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FACTORS AFFECTING COMMUNICATION QUALITY IN PROJECTS TEAMS

Abstract: Communication planning in project teams is one of the fundamental tasks of project managers. Despite the fact that model of the communication process is well described in the literature, few studies have focused on detailed measures of the process and relationship between them and quality of communication. This issue is relevant in the context of the project based sector which is the construction industry. The aim of this article is to present the model of communication quality in construction project team and relationship between its elements. Research was done on a sample of 25 construction project managers. Factor analysis and multiple regression were used to create and validate model. Results allow to identify three factors: associated with the sender, the organization of the communication process and the recipient. The greatest impact on quality of communication in the construction project teams have factors related to the organization of the process of communication.

Key words: project management, communication, construction industry, factor analysis.

Introduction

Increasing competition in global market results in loose of a traditional competition factors value. To survive on the market enterprises have to constantly improve all areas of their activity. In dynamic and constantly changing conditions of economic activity communication is seen as a crucial factor of a success. That is especially true in a case of a project management which is always associated with the activities carried out in teams. The main goal of communication within project team is to satisfy the information need of all its members. Project team need information to perform assigned tasks at the expected quality and within the specified time. Communication is also aimed to create a cooperation environment within a project team. That is to connect all the stakeholders involved in construction project in order to satisfy contract conditions.

PMI (2013a, p. 286) defines communication management in projects as: *"(…) the processes that are required to ensure timely and appropriate planning, collection, creation, distribution, storage, retrieval, management, control, monitoring and (…) disposition of project information.*" Role of project communication is aimed to: communicate with all the "external" stakeholders of the project and the exchange of information within project team ("internal" stakeholders). Range of construction projects information needs include following project's phases: tender management, contract and construction process management, guarantee service management and building management. Detailed analysis of construction company information process and sources of information can be found in Głodziński (2010).

American Society of Civil Engineers considers communication as one of the requirements of effective construction projects management. Civil Engineering Body of Knowledge points out that civil engineer profession *"(…) requires (…) to plan, compose, and integrate verbal and graphical communications for both technical and nontechnical audiences."* (ASCE, 2008, p. 95). In literature

communication is perceived as a one of a project's success critical factors. Krahn and Hartment (2006) prove that listening and verbal communication are in the top 10 competencies important for project managers. Goris (2007) showed that communication can serve as a predictor of performance and satisfaction. Nevertheless, components of a good communication in project team are not known. Therefore the aim of this paper is to create a model and determine the factors affecting communication quality in construction projects teams.

Communication process and its quality

Oliver (1997, p. 64) defines communication as "*an interchange of ideas, facts and emotions, by two or more persons, with the use of words, letters and symbols. Based on the technical problem of how accurately the symbols can be transmitted, the semantic problem of how, precisely, the symbols convey the desired meaning, and the effectiveness of how the received meaning affects conduct in the desired way*".

The general communication model assumes source of information, signal (with communication channel) and recipient. Melcrum Inc (2016) created the framework that sets out components of effective Internal Communication. The model is presented on figure 1. Melcrum (2016) emphasizes five areas:

1. Audience/stakeholders - to understand needs and choice a right strategy dependent on the recipient.
2. Infrastructure - a choice of communication channels used in communication.
3. Managers and leaders - competent and responsible in communication with their teams.
4. Line of sight for business strategy - supports teams in translating the business strategy into action.
5. Research and measurement - to guide and prioritize communication decisions

Model also indicates partnership as a source of effective communication in organization.

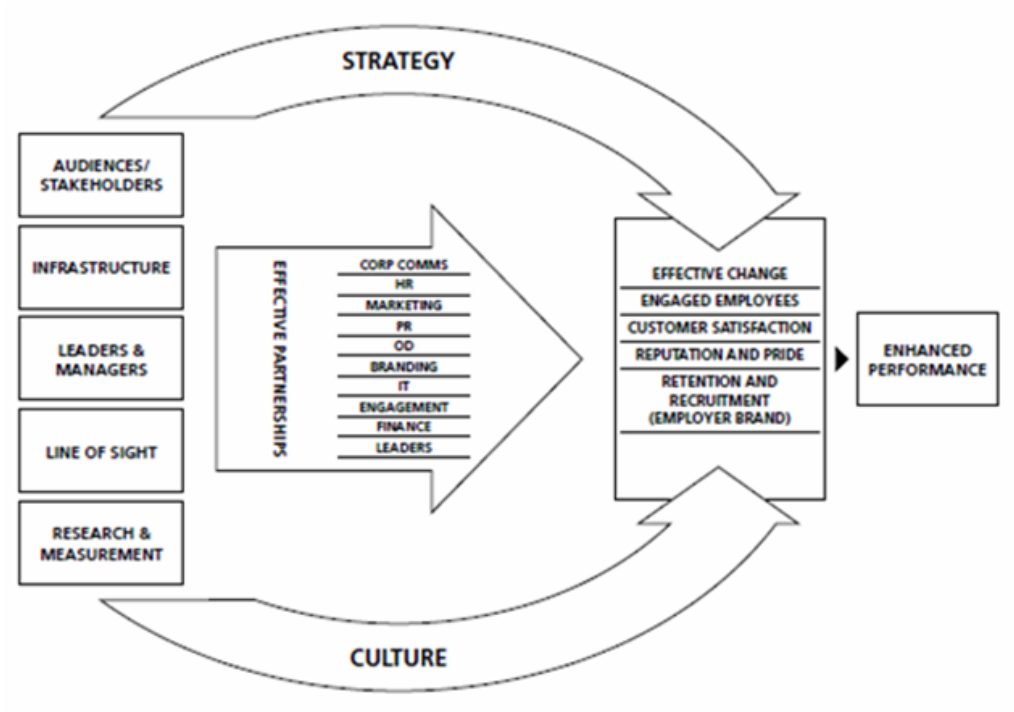

Fig .1. A framework for an effective Internal Communication function

Source: Melcrum Inc. (2016).

Quality of communication results from a features of particular elements of communication process. In recent years, researchers pay more attention to the components of the communication process and their impact on the quality of the process. White and Fortune (2002) demonstrated that critical to project's outcome are feedback mechanisms and clear communication channels. Ammeter and Dukerich (2002) proved importance of communicating project goals as the most important role of a team leader that influences project's performance. Henderson's (2004, 2008) findings indicate that project managers' competencies in decoding and encoding[1] communication significantly contribute to team member satisfaction and productivity. Jorfi and Jorfi (2011) showed that there is a strong correlation between communication effectiveness and job satisfaction. Hola (2012) proved that communication has a significant impact on company operations, job performance, work behavior and attitudes of employees. Hawrysz and Hys (2014) show that there is a statistically significant difference in knowledge sharing tendency, evaluation of information flow and communication channels used by managers and employees. While Daim et al (2012) analyzed factors that can cause communication breakdown in global virtual project teams. Grabosz (2014) proposes a diagnostic tool for audit of internal communication and evaluation of information flows between work stations. In that paper following communication process features were adopted: access to information, information speed, information received/needed ratio, information accuracy, information reliability, information completeness, information environment, adaptation of information to team needs, responsibility for the information given (Rogala, 2013).

[1] Encoding are all activities in transforming information into messages. Speech and writing are encoding. Decoding is transformation of messages into meaning. Listening and reading i decoding (Henderson, 2008).

Research Methodology

A pilot study was conducted in an attempt to investigate which are the most important factors affecting communication quality in projects teams. An electronic questionnaire was distributed among the project managers of construction company operating in the housing sector. The survey was carried out at the beginning of 2016 and 25 construction project managers were investigated. The respondents were asked to rank the influence level of chosen measures on communication quality in their projects on a 1 to 100 scale. Characteristics of the sample is indicated in table 1.

Table 1. Sample characteristics

Feature	
Number of respondents	25
Average number of projects in the last 36 months	54
Average duration of project (months)	5
Average number of project team members	4
Average number of projects run simultaneously	20
Share of females in a sample	36%
Share of males in a sample	64%

Source: own research.

Following research question was adopted: Which are the factors that have the highest impact on communication quality in construction projects? Following steps were used in order to answer the question: (1) literature research to establishing key factors affecting communication in project, (2) collecting data, (3) use of a factor analysis and regression analysis to establish relationship between selected factors and communication quality in projects team. For statistical analysis SPSS was used (IBM, 2015).

To reduce the number of the variables used in the analysis and establish factors that influence project communication a statistical method of a Factor Analysis was used. Factor Analysis is a method used to describe variability among observed and correlated variables and to reduce them into the smaller number of unobserved variables that reflect the same information as the original observed variables. The correlation between observed variables, influence of a chosen measures of a communication quality, is shown in table 2. The following codes were used to replace variables names: communication quality (V1), access to information (V2), information speed (V3), information received/needed ratio (V4), information accuracy (V5), information reliability (V6), information completeness (V7), information environment (V8), adaptation of information to team needs (V9), responsibility for the information given (V10). Statistically significant correlations are written in italics and bold.

Table 2. Correlation between variables

	V1	**V2**	**V3**	**V4**	**V5**	**V6**	**V7**	**V8**	**V9**	**V10**
V1	1,00									
V2	***0,74***	1,00								
V3	***0,71***	***0,80***	1,00							
V4	0,35	0,38	***0,64***	1,00						
V5	0,29	***0,56***	***0,59***	***0,53***	1,00					
V6	***0,65***	***0,75***	***0,57***	0,34	***0,57***	1,00				
V7	***0,72***	***0,76***	***0,82***	***0,50***	***0,49***	***0,74***	1,00			
V8	***0,79***	***0,46***	***0,59***	***0,42***	0,15	0,38	***0,58***	1,00		
V9	***0,73***	***0,59***	***0,77***	***0,46***	0,30	***0,46***	***0,76***	***0,78***	1,00	
V10	***0,56***	***0,53***	0,30	0,28	***0,45***	***0,78***	***0,54***	***0,44***	0,39	1,00

Source: own research.

Most of the variables are highly correlated. Those correlations indicate that there is some obvious structure in the data. To confirm these Bartlett (1954) test was used. Adequacy of the correlation was assessed using Kaiser-Mayer-Olkin criterion – KMO (Kaiser, 1974). Values of KMO are within <0,1> range, therefore the higher they are the stronger are the grounds for the factor analysis application. KMO criterion and Bartlett's test results and are shown in table 3.

Table 3. Bartlett test and KMO criterion

	Chi square	**df**	**p value**
Bartlett test	185,275	45	0,000
General KMO criterion			0,809

Source: own research.

Bartlett test statistics is lower from the critical values on the significance level $\alpha \cong 0$. Hypothesis about the lack of correlation between variables must therefore be rejected. Values of KMO criterion are very high and are above recommended value of 0,5 (Kaiser, 1974). Thus, the data may be considered as suitable for factor analysis.

Detection of a data structure was begun with determining the number of factors that should be used for further interpretation. For that reason eigenvalues of a dataset were calculated. In table 4 eigenvalues and the level of variance explained in dataset is shown.

Table 4. Eigenvalues and level of variance explained

	Eigenvalue	% of explained variance in dataset	% of cumulative explained variance in dataset
1	5,40	60,03	60,03
2	1,18	13,11	73,14
3	0,96	10,67	83,82
4	0,61	6,79	90,61
5	0,31	3,44	94,06
6	0,24	2,69	96,75
7	0,14	1,59	98,35
8	0,09	1,10	99,46
9	0,04	0,53	100

Source: own research.

Jolliffe (2002) criterion recommends retaining factors with eigenvalue above 0,70. Three factors explaining 84% of variance have been chosen for further analysis. Table 5 presents factor loadings obtained from factor analysis. Factor loadings were subjected to rotation. This was done using the Biquartimax method which aim is to simultaneously maximize variance in rows and columns of the matrix of raw factor loadings. As a result of rotation, variables are closer to the axis of the factors and a simpler structure was created. Loadings with the value higher than 0,7 are written in italics and bold.

Table 5. Factor loadings with Biquartimax rotation

Variable	Factor 1	Factor 2	Factor 3
Access	0,47	*0,60*	0,39
Speed	***0,70***	0,23	*0,60*
Quantity	0,43	0,01	***0,73***
Accuracy	0,03	0,46	***0,79***
Reliability	0,27	***0,87***	0,26
Completness	*0,66*	0,51	0,34
Environment	***0,89***	0,19	-0,05
Adaptation	***0,90***	0,20	0,16
Responsibility	0,23	***0,88***	0,01

Source: own research

Factor loadings can be interpreted as a proportion of explained variable variance. The first factor is mainly related with communication environment, adaptation of information to team needs and speed of information. Information completeness can be associated with this factor. Therefore *Factor 1* is imitating measures related to the *organization* of communication system in company. Second factor is related to reliability of the information and responsibility for the information given. Issue of access to information is related to factor 2. Therefore *Factor 2* is related to the *sender* of the information. Factor 3 is linked to quantity of information received vs. information needed and accuracy of information. Reflected is also issue of information speed. Therefore *Factor 3* imitate the *receiver* of the information. For the evaluation of the proposed factors residual correlations for the three factors solution were calculated. Values of residual correlations are presented in table 6.

Table 6. Residual correlations of the three factor solution

	Access	Speed	Quantity	Accuracy	Reliability	Completness	Environment	Adaptation	Responsibility
Access	0,25								
Speed	0,08	0,09							
Quantity	***-0,12***	***-0,11***	0,27						
Accuracy	-0,06	-0,02	-0,08	0,15					
Reliability	-0,02	0,01	0,02	-0,05	0,09				
Completness	-0,01	0,02	-0,05	-0,05	0,02	0,17			
Environment	-0,06	-0,05	0,07	0,08	-0,02	-0,10	0,16		
Adaptation	-0,03	-0,01	-0,05	0,05	-0,01	-0,00	-0,06	0,11	
Responsibility	***-0,12***	-0,08	***0,16***	0,02	-0,06	-0,07	0,07	0,00	0,17

Source: own research

Values in table 6 can be interpreted as that part of the correlation that is not explained by a three factors (unobserved variables) solution. There are only four values (which are in italics and bold) exceeding range of <-0,1 ; 0,1>. It appears that three factors solution is satisfactory. Based on a factor analysis a model of communication quality in construction project teams is created (figure 3). The thickness of the lines indicate the importance of factor in influencing the level of satisfaction with the communication system in the projects.

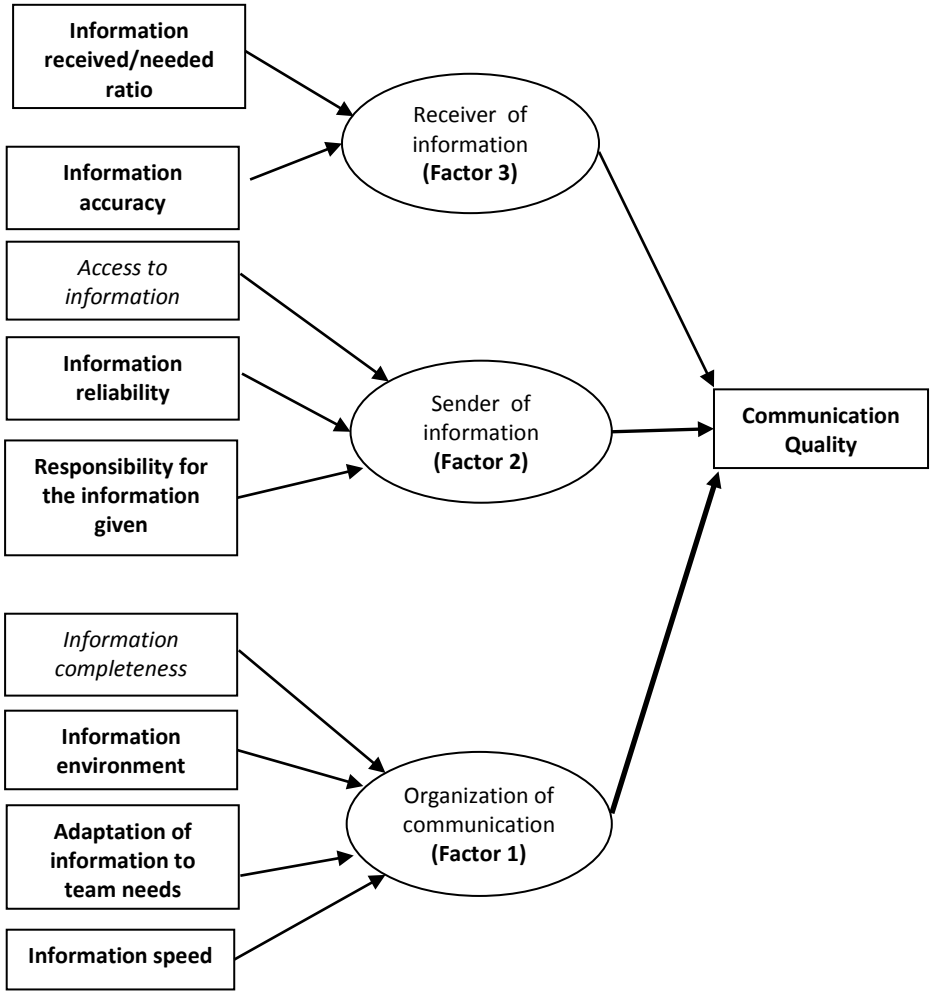

Fig .3. Model of communication quality in construction project teams

Source: own research.

Subsequent phase of analysis was aimed to estimate relationship between three reduced variables (established factors: receiver, sender and organization of communication) and quality of communication in construction project teams. Therefore multiple regression analysis was performed. Table 7 presents the results of that analysis.

Table 7. Multiple regression analysis results

	b	**p**
(Constant)	51,43478	0,000000
Organization of communication	15,83213	0,000001
Sender of information	10,30192	0,000225
Receiver of information	1,36928	0,553614

R= 0,88626642 R^2= 0,78546817; F(3,19)=23,188; p<0,00000 Standard estimation error: 10,650

Source: own research.

Results of multiple regression reveal a significant positive relationship between organization of communication system, sender of information and quality of communication. Positive values indicate a positive impact of established factors on the overall assessment of communication quality in construction project teams. Values of coefficient of determination (R^2) indicates that 78,5% of variance in the quality of communication of construction project teams is explained by the model. Durbin-Watson statistic (1,479) shows the independence of residuals in the model and Shapiro-Wilk statistics (W= 0,96364 ; p= 0,54061) confirms normal distribution of residuals. Plot of residuals against the predicted values indicates homoscedasticity. The error term is the same across all values of the independent variables. Created model gives satisfactory explanation to relationship between communication quality and chosen measures of that process.

Discussion

Researchers agree that effective communication is critical for project success. Nevertheless not enough work has been done assessing what are the building blocks of an efficient communication in project teams. Research of Rogala (2013) on internal communication efficiency denote a positive correlation between communication efficiency and information quantities, speed and accuracy. PMI's research (PMI, 2013b) provides evidence that in successful projects: information is adapted to team needs, is provided in a timely manner and with a relevant frequency. Those results support the *Factor 1* components (communication environment, adaptation of information to team needs and speed of information) as the most influencing the communication quality in project teams. Created model of communication in project teams reveal a new pattern of communication system requirements. Intuitively, it is expected that providing an access to information would be one of a primary requirements of team members within first factor i.e. organization of communication system. It is not. Access, completeness and to some extent speed of information lost its significance as a performance indicators in communication system. Those performance features turn into "must be" features. Respondents do not perceive them as critical for the quality of the communication system in the construction projects. It can be assumed that these features are usually provided or have to be provided to maintain essential level of communication system functionality.

Conclusions

The issue of communication in project teams in construction industry shall be scholars concern due to professional origin of construction project managers. Vast majority of the project managers in that sector have their background in engineering, what usually results in a lack of management knowledge. Gaps of this knowledge are supplemented by postgraduate studies or catched up with

intuitive management styles and on work experience. Additionally PMI's report documented need for improvement of communication in projects. The Pulse of the Profession report (PMI, 2013b) revealed that US$135 million is at risk for every US$1 billion spent on a project. While US$75 million of that $135 million (56%) is at risk due to issues in communicating. Poor communication account for a 30% of reasons behind project failures (PMI, 2015).

This study was aimed to investigate components influencing communication quality in construction project teams. A model of construction project team communication quality was created. Model confirms general theory of communication process. However the greatest weight is given to the organization issues of the communication process (signal and its transmission) and sender of the information. The reason could be specifics of the communication in engineering based industry and personal characteristics of the engineers that value reliability and responsibility. Another explanation could be sample characteristics that included construction project managers communicating with subcontractors. That is why the receiver issues did not gain statistical significance.

It has been found that good predictors of communication quality are factors associated with organization of communication process (information completeness, information environment, adaptation of information to team needs and information speed) and sender (information reliability and responsibility for the information given).

Presented results can be implemented in practice of construction companies. Can be used in creating or changing the management process of communication in project teams and therefore effectively influence project's effectiveness.

Future research efforts should identify the components of communication environment and its impact on communication process. Additionally, role of access to information, its completeness and speed as a "must be" features in modern communication systems shall be verified. Furthermore, certain limitations of this study should be noted. Small sample limited to one company and construction industry do not allow to formulate any recommendations or generalization results.

REFERENCES

[1] Ammeter A. P., & Dukerich, J. M. (2002), Leadership, team building, and team member characteristics in high performance project teams, "Engineering Management Journal", Vol. 14, No. 4, pp. 3-10.
[2] ASCE (2008), Civil Engineering Body of Knowledge for the 21st Century, American Society of Civil Engineers, Reston, Virginia.
[3] Bartlett M. S. (1954), A note on the multiplying factors for various chi square approximations, "Journal of Royal Statistical Society", No. 16(Series B), pp. 296-298.
[4] Daim U.T., Ha A., Reutiman S., Hughes B., Pathak U., Bynum W. & Bhatla A. (2012), Exploring the communication breakdown in global virtual teams, "International Journal of Project Management", Vol. 30, Iss. 2, pp. 199–212.

[5] Głodziński E. (2010), Pozyskiwanie informacji w fazie realizacji projektów budowlanych, [in:] R. Borowiecki, J. Czekaj (eds.), Zarządzanie zasobami informacyjnymi w warunkach nowej gospodarki, Difin, Warszawa, s. 337-350.
[6] Goris J.R (2007), Effects of satisfaction with communication on the relationship between individual-job congruence and job performance/satisfaction, "Journal of Management Development", Vol. 26, Iss. 8, pp. 737 – 752.
[7] Grabosz J. (2014), Audyt komunikacji wewnętrznej w przedsiębiorstwie: propozycja narzędzia diagnostycznego, [in:] B. A. Basińska, I. Garnik (eds.). Zarządzanie informacyjnym środowiskiem pracy, Wydział Zarządzania i Ekonomii Politechniki Gdańskiej, Gdańsk, pp. 37-55.
[8] Hawrysz L. & Hys K. (2014), Communication channels of middle managers and non-managers in public sector organisations in Poland, "International Journal of Contemporary Management", Vol. 13. No.4, pp. 27-38.
[9] Henderson L. S. (2004), Encoding and decoding communication competencies in project management–An exploratory study, "International Journal of Project Management", Vol. 22, No. 6, pp. 469 - 476.
[10] Henderson L.S. (2008), The Impact of Project Managers' Communication Competencies: Validation and Extension of a Research Model for Virtuality, Satisfaction, and Productivity on Project Teams, "Project Management Journal", Vol. 39, No. 2, pp. 48–59.
[11] Hola J. (2012), Internal Communication in the Small and Medium Sized Enterprises, "Economics and Management", Vol. 15, Iss. 3, pp. 32-45.
[12] IBM Corp. (2015). IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY.
[13] Jolliffe I.T. (2002), Principal Component Analysis, 2nd ed., Springer, New York.
[14] Jorfi H., & Jorfi S. (2011), Strategic Operations Management: Investigating the Factors Impacting Communication Effectiveness and Job Satisfaction, "Procedia Social and Behavioral Sciences", Vol. 24, pp. 1596-1605.
[15] Kaiser H. F. (1974), An Index of Factorial Simplicity, "Psychometrika", Vol. 39, No. 1, pp. 31–36.
[16] Krahn J., & Hartment F. (2006), Effective project leadership: A combination of project manager skills and competencies in context. Paper presented at the biennial meeting of the Project Management Institute Research Conference, Montreal, Canada.
[17] Melcrum Inc (2016), A framework for an effective Internal Communication function, http://www.melcrum.com/, access date: 20.05.2016
[18] Oliver S. (1997), Corporate Communication: Principles, Techniques and Strategies, Kogan Page, London.
[19] PMI (2013a), A guide to the project management body of knowledge 5th edition, Project Management Institute, Newton Square, Pennsylvania.
[20] PMI (2013b), Project Management Institute. Pulse of the professional in-depth report -The high cost of low performance: The essential role of communications. Project Management Institute, Newton Square, Pennsylvania.
[21] PMI (2015), Project Management Institute. Pulse of the professional in-depth report -The high cost of low performance: The essential role of communications. Project Management Institute, Newton Square, Pennsylvania.
[22] Rogala A. (2013), Determinanty skuteczności komunikacji wewnętrznej w przedsiębiorstwie, Ph.D. Thesis, Uniwersytet Ekonomiczny w Poznaniu.
[23] White D., & Fortune, J. (2002), Current practice in project management–An empirical study, "International Journal of Project Management", Vol. 20, No. 1, pp. 1-11.

CZYNNIKI WPŁYWAJĄCE NA JAKOŚĆ KOMUNIKACJI W ZESPOŁACH PROJEKTOWYCH

Streszczenie: Planowanie komunikacji w zespołach projektowych jest jednym z podstawowych zadań kierowników projektów. Pomimo tego, że model procesu komunikacji jest dobrze opisany w literaturze, niewiele badań dotyczyło szczegółowych miar tego procesu i relacji między nimi a jakością komunikacji. Zagadnienie to wydaje się być istotne w kontekście sektora „projektowego" jakim jest branża budowlana. Celem artykułu jest przedstawienie wyników badań, które posłużyły do stworzenia modelu jakości komunikacji w zespole projektowym i opisu relacji między jego elementami. Przedstawiono wyniki badań przeprowadzonych na próbie 25 kierowników projektów budowlanych. Do stworzenia modelu wykorzystano analizy: czynnikową i regresji wielorakiej. Wyniki analiz umożliwiły wyodrębnienie trzech czynników w modelu związanych z nadawcą, organizacją procesu komunikacji i odbiorcą. Największy wpływ na jakość komunikacji w budowlanych zespołach projektowych mają czynniki związane z organizacją procesu komunikowania się.

Słowa kluczowe: zarządzanie projektami, komunikacja, budownictwo, analiza czynnikowa.