000 m € in 2013 [1]. This decision has generated strong competition between companies to maintain a position within the Spanish construction market.

Though the construction industry has greatly improved in terms of total productivity in last decades with the development of machinery and work equipment more powerful on the one hand, and new construction procedures on the other, it still continues to be a labor-intensive industry where labor costs still remain an important part of the overall project´s cost [2]. In fact, other authors have revealed that, generally, labor costs represent up 30% to 50% of the overall cost of the project [3], [4]. In 2012, labor costs amounted to 27,702.9 m €- almost a third of the total business volume in the Spanish construction industry [5].

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Given this scenario, it is easy to see that construction labor productivity (CLP) plays a critical role in most of the construction projects and hence, labor productivity in Spain should not remain unnoticed. Consequently, efforts to improve labor productivity levels in construction companies should be considered. Understanding critical factors that affect labor productivity can help to develop strategies to reduce inefficiencies and to more effectively manage construction labor forces. This will not only improve the project performance of construction companies, but also make them more competitive and consequently increase the chances of survival within this highly competitive sector.

Previous researchers have studied the factors influencing CLP in the last decade in different countries; however, no studies has been conducted in Spain concerning construction labor productivity, thus deeper research is still needed in this area. Therefore, the main objective of this study is to identify, analyze and rank factors affecting labor productivity in the Spanish construction industry with respect to their relative importance.

II. Background and Literature Review

A. Defining Labor Productivity

Improving productivity is a major concern for any profit-oriented organization, as representing the effective and efficient conversion of resources into marketable products and determining business profitability [6]. Although a great number of publications exist concerning construction productivity, there is no agreement on a standard productivity measurement system. Researchers have concluded that it is difficult to obtain a standard method to measure labor productivity because of project complexity and the unique characteristics of construction projects [7]. The uniqueness and non-repetitive operations of construction projects make it difficult to develop a standard productivity definition and measure [8].

However, there exists a general consensus among researchers to define productivity as the ratio of output to input. Consequently, construction productivity can be regarded as a measure of outputs that are obtained by a combination of inputs. In view of this, two measures of construction productivity emerge. These are total factor productivity (TFP), where all outputs and inputs are considered and partial factor productivity (PFP), often referred to particular factor productivity, where outputs and single selected input are considered [9].

TFP can be defined as the ratio of outputs to the amount of all inputs, as expressed in (1) and (2):

$$\text{TFP} = \frac{\text{Total Output}}{\sum \text{of all imput resources}} \tag{1}$$

or

$$\text{TFP} = \frac{\text{Total Output}}{\text{Labor} + \text{Materials} + \text{Equipment} + \text{Energy} + \text{Capital}} \tag{2}$$

The TFP measure is often impractical since it is difficult to accurately measure and determine all of the input resources utilized to achieve the output.

Partial factor productivity (PFP) establishes a relationship between outputs and a single or selected set of inputs. The definition is best exemplified by the term labor productivity, where only the input of labor is considered as displayed in (3). Other single or partial factor productivity measures may include capital, energy, and equipment productivity.

$$\text{Labor productivity} = \frac{\text{Output quantity}}{\text{Labor hours}} \tag{3}$$

The advantages of the partial factor productivity are manifold. By focusing on a selected factor, in this research, labor input, the measurement process becomes easier and more controllable. As a result, more reliable and accurate data can be obtained. The complex nature of the construction process and the interaction of its activities make the partial factor productivity measure the popular option because effective control systems monitor each input separately [10].

Moreover, since the construction employs a large number of laborers, thereby, it can be argued that manpower is the dominant productive resource, thus construction productivity is mainly dependent on human effort and performance [11]. In this way, efforts and consideration concerning labor productivity becomes crucial because of the concentration of manpower needed to carry out a specific task.

B. Literature Search

To conduct a literature search the first step was to identify well known articles relating to factors affecting labor productivity in the construction industry. A literature review was conducted based on these findings. For this purpose, a three-stage literature search was performed to acquire a more deep understanding of these factors affecting CLP. Fig. 1 presents the strategy followed for the search process.

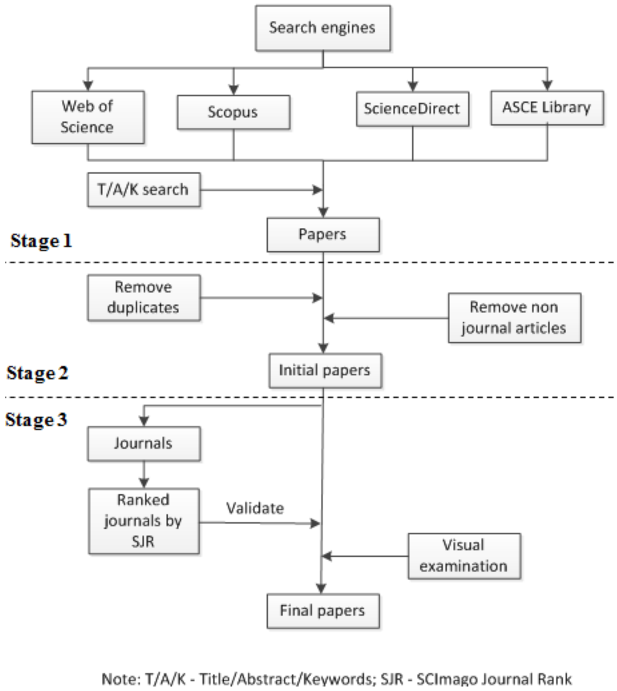

Fig. 1 Research framework used for the literature search (adapted from [12])

In the first stage, a comprehensive bibliometric search under the "article/ title/ abstract/ keyword" field was conducted in a sequential mode since this type of exploration provides relevant information when analyzing the current state of knowledge from the general to the particular. Stage 2 consisted of an analysis of the results from stage 1. Firstly, "exact duplicates" or "close duplicates" were removed in order to avoid repeated publications. Secondly, articles published under the broad categories of editorial, book review, forum, discussions/closures, letter to the editor, article in press, foreword, index, introduction, conference/seminar report, briefing sheet, and comment were excluded. Lastly, the purpose of stage 3 was to get a manageable number of factors affecting CLP related articles by complementing and deepening the analysis developed in stage 2. In this stage, each of the journals in which each article has been published were selected and compared by their SCImago Journal Rank (SJR indicator). Journals with low SJR index were not taken into account and hence, articles published in these journals were removed. During this final step, of the remaining articles were examined and those articles which did not match the terms of this investigation were neither considered.

C. Literature Review

According to the theory that if all the factors that affect CLP were known and could be perfectly quantified, it would be possible to forecast labor productivity in an effective way [13], several efforts have been made to investigate the factors influencing labor productivity. However, researchers have not coincided on a universal set of factors with significant influence on productivity and no agreement has been reached on the classification of these factors [14].

On the basis of this knowledge published in previous literature, main contributions were collected, determining a summary of factors affecting CLP in different countries. Most suitable factors from the literature summary shown in Table I were selected to be explored in this research according to the proper characteristics of the Spanish construction sector.

Additionally, a new factor was considered for the first time that relates to the integrity of laborers. It considers the adherence to moral, ethical, and legal principles. Moreover, it intends to highlight the importance for increasing performance in the way people honor their words [15].

TABLE I
LITERATURE SUMMARY REGARDING FACTORS AFFECTING CLP

Country	Reference	Total number of studied factors
Egypt	[2]	30
Gaza Strip	[14]	45
Kuwait	[10]	45
Malaysia	[28]	50
New Zealand	[21]	56
Singapore	[30]	17
Thailand	[23]	23
Uganda	[24]	36
U.K.	[22]	13

Thus, a set of 35 factors were selected for this research. In order to better identify and manage these factors, a classification of these factors influencing CLP into categories was developed. Factors explored in this study were then grouped in five different categories according to the nature of each factor. Proposed categories were: (1) project category, which grouped factors related with the project itself; (2) human category, involving the factors affecting the laborers; (3) management or organizational category for those factors referred to planning, management, scheduling and supervising issues; (4) materials and tools category, grouping factors related with the supply or shortage of materials, tools, equipment or machinery; and finally (5) environmental factors category. Table II displays a list comprised of the 35 factors selected for this research classified according to their categories. Furthermore, a code for each factor was established so that they could easily be identified in the results section of this paper.

TABLE II
LISTING OF FACTORS CONSIDERED FOR THE RESEARCH

Code	Factor	Category
F1	Construction method	Project category
F2	Complexity of the design	
F3	Clarity of the drawings and project documents	
F4	Project scale	
F5	Level of Skill and experience	Human category
F6	Ability to adapt to changes and new environments	
F7	Labour motivation	
F8	Working overtime	
F9	Number of breaks and duration	
F10	Worker´s integrity	
F11	Incentive policies	Management or organizational category
F12	Clear and daily task assignment	
F13	Insufficient supervision of subcontractors	
F14	Improper coordination of subcontractors	
F15	Inadequate planning	
F16	High congestion	
F17	Delays in payments to workers	
F18	Delays in payments to suppliers	
F19	Unrealistic scheduling	
F20	Communication problems	
F21	Reallocation of laborers	
F22	Coordination between crews	
F23	Lack or delay in supervision	
F24	Rework	
F25	Shortage or late supply of materials	Materials and tools category
F26	Unsuitability of materials storage location	
F27	Tools or equipment shortages	
F28	Performing work at night	Environmental category
F29	Influence of working at height	
F30	Motion´s limitation in the jobsite	
F31	Air humidity	
F32	High/low temperatures	
F33	Rain	
F34	High winds	
F35	Distance between construction sites and cities	

III. RESEARCH METHODOLOGY

A. Design of the Questionnaire

The research methodology was based on a literature review in order to analyze existing scientific articles regarding factors affecting CLP. The main instrument of collecting data from construction companies was a structured questionnaire survey. This way of data acquisition has proved to be extremely efficient at providing large amounts of data at relatively low cost.

The questionnaire was comprised of statements generated on the basis of the factors listed in Table II. For this purpose, literature review became a determining issue since data acquired from papers and related publications will be the base for the structured questionnaire survey preparation. Participants were required to rate the statements as to their effect on labor productivity taking into account time, cost, and quality based on their own experiences on construction sites.

The main characteristics of the questionnaire design were that the statements used had to be easy to read and, understand with no room for interpretation–Furthermore, accuracy and time efficiency in filling out the questionnaire was of essence. The need of taking as little time as possible for construction companies to respond was considered very seriously in order to obtain the maximum possible answers. The participants were contacted and invited to participate in the research by e-mail.

For this research, the Likert scale has been used to assess the individual´s performance or opinion of the given questions. In this study, respondents were required to rate the factors affecting labor productivity on a scale from "1," very little effect; "2," little effect; "3," average effect; "4," high effect to "5," very high effect, according to the degree of importance on CLP.

B. Pilot Test

This stage aimed at minimizing inevitable problems of converting the design of the questionnaire into reality. A little survey was piloted on a small scale in order to ensure the questionnaire's readability, accuracy, and comprehensiveness to the participants. Two researchers of the same field examined the questionnaire. Their feedback included validations and improvements in terms of wording of statements, the overall content, and the format and layout. Consequently, the questionnaire was validated through this process with suggestions from experts before launching the survey.

C. Determination and Selection of Samples

The target population for this research included all companies related with the construction industry cataloged in the Official Register of Classified Companies of Spain. This classification groups all Spanish construction companies which can contract with the administration. In consequence, the number of contractors classified was 7,840 [16]. This number represents the size sample of the available population (N). In order to ensure a representative sample size (n) of participants of all targeted contractors, a systematic random sample was selected by using (4) [17].

$$n = \frac{m}{1 + \left(\frac{m-1}{N} \right)} \tag{4}$$

where n = the sample size of the limited population; N = the sample size of the available population and m = sample size of the unlimited population which is estimated by (5).

$$m = \frac{z^2 \times p \times (1 - p)}{\varepsilon^2} \tag{5}$$

where z = the statistic value for the confidence level used. In this research, a confidence level of 95.5% which corresponds to z = 1.96 sigma's or standard errors was adopted.

p = the value of the population proportion that is being estimated. As the population variance is unknown, we considered the largest possible variance. Thus, the worst hypothesis of maximum uncertainty was used and a conservative value of 0.50 was applied so that the sample size obtained was at least as large as required.

Sampling error of the point estimate was represented with the letter ε meaning the error or diversion when extrapolating the results. It is the margin of error that is acceptable. For example, if the margin of error considered is 3.16%, the formula will take (ε) value of 0.0316. And if for a given question 64.3% of respondents have answered "yes", this means that the answer "yes" in the population is between (64.3 -3.16) % and (64.3 + 3.16) %. The lower the sampling error is, the more accuracy we will have but obviously, it will also increase the population needed. For this research it was selected a sampling error (ε) = 0.05.

Then, using a confidence level of 95% which corresponds to z = 1.96; a value of the population proportion that is being estimated of p =0.50 and a sampling error (ε) = 0.05, (5) was approximated as follows:

$$m = \frac{(1.96)^2 \times 0.50 \times (1 - 0.50)}{(0.05)^2} = 384.16 \cong 385$$

Finally, the sample size was statically determined from (4) considering the total number of construction companies cataloged in the Official Register of Classified Companies of Spain (N=7,840).

$$n = \frac{385}{1 + \left(\frac{385-1}{7,840} \right)} = 366.25 \cong 367$$

Thus, the minimum number of samples necessary to ensure a representative sample size was established in 367.

D. Analysis of the Data

Some researchers, i.e. [18]-[20] are of the opinion that the mean and standard deviation of each individual factor is not a suitable measure to assess global rankings as they do not reflect any relationship between them. The technique used for analyzing data was the relative importance index (RII). The analysis involved the computation of a weighted average or representative rating point for the collective ratings made for each variable in the subset [21]. Thus, by using this tool, it is pretended to rank each factor explored taking into account the level of experience of each respondent: (k_1), less than five years; (k_2), between 5 and 10 years; (k_3), between 10 and 15 years; and lastly (k_4), more than 10 years of experience within the construction industry. In order to calculate the RII for the different factors of each category, (6) was applied.

$$RII_k(\%) = \frac{5(n5) + 4(n4) + 3(n3) + 2(n2) + (n1)}{5(n1 + n2 + n3 + n4 + n5)} \times 100 \tag{6}$$

RII_k (%) = RII (%) related to each category of years of experience (k_n); n1 = the number of respondents who selected: "1", for very little effect; n2 = the number of respondents who selected: "2" for little effect; n3 = the number of respondents who selected: "3" for average effect; n4 = the number of respondents who selected: "4" for high effect; and n5 = the number of respondents who selected: "5" for very high effect.

RII_k of each factor is computed separately for each category (k_1, k_2, k_3, and k_4). Then, (7) is used for calculating the overall RII (%) for each factor considering weighting coefficients. Weighting coefficients assigned to each category depended of the years of experience in the construction industry: less than

5 years of experience, k_1=1; between 5 and 10 years of experience, k_2=2; between 10 and 15 years of experience, k_3=3; and more than 15 years of experience within the Spanish construction industry, k_4=4.

$$OverallRII\,(\%) = \frac{\sum_{k=1}^{k=4} (k \times RII_k)}{\sum_{k=1}^{k=4} k} \tag{7}$$

After all overall RIIs were computed, factors were arranged in descending order according to their ranks, factors with a score close to 100%, the highest RII rank indicate that they have maximum impact on labor productivity. Conversely, factors with the lowest rank indicate that they have little effect on labor productivity. Moreover, RII for each category of factors were also calculated by using an average measure of the RII of all factors included within the category considered.

IV. Results and Discussion

A. Project Related Factor´s Category

Findings regarding the ranking and perceived importance of factors classified under the project category are analyzed in Table III.

TABLE III
Overall RII and Ranking of Factors in the Project Category

Rank	Code	Factor	Overall RII (%)
1	F3	Clarity of the drawings and project documents	86.41
2	F2	Complexity of the design	66.86
3	F1	Construction method	65.49
4	F4	Project scale	64.17

Ranked with a RII of 86.41%, F3 arranges first in the project related factors' category but also ranks second among the 35 factors rated by the respondents. This finding supports the results obtained by [11], who classified this factor as the most important factor within its category with significant effect on construction labor productivity in Kuwait. Reference [14] also detected a high impact in the Gaza Strip when drawings or specifications were altered during execution. Other researches have also realized the importance of this factor on labor efficiency. In this way, lack of clarity, incomplete drawings or technical were further recognized among the significant factors affecting construction productivity in the United Kingdom, Thailand, and Uganda [22]-[24]. In this sense, [25] stated that loss of efficiency may reach 30% when work changes are being carried out during execution. This impact might be related to the short time available to designers between the design start and the call for tender. As a result of this, tender documents are most often incomplete, unclear, or contain serious conflicts among the various disciplines involved. This lack of clearness leads to continuous requests for clarification and hence, consecutive interruptions in the workflow [11].

F2 was ranked second within the project related factors' category with a RII of 66.86% although 26thamong all 35 surveyed factors. The limited impact of this factor on labor productivity in Spain may be attributed in whole or in part to the fact that most of the respondents work for small/medium companies whose construction projects design is relatively simple.

The third ranked factor in project related factors' category was F1 with a RII of 65.49%. In the overall classification among the 35 factors analyzed, it was classified 27th. Although related research conducted by [2] in Egypt concluded that the "construction method" factor was one of high influence, and indeed, it was ranked first within its category and sixth among all 30 surveyed factors. Reference [14] ranked the same factor third within the project related factors' category and 32nd among all 45 explored factors in the Gaza Strip which is in consonance with the findings obtained in this study.

The last factor classified under this category, F4,was perceived to have an average impact on CLP in Spain and was ranked 4thwith a RII of 64.17%. Taking into account all the factors surveyed in this study, the "project scale" factor was ranked 30th.

B. Human Related Factor´s Category

This section analyzes and discusses the factors within the human related factor´s category. Table IV shows human factors identified and their perceived influence on labor productivity.

TABLE IV
Overall RII and Ranking of Factors in the Human Category

Rank	Code	Factor	Overall RII (%)
1	F5	Level of Skill and experience	83.16
2	F6	Ability to adapt to changes and new environments	80.84
3	F7	Labour motivation	77.47
4	F10	Worker´s integrity	75.00
5	F9	Number of breaks and their duration	62.67
6	F8	Working overtime	59.82

Results show that F5 was ranked in the highest position with a relative importance index of 83.16%. Furthermore, it obtained a 5th position when all 35 factors surveyed are considered. The findings substantiate the results obtained by [22], ranking the skill of labor factor first in importance to labor productivity in the United Kingdom. Moreover, this result is further supported by [14], [24], whose researches recognized the skill and experience of laborers among the most significant factors. They impact on the efficiency of the labor force since the level of skill and experience of laborers is detrimental to the productivity of the construction process. To provide more reliability to these findings, [2] "laborer experience and skill" factor ranked first in the labor/human category and also first among all 30 surveyed factors with RII of 93.29%, while [11] the "Skilled and shortage of experienced labor" factor ranked second and fourth within the human/labor category. Poorly trained and unskilled operatives' outputs are almost always rejected, either in whole or in part by the inspection engineer, resulting in extensive and expensive rework, rectifications, or repairs. Opposed to that, experienced operatives are able to find practical solutions to encountered obstacles, possessing high technical and motor skills, all of which lead to higher productivity, lower cost of labor, and better quality of finished outputs.

Surveyed practitioners ranked F6 as the second factor influencing labor productivity under this category, with a RII of 80.84%. This effect shows the high influence of the ability of laborers to adapt to new working environments and apply new construction techniques. A quick adaptation to changes and new environments allows laborers to limit the effect of the learning curves and achieve optimum productivity levels sooner.

F7, with a RII of 77.47% was ranked third within the human category and 13thamong all the factors explored. Motivated laborers are usually more enthusiastic and initiative. They work harder and respond faster to instructions. Their pace is associated with a greater sense of pride, satisfaction, and responsibility, thus they typically achieve better levels of productivity, in comparison with demotivated or discouraged laborers. To support this outcome, findings obtained by [26], [27] emphasized the importance of this factor to labor productivity. Recent studies carried out by [11] also corroborate these findings as they ranked labor motivation first in its human/labor category group and fourteenth among all factors surveyed in Kuwait.

With a Relative importance index of 75.00%, F10 was ranked fourth among the factors belonging to the human category and 17th among all 35 factors surveyed. This factor refers to a set of principles, moral and ethical behavior laborers should follow aiming to increase labor performance and project value. In addition, this factor has not been previously studied as a factor that could affect labor productivity; however, the data obtained through the questionnaire reflects that it has a high effect as a factor influencing labor CLP in Spain. As explained by [15], integrity in construction means "Honoring One's Word" which means you either keep your word (do what you said you would do and by the time you said you would do it); or, as soon as you know that you will not, you say that you will not and clean up any mess caused for those who were counting on your word. However, it should be noted that there is integrity of a person, integrity of a group and integrity of an organization where the used model of integrity within this research is only the integrity of a person which presents the labor's integrity.

With RIIs of 62.67 and 59.82%, F9 and F8 were ranked 5th and 6th, respectively, within the human category. Furthermore, among all 35 investigated factors, they were ranked 32ndand 33rd, correspondingly.

C. Management/Organizational Related Factor´s Category

The perceived importance according to the RIIs and ranking of the 14 factors grouped under the management or organizational category are shown in Table V.

TABLE V
OVERALL RII AND RANKING OF FACTORS IN THE MANAGEMENT OR ORGANIZATIONAL CATEGORY

Rank	Code	Factor	Overall RII (%)
1	F12	Clear and daily task assignment	85.53
2	F17	Delays in payments to workers	82.47
3	F22	Coordination between crews	82.00
4	F14	Improper coordination of subcontractors	81.59
5	F13	Insufficient supervision of subcontractors	81.03
6	F20	Communication problems	80.88
7	F15	Inadequate planning	78.10
8	F18	Delays in payments to suppliers	76.99
9	F19	Unrealistic scheduling	75.07
10	F16	High congestion	73.94
11	F24	Rework	73.19
12	F21	Reallocation of laborers	70.80
13	F23	Lack or delay in supervision	70.22
14	F11	Incentive policies	69.65

F12 was ranked with the highest RII within this category. In fact, with a RII of 85.53% it was also considered by the respondents the third factor among all surveyed factors which impacts more on CLP in Spain. Since one of the main objectives of the project manager is to maintain a constant workload for all workers, daily task assignment according to the needs of the construction site becomes crucial so as to reach optimum levels of productivity. Sustaining this finding, [28] ranked the same factor 24th among all 50 surveyed factors, [14] ranked it second in the project category and 24th among all 45 investigated factors, and [11] ranked it ninth in the management category and 25th among all 45 explored factors.

F17 represents with a RII of 82.47% the second factor with more implications on labor productivity within the management or organizational category. In addition, it is ranked in 6th position among all the factors surveyed. Reference [14] also noticed that payment delay has negative effect on laborers mood, and consequently decreases its productivity. In their study carried out in the Gaza Strip, payment delay was ranked 6th of all 45 factors negatively affecting labor productivity considered.

Practitioners ranked F22 as the third most influencing factor within this category, with a relative importance index of 82.00%. This factor was further ranked 7th in its effect among all 35 factors evaluated in this study, which indicates the high effect of this factor on labor productivity within the Spanish construction industry. This lack of coordination between crews may lead to overlap activities or cause interference between gangs and workers due to mismanagement on construction sites.

F14 and F13 factors were ranked 4th and 5th with RIIs of 81.59% and 81.03%, respectively under the management or organizational category. When considering all the 35 surveyed factors, "improper coordination" ranked 8th and "insufficient supervision to subcontractors" was classified 9th. These effects have great implication in labor productivity in the Spanish construction industry since the proportion of work subcontracted may far exceed 50% of the total workload.

Basically, subcontracting work packages or certain trades means offer sums to subcontractors to accomplish and hand over, in accordance with contracts' specifications and within specified durations. Consequently, any additional costs required to making good on faulty or nonconforming work, along with any associated liquidated damages incurred, would be borne directly by the related subcontractors. This finding further supports the results obtained by [22], reporting this factor among the most significant to labor productivity in the British construction industry.

With a RII of 80.88%, F20 ranked 6thin this category and 10th among all 35 factors surveyed. In Thailand, [23] ranked poor communication sixth among all the 23 factors surveyed. Authors from this study advised that, instead of using informal verbal communication, documentation such as work procedures, manuals, charts and guidelines should be used. Further support is provided by [2] who ranked clarity of instructions and information exchange 6th within the management category and in position 10th among all 30 factors explored. Reference [14] also sustained these findings since misunderstandings between laborers and superintendent was ranked 4thamong all 45 factors negatively affecting CLP in Gaza Strip.

F15 ranked 7thunder the management and organizational category and 12thamong all the factors explored in this research. This inadequate planning refers to the incompatibilities and restrictions coming about when planning or scheduling activities. Reference [2] exposed that applying modern concepts and systems such as the Last Planner System (LPS) can help to control and drive the management factors that affect labor productivity in the construction industry. Reference [29] concluded that productivity is not improved by completing as many tasks as possible regardless of the plan, nor from increasing workload, work output, or the number of work hours expended. In contrast, productivity does improve when workflow based in an adequate planning is made more predictable.

With relatives importance indexes of 76.99, 75.07, 73.94, 73.19, 70.80, 70.22, and 69.65%, F18, F19, F16, F24, F21, F23, and F11 were ranked 8th, 9th, 10th, 11th, 12th, 13th, and 14th respectively, within the management or organizational category. Furthermore, among all 35 factors surveyed, they were ranked 14th, 16th, 18th, 19th, 21st, 22nd, and 23rd, respectively.

D. Materials and Tools Related Factor´s Category

Table VI shows the RIIs and ranks of the 3 factors classified under the materials and tools category.

TABLE VI
OVERALL RII AND RANKING OF FACTORS IN THE MATERIALS AND TOOLS CATEGORY

Rank	Code	Factor	Overall RII (%)
1	F25	Shortage or late supply of materials	87.40
2	F27	Tools or equipment shortages	85.20
3	F26	Unsuitability of materials storage location	75.36

F25, with a RII of 87.40% was classified first under this category and also among all 35 factors surveyed. As any work cannot be accomplished without necessary materials, this factor has very high impact on labor productivity in the construction industry. Moreover, this finding is further substantiated by many CLP studies conducted in the US, UK, Nigeria, Singapore, Gaza Strip, Kuwait, Egypt [2], [3], [11], [14], [22], [28], [30]. This result might be justified in Spain, since a very high proportion of the materials needed are provided for external providers which not always fulfill with their delivery agreements in terms of quality and time. Also an improper planning from site manager of the activities that have to be executed may lead to a shortage of materials or a delayed delivery of needed construction materials with the consequent loss of efficiency and consequently, a decrease in labor productivity.

Second factor classified under this category was F27, with a RII of 85.20%. Furthermore, it was ranked 4thamong all factors explored. This fact confirms the high influence of this factor on labor productivity in Spain. In addition, tools and equipment shortages also have a high effect in the US, UK, Nigeria, Thailand and Gaza Strip [3], [14], [22], and [23]. These findings might be substantiated by inadequate management since laborers need a minimum number of tools and equipment to work effectively. Moreover, a lack of maintenance programs from companies might lead to inefficient use of tools or equipment, the use of old and obsolete equipment or shortage of spare parts. Also, as [14] suggested, overestimating the capacity of the equipment may result in insufficient number of equipment employed for a given activity which will lead to an equipment shortage and thus, productivity will decrease.

Finally, F26 was ranked third within the materials and tools category with a RII of 75.36% and 15thamong all 35 explored factors. Unsuitability of materials storage location has an average-high effect influencing construction labor productivity in Spain. This result is further sustained by [14] and [31] who reported that size and disposition of materials storage have a noteworthy influence in masonry productivity. This is justified by as either workers or machinery have to move long distances from their workplace to these unsuitable storage locations in order to get the materials or tools they will use for their activities, this entails a waste of time and therefore productivity will decrease.

E. Environmental Related Factor´s Category

The RIIs and ranks of factors under the environmental category are shown in Table VII.

TABLE VII
OVERALL RII AND RANKING OF FACTORS IN THE ENVIRONMENTAL CATEGORY

Rank	Code	Factor	Overall RII (%)
1	F30	Motion´s limitation in the jobsite	72.08
2	F32	High/low temperatures	69.53
3	F28	Performing work at night	67.93
4	F33	Rain	64.39
5	F29	Influence of working at height	64.36
6	F34	High winds	63.25
7	F35	Distance between construction sites and cities	54.23
8	F31	Air humidity	53.56

F30 was ranked first within this category with a relative importance index of 72.08% and classified 20th among all the factors considered for this research. Poor site conditions like limitation of motion at jobsites may be responsible for laborers cannot work effectively, and consequently, they may have negative impacts on labor productivity.

The second factor ranked in the environmental related factors category was F32 with a RII of 69.53%. "High/low temperatures" was further ranked 24th among all surveyed factors. Temperature depends basically of the geography, weather conditions and location of the country. In this case in Spain, temperature conditions can vary greatly depending on the region in which the worksite is located.

Respondents ranked F28 as the third most influencing factor within this category and 25thwhen all factors are considered with a RII of 67.93%. This average impact on labor productivity may be explained since laborers need a proper and sufficient lighting to develop their work in an effective way, and performing activities at night leads in most of cases to have an insufficient lighting. The noteworthy influence of this factor was also recognized by [14].

F33 was ranked fourth in its influence within the environmental related factors category with a RII of 64.39%, and 28thoverall. This environmental factor is linked with adverse weather conditions that reduce labor productivity; particularly in activities developed in the outside such as formwork, steel work, concrete casting, external plastering, external painting, and external tiling. Adverse weather sometimes stopped work totally.

With RIIs of 64.36, 63.25, 54.23, 53.56%, F29, F34, F35, and F31 were ranked 5th, 6th, 7th, and 8th, correspondingly, within the environmental category. Additionally, they were ranked 29th, 31st, 34th, and 35th, respectively, among all factors surveyed.

Table VIII exposes the overall RIIs and ranks of the five surveyed categories. Outcomes indicated that materials and tools category ranked first with an average RII of 82.65%, further supporting the high effect of the factors within this category. Secondly, with a RII of 77.25%, management or organizational category was ranked. In third and fourth position, human and project category were classified with RIIs of 73.16% and 70.73%, respectively, and finally, with a RII of 63.67%, environmental category was ranked.

TABLE VIII
OVERALL RII AND RANKING OF ALL CATEGORIES OF FACTORS SURVEYED

Rank	Factor	Overall RII (%)
1	Materials and tools category	82.65
2	Management or organizational category	77.25
3	Human category	73.16
4	Project category	70.73
5	Environmental category	63.67

Table IX shows the average RIIs and ranks of the 35 explored factors.

TABLE IX
OVERALL RII AND RANKING OF ALL FACTORS SURVEYED

Rank	Code	Factor	Overall RII (%)
1	F25	Shortage or late supply of materials	87.40
2	F3	Clarity of the drawings and project documents	86.41
3	F12	Clear and daily task assignment	85.53
4	F27	Tools or equipment shortages	85.20
5	F5	Level of Skill and experience	83.16
6	F17	Delays in payments to workers	82.47
7	F22	Coordination between crews	82.00
8	F14	Improper coordination of subcontractors	81.59
9	F13	Insufficient supervision of subcontractors	81.03
10	F20	Communication problems	80.88
11	F6	Ability to adapt to changes and new environments	80.84
12	F15	Inadequate planning	78.10
13	F7	Labour motivation	77.47
14	F18	Delays in payments to suppliers	76.99
15	F26	Unsuitability of materials storage location	75.36
16	F19	Unrealistic scheduling	75.07
17	F10	Worker´s integrity	75.00
18	F16	High congestion	73.94
19	F24	Rework	73.19
20	F30	Motion´s limitation in the jobsite	72.08
21	F21	Reallocation of laborers	70.80
22	F23	Lack or delay in supervision	70.22
23	F11	Incentive policies	69.65
24	F32	High/low temperatures	69.53
25	F28	Performing work at night	67.93
26	F2	Complexity of the design	66.86
27	F1	Construction method	65.49
28	F33	Rain	64.39
29	F29	Influence of working at height	64.36
30	F4	Project scale	64.17
31	F34	High winds	63.25
32	F9	Number of breaks and their duration	62.67
33	F8	Working overtime	59.82
34	F35	Distance between construction sites and cities	54.23
35	F31	Air humidity	53.56

V. CONCLUSIONS AND RECOMMENDATIONS

As part of the main objective of this research, an identification and recognition of the primary factors influencing labor productivity in Spain was developed. 35 factors affecting CLP in Spain were considered for this research and in order to rank these factors in a consistent way, data from questionnaires were analyzed considering the category of level of experience of the practitioners.

A predictable factor identified, "clarity of the drawings and project documents" is the most influencing factor within the project category. Tender documents are most often incomplete, unclear, or contain serious conflicts among the various disciplines involved. This fact further supports that the design phase needs much more effort and consideration in the Spanish construction industry since a lack of cohesion between designers/engineers and contractors was observed. This inability occasionally leads to incomplete drawings or technical specifications which need to continuous requests for clarifications, hence consecutive interruptions and/or disruptions to work progress. Suggestions might include encouraging procurement methods that allow the involvement of contractors during the design stage of projects, such as design/build (DB), design/build/operate/transfer (DBOT), or turnkey/engineering, procurement, and construction (EPC), and thus accelerate the incorporation of the construction experience at the early stage of the project development process so that the desired benefits can be achieved during the construction phase. Considering the results, also further control and revision of the documents comprising the project should be developed by the public administrations, in order to minimize the number of omissions, unclear features or conflicts among the various disciplines involved. It could be considered to stipulate a formal value engineering assessment before the project was delivered to bidders, in which minimum requirements of constructability and quality must be satisfied before the project starts up the tender´s phase.

Also, the findings discussed the importance of the "shortage or late supply of materials" as well as the "tools or equipment shortages" factors which were ranked first and fifth, respectively, among all 35 factor surveyed, further revealing the need for the contractor to prepare a careful delivery plan for the required materials/equipment providing a materials/machinery supply schedule for each supplier. Moreover, it reflects the need for proper selection of suppliers and efficient selection of the location of material storage avoiding wastage of labor time. In addition, implementing maintenance programs in construction companies might lead to an efficient use of tools or equipment.

"Clear and daily task assignment" and "coordination between crews" factors are the most important ones within the management or organizational category. It is highly recommended to use project scheduling techniques (such as computer-aided construction project management) during the construction phase to optimize the times of related activities and to ensure that work allow continuous task performance and hence, reducing idleness of the labor force to a minimum. Additionally, communication problems between site management and workers and also between crews may be mitigated through all-foreman meetings, which could help to identify overlapping activities and address potential problems on the job site. Furthermore laborers should meet at the beginning of each workday for 5 to 10 minutes to review the work to be done that day as well as scheduling, safety or housekeeping issues. Involving laborers in decisions affecting their jobs lead to a creative thinking offering process improvements and thus continuous improvement through feedback from laborers. Also, it is common that laborers are not regularly informed of completion dates, for this purpose and aiming workers to feel more involved in the execution of the project, it is suggested to plot all completion dates and middle project milestones throughout the project and post them in different job sites so laborers can feel themselves important to the organization.

The outcomes of this research regarding the result of "level of skill and experience" factor reveals the importance of developing construction labor skills and experience in all levels of the organization. On the one hand, it becomes necessary to conduct training courses and seminars in management topics for the site managers, on the other hand, contractors should provide strong assistance and support regarding the continual training of their laborers.

Results obtained, also points that "Delays in payments to workers" represents nowadays a high influencing factor affecting labor productivity in Spain. However, this factor can be considered conjunctural and might be explained by the financial difficulties that many small construction companies are suffering due to the crisis and thus increasing the hopelessness of their laborers.

Lastly, on the basis of the outcomes of this study, factors related with the coordination and supervision of subcontractors also have high effects on labor productivity. In the Spanish construction industry the proportion of work subcontracted may far exceed 50% of the total workload. Additional costs incurred, would be borne directly by the concerned subcontractors. This fact linked with improper coordination and supervision of subcontractors as well as when lack of integrity exists from subcontractors or site manager may lead to misdealing situations. In this context, in order to help to control and mitigate the factors under the management or organizational category, it becomes desirable the application of modern management approaches and tools such as the lean construction and its main tool, namely the LPS. These management factors further includes coordination and communication between crews and between crews and site managers as well as assignments and supervision from site managers. LPS is a set of principles and tools designed to enhance work flow reliability through better planning strategies. LPS consists in different planning stages including phase scheduling, look ahead planning phase and lastly, commitment work planning phase. These planning phases identify the work that "should" be done, "can" be done, and "will" be done, respectively [29]. In order to effectively implement this technique, transparency as well as trust and reliance on others becomes decisive. These attitudes aim to improve reliability between construction agents.

Furthermore, cost variance analysis is frequently the only performance indicator introduced in the companies in order to know the deviation respect the planned budget. However, it could result interesting to complement this analysis implementing also the variance of assignments as a meaningful performance measure. As soon as the assignments are not completed on the scheduled time, the construction manager provides the immediate cause, i.e. weather conditions or improper scheduling. Providing the root causes of variances, construction manager is able to set action plans to deal with delays and limit the flow variability. Consequently, implementing these sorts of lean techniques can certainly help minimizing the effects of these factors previously exposed and thus, improving labor productivity in the Spanish construction industry.

Thus, improvement´s efforts for increasing labor productivity levels inside construction companies in Spain should then be focused on these high ranked factors, since this will not only make the construction companies more profitable, but also more competitive and thus increasing the chances of survival within the Spanish construction industry. In conclusion, it is believed that the outcomes of this research can provide a starting point from which recommendations and especially Lean techniques could be implemented in order to improve labor productivity and also help contractors and construction managers for the effective management of the labor forces.

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