MSc Alireza Tabrizikahou[1)]
ORCID: 0000-0002-3161-2224
Dr. Eng. Piotr Nowotarski[1)]*
ORCID: 0000-0002-6782-7147

Analysis of problems and barriers in construction sites processes

Analiza problemów i barier w procesach zachodzących na placach budów

Abstract. There are various problems in modern construction sites. Some of these problems affect a construction process directly while some have side effects such as global warming. The purpose of this study was to find the most important problems based on two different methods. Firstly, by using statically and comprehensive analysis of top cited articles the most important problems based on Web of Science database and data comparison were given in execution and monitoring stage of a construction project. Secondly certain number of construction engineers were asked to define the most important problems by ranking eight determined problems based on their importance. In general lack of skilled workers on site were considered as the most important problem while shortage in site equipment as the least important one based on presented assumptions.

Keywords: construction; construction project process; barriers and problems; construction management; risk analysis; Web of Science.

Streszczenie. Na współczesnych placach budowy występują różne problemy. Niektóre z nich wpływają bezpośrednio na proces budowlany, podczas gdy inne mają skutki uboczne, takie jak np. globalne ocieplenie. Celem tego artykułu było znalezienie najważniejszych problemów na podstawie dwóch różnych metod. Po pierwsze, za pomocą analizy statystycznej i kompleksowej najczęściej cytowanych artykułów, na podstawie bazy Web of Science i porównania danych, podano najważniejsze problemy na etapie realizacji i monitorowania projektu budowlanego. Po drugie, poproszono pewną liczbę inżynierów budowlanych o zdefiniowanie najważniejszych problemów przez uszeregowanie ośmiu określonych według ich ważności. Ustalono, że brak wykwalifikowanych pracowników na budowie został uznany za najważniejszy problem, podczas gdy brak sprzętu za najmniej ważny (na podstawie przyjętych i opisanych założeń).

Słowa kluczowe: budownictwo; proces budowlany; bariery i problemy; zarządzanie budową; analiza ryzyka, Web of Science.

Construction sector is one of the most important industries because of its significant impacts on economy, environment, energy consumption, safety and sustainability. Any infrastructure or building constructed is undertaken by sectors under construction industry. In comparison of development and innovation in construction industry with other industries such as information technology, it has a lower growth rate. The tendency of adopting new technologies in construction industry is low due to costs, risks and other factors.

The construction industry is a growing market. It is already one of the most significant sectors (according to PwC – Pricewaterhouse Coopers). The construction sector worldwide currently accounts for more than 11% of global GDP and the report predicts that it will account for 13.2% of world GDP by 2020 [1].

According construction blog Bimhow, the construction sector is responsible for 23% of air pollution, 50% of the climatic change, 40% of drinking water pollution, and 50% of landfill wastes. In another study by the U. S. Green Building Council (USGBC), the construction industry contributes to 40% of global energy consumption [2]. Due to the importance of this industry, wide researches have done to improve and optimize the performance of this industry. However, it is beneficial to review these studies in general and debrief engineers to find the most important barriers in construction industry. It can be useful to recognize these barriers in advance and tackle them conveniently. The obstacles which make the project unable to reach its achievements are different according to their operation sector.

Methodology

Literature review. Web of Science (WoS) is a website which provides subscription-based access to multiple databases that provide wide-ranging citation data for many different academic disciplines. It was originally formed by the Institute for Scientific Information (ISI) and is currently continued by Clarivate Analytics [3]. First of all, the topics that researchers focused more in construction sector were defined by the WoS database with different keywords search. Later for each topic, ten issues were selected from the highest citation articles to the lowest, between 2005 to 2020, which shows the main and popular issues among the researchers for the 15 year period before COVID. Each article was categorized into main phases in life cycle of a building/project. The phases of each article were selected by their abstract information, scan and skimming the articles. Each article can consist of one or more phases. Later the focus was put on the 'Execution phase of the construction project' and 'Controlling and monitoring'.

Surveying. Eight the most common problems in construction site had been selected then engineers were asked to sort these problems from the most to the least important. The criterion for selecting these problems was based on frequ-

[1)] Poznan University of Technology, Faculty of Civil and Transport Engineering
[*]) Corespondence address:
piotr.nowotarski@put.poznan.pl

ency and repetition of them during all five project phases – Initiation, planning, execution, monitoring and closure. The questionnaire was made in Google Forms format in two languages English and Polish. Different range of answers were collected from 20 engineers with different location of work, experience, education. This ranking provides the study a clear point of view from all the respondent with different experience, education level and etc. However, in the next sections the results and ranking based on experience and education level were reviewed. Since each problem might have different rank due to different answers from respondents, for defining the importance of every problem the formula below was used [4].

Degree of importance of the problem

$$(DIP_j) = \sum n_{ji} \cdot a_i \qquad (1)$$

where:
i – the number of the ranking from 1 to 8;
j – the specific number of the problem;
n_{ji} – total number of a specific rank for a problem;
a_i – the ranking coefficient.

This formula developed based on RPN (Risk Priority number) [5 ÷ 7] with one less element. In the RPN formula the factors are severity, occurrence and detection. However here the focus was to find only the importance degree level of an issue and rank them. That is why the number of people who selected a problem and rank its importance degree level.

Table 1. Ranking coefficient (a_i) of DIP
Tabela 1. Ranking współczynnika (a_i) wg DIP

Number of rank	Ranking coefficient (a_i)
Rank 1 (a_1)	3,5
Rank 2 (a_2)	3,0
Rank 3 (a_3)	2,5
Rank 4 (a_4)	2,0
Rank 5 (a_5)	1,5
Rank 6 (a_6)	1,0
Rank 7 (a_7)	0,5
Rank 8 (a_8)	0,0

Reviewing Web of Science Database

**Most important topics based on statistical review of WoS database.** The search engine of WoS is used by different keywords related to the barriers in construction industry. The aim of this task was to find the topics in which these keywords had been used. The purpose was to find number of the most related articles to each keyword. With each keyword, the WoS search engine categorizes the articles in maximum five topics. In each topic the frequency of articles that placed in it were given. The frequency of topics shows the number of articles on WoS database that related to an individual topic for a specific used keyword.

Table 2 and Figure 1 demonstrates that the articles related to Engineering subjects found by the keyword search in WoS have almost 29.37% share of the total articles. They are followed by Business Economics, Construction Building Technology, Environmental Sciences Ecology, Computer Science and other topics respectively. The other topics conclude of Material science, Ma-

Table 2. Topics by keyword search in WoS
Tabela 2. Tematyka wg słów kluczowych w WoS

Topic	Frequency	Percentage [%]
Engineering	133383	29,37
Business Economics	107213	23,60
Construction Building Technology	76180	16,77
Environmental Sciences Ecology	52507	11,56
Computer Science	31769	6,99
Other	53151	11,70
Total	454203	100
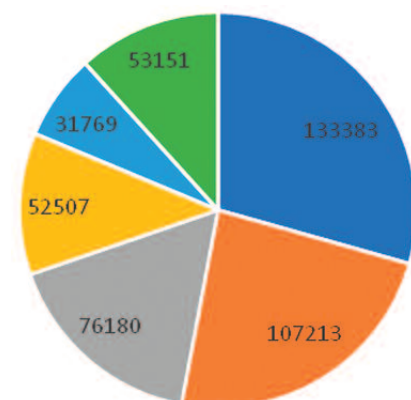
Signs: ■ Engineering ■ Business Economics ■ Construction Building Technology ■ Environmental Sciences Ecology ■ Computer Science ■ Other

Fig. 1. Frequency of topics by keywords search in WoS
Rys. 1. Występowanie tematyki wg słów kluczowych w WoS

thematics, Energy Fuels, Transportation, Social Issues, Management science and Government law.

Statistical review of the highest citation articles. For the purpose of finding out what are the most important topics for the researchers based on the total numbers of highest citation articles the following procedure was adopted. After accumulation all the citation numbers of articles with the highest citation the importance of topics appears. According to the table 3 the material science is the most important topic and business economic the least between other seven topics. The outcome of this table does not mean accurately the order of importance of topics in construction industry. This table demonstrates the order of importance of these topics between former studies. In the next chapters it is tried to find out the most important issues on site.

According to the table 3 and Figure 2 **Material Science with the 22% share has the highest citation**. Which seems rational due to the fact that the building sector is needy for material from the very initial to the very last steps. Also study on the material and their performance usually have to be done in laboratories and off-site situation which shows the high relation between academic researches and material science. **Business Economics** with only 4% portion **has the least citation**. It is important to mention; **this number is not referring that this topic has not the same importance as other topics**. Since every project needs the financial resources and without budget a project would not progress, considering the importance

Table 3. Topics with the highest citation
Tabela 3. Tematyka z najwyższym poziomem cytowania

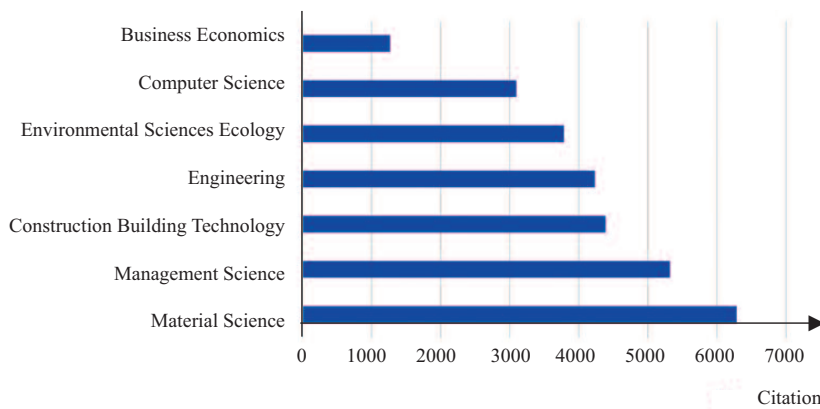| Number	Topic	Citation
1	Material Science	6294
2	Management Science	5318
3	Construction Building Technology	4397
4	Engineering	4227
5	Environmental Sciences Ecology	3786
6	Computer Science	3100
7	Business Economics	1258

Fig. 2. Topics with the highest citation
Rys. 2. Tematyka z najwyższym poziomem cytowania

of the economic aspects of construction industry is vital.

In general, Material Science has the leading role in the researches related to execution phase of a construction project. Since in almost every step of execution phase materials are being in use, it is vital to provide sufficient durability, workability, strength and eco-friendly construction materials. In the table 4 the review of five articles were provided in summary.

In conclusion, the most important barriers in the phase of execution and monitoring include of different topics but mainly focused on material science such as using alternatives cementitious in concrete. These problems were listed below [9 ÷ 13]:

● sustainability in construction industry;

● reducing the cost of material usage

● optimizing the materials features such as strength, flexible, durability and etc.;

● adopting new technologies in material usage such as Nano-material;

● decreasing the carbon emissions and energy consumptions.

Questionnaire

Background questions. In total 20 answers were collected during four weeks. In the general, the majority of the respondents works in the region of Greater Poland region of Poland with 75%. The city of Warsaw and the country of Sweden with 10% and 15% respectively form the other answers. Education level in this study were considered as one of the important factors in the questionnaire. As this study more based on the

review of article levels, the academic knowledge of respondents is important. That majority of respondents have Bachelor degree and Master degree 60% and 30% respectively. Whereas none of them have primary and secondary education. Researchers checked also position of the respondents, experience and company type to make sure that survey

covers all people who might have influence on problem detection in construction processes.

Most important problems based on questionnaire. This is the main section that the respondents were asked to rank the eight determined common problems related to construction site from the most to not at all important. The table 5 illustrates all the DIPs that calculated and sorted from the highest DIP to the lowest that shows the importance ranking of the problems.

Degree of importance of the problem

$$DIP_j = \sum n_{ji} \cdot a_i \qquad (2)$$

In general, lack of skilled workers or the **selection of unskilled workers by the contractor to work on site with DIP value of 47 has the highest importance** problem between the respondents. On the contrary, shortage in site equipment accounts for the not important problem.

Table 4. Review results of the top five high cited articles in WoS database
Tabela 4. Wyniki analizy pięciu najczęściej cytowanych artykułów w bazie danych WoS

Article	Topic	The focus of the article
A framework of sustainable supply chain management: moving toward new theory [9]	Management Science	1. The concept of sustainability to the field of supply chain management 2. The relationships among environmental, social, and economic performance within a supply chain management context 3. The integration of environmental, social, and economic criteria that allow an organization to achieve long-term economic viability
A review on the utilization of fly ash [10]	Material Science	1. Problems presented by the fly ash 2. The utilization of fly ash in construction, as a low-cost adsorbent for the removal of organic compounds, flue gas and metals, lightweight aggregate, mine backfill, road sub-base, and zeolite synthesis 3. Using fly ash for adsorption of NOx, SOx, organic compounds, and mercury in air, dyes and other organic compounds in waters
Supplementary cementitious materials [11]	Material Science	1. The use of silica rich SCMs 2. The influence on the amount and kind of hydrates formed and thus the volume, the porosity and finally the durability of these materials 3. The changes in phase assemblages 4. Thermodynamic modelling 5. Generic relations between composition, particle size, exposure conditions as temperature or relative humidity 6. The role of composition, fineness and the amount of glassy phase
Nanotechnology in concrete – A review [12]	Construction Building Technology	1. Definitions of nanotechnology, including nanoscience and Nanoengineering in concrete 2. The impact of recent advances in instrumentation and computational materials science and their use in concrete research 3. Recent progress in Nano-engineering and Nano modification of cement-based materials
Advances in alternative cementitious binders [13]	Material Science	1. Alternatives to Portland cement as a binder in concrete 2. Reducing the energy used in production of Portland cement clinker 3. Four promising binders available as alternatives to Portland cement are calcium aluminate cement, calcium sulfoaluminate cement, alkali-activated binders, and super sulphated cements 4. Binders compositions and reaction mechanisms, benefits and drawbacks, unanswered questions, and primary challenges

Table 5. Final total calculated DIP – ranking of the importance of the problems
Tabela 5. Ostateczny ranking wg współczynnika DIP – ranking istotności problemów

The problem	Designation	Degree of importance of the problem
Lack of skilled workers or the selection of unskilled workers by the contractor to work on site	DIP_2	47
Delay in the project timetable	DIP_1	45
Mistakes in construction works and Poor quality of construction works	DIP_6	43
Low productivity of the workers	DIP_4	39
Personnel safety issues	DIP_3	29
The increase in materials cost during the building's construction	DIP_5	27.5
Unavailability of materials	DIP_8	25.5
Shortage in site equipment	DIP_7	24

This ranking provides the study a clear point of view from all the respondent with different experience, education level and etc. However, in the next sections the results and ranking based on experience and education level were reviewed. Additionally, the results were reviewed based on the high education level and work experience among the respondents. These results were summarized below:

■ high experienced respondents (more than 5 years) generally were considered the lack of high skilled workers as the most important problem and unavailability of materials as not important at all;

■ high educated respondents (more than master engineering) generally were considered delay in the project timetable as the most important problem and shortage in site equipment as not important at all.

Summary

In this study the most important problems and topics based on articles were determined and discussed. These topics are Engineering, Business Economics, Construction Building Technology, Environmental Sciences Ecology, Computer Science. In each of these topics there were several issues that the researchers were dedicated to them more which are listed below:

● engineering: the concept of sustainability to the field of supply chain management, the application of life cycle assessment, optimizing the improvement of the social, economic and environmental indicators of sustainability;

● Business Economics: cost escalation and schedule delays, economic input-output LCA model and cost optimization;

● Construction Building Technology: nanotechnology in concrete, phase change materials, geo-polymer based concrete production and recycled aggregate concrete;

● Environmental Sciences Ecology: CO_2 emissions, electricity demand, energy consumption and waste management;

● Computer Science: BIM usage, designing optimization and energy consumption modelling and controlling;

● Materials Science: utilization of fly ash, alternative cementitious binders, supplementary cementitious materials, bio-fibres and bio-composites and sustainable cement production;

● Management Science: life cycle assessment, supply chain management, inadequate preparation of project scope, poor documentation, impropriate management plan, inaccurate cost and time estimation and poor communication.

Also the most important problems for construction engineers based on the questionnaire were discussed and listed in order of their importance: lack of skilled workers or the selection of unskilled workers by the contractor to work on site; delay in the project timetable; mistakes in construction works and poor quality of construction works; low productivity of the workers; personnel safety issues; the increase in materials cost during the building's construction; unavailability of materials; shortage in site equipment.

It is significant that there is a noteworthy difference between these results. Clearly the reason for this vivid difference should discussed. The problems that are conversing among the researchers are not totally meet the problems which construction engineers are facing at construction sites. It is recommended that the approach of future studies should be closer to the facts that happening on the construction site.

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