SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2023
ORGANIZATION AND MANAGEMENT SERIES NO. 169

TECHNICAL EDUCATION AND EXPERIENCE OF A LEADER AS A DETERMINANTS OF TEAM WORK EFFECTIVENESS IN IT PROJECTS

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Purpose: The realization of large, characterized by high uncertainty and variability IT projects is usually complicated and overlong, and their effectiveness often lower than expected. Hence the role of the project leader as the person responsible for the success of the project is of particular importance. In this context the purpose of the paper was to investigate the relationship between technical (directional in IT) education and technical experience in IT of a leader, and team work effectiveness in IT projects, recognized as one of the predictors of the project's success.
Design/methodology/approach: Empirical research was conducted to verify the existence of the predicted relationship and to reach the aim of the paper. The study was quantitative in character. The set of hypotheses was built based on the theoretical research and then verified the CAWI method on sample of 178 respondents working on IT projects in organizations operating in Poland. The calculations were made using the PS Imago Pro ver. 7.0 and Process macro for SPSS ver. 4.1 by Andrew F. Hayes.
Findings: It has been shown that there is indirect relationship between the studied variables, and the mediators of this relationship are leader's technical competences and the leader's efficiency. There is a mediation relationship between the dependent variable (team work effectiveness) and independent variables (technical education and technical experience in IT of a leader).
Research limitations/implications: Performed empirical study is burdened with certain limitations. The obtained sample of 178 respondents is by far not a representative sample and verified only in one business context (Poland). In order to generalize the results in future research cross-national study and larger samples can be collected.
Practical implications: The obtained results contribute to practice of management, showing that among various groups of factors determining team work effectiveness in IT projects both soft and hard (technical) competencies of the leader are important. The latter are shaped by the technical, directional (in IT) education and technical (in IT) experience of the leader. This has practical implications, especially for HR services in the process of employees recruitment. In addition to soft skills, knowledge of programming languages and programming experience should be a significant assets wanted when hiring IT project managers.

Originality/value: This research enhances understanding factors determining team work effectiveness in IT projects. The research make an important contribution to the body of project management and human resources management literature by demonstrating the meaning of the technical education and technical experience of a leader for team work effectiveness in IT projects.

Keywords: project management, technical competencies, leader efficiency, team effectiveness.

Category of the paper: Research paper.

1. Introduction

The Standish Group International publishes reports which gather information about project management. In 2020 half of all IT projects have been completed with a delay, over the planned budged or without fulfilling the requirements. 19% of projects have been cancelled before completion or completed but never deployed and used. Only 31% of projects have been successfully completed (The Standish Group International, 2020) and most projects failures are related to social issues (Belout, Gauvreau, 2004). Among factors affecting project success project management success is often pointed (Alias et al., 2014; Cooke-Davis, 2002; Radujković, Sjekavica, 2017; Shokri-Ghasabeh, Kavoousi-Chabok, 2009), and going deeper into this area – factors influencing it, related to the project manager and the way he manages (Belout, Gauvreau, 2004; Sanches, Terlizzi, 2017; Verner, Evanco, 2005; Westerveld, 2003), related to the team members (Belassi, Tukel, 1996; Sanches, Terlizzi, 2017) (e.g. project team commitment, team work (Chan et al., 2001)) and to communication as well (Andersen et al., 2006; Garbharran et al., 2012; Trocki, 2012).

Haffer (2013) considers the commitment of the project executors (both leaders and team workers) to be the key factor in the success of the project. Project realization is always team work, thus team work effectiveness seems to be a fundamental condition for project success achievement. In this context, the role of the project leader as the person responsible for the success of the whole is of particular importance. Nowadays, the importance of the leader's soft skills is strongly emphasized (Werewka, Wietecha, 2015; Mtsweni et al., 2016; Smółka, 2006), however, taking into account that in IT projects we often deal with innovative solutions, new technologies and advanced programming languages, the leader's technical competences - largely shaped by his experience in the industry and education in the field of IT - seem to be no less important. This issues has not been addressed directly in literature yet and there is a research gap that needs to be addressed.

In order to fill the observed gap the main purpose of the paper was to investigate the relationship between technical (directional in IT) education and technical experience in IT of a leader, and team work effectiveness in IT projects, recognized as one of the predictors of the project's success. Additional attempt was made to identify the mediators of this relationship.

Such research intent was structured by literature review on the factors shaping team work effectiveness related to the person of the leader. Following the aims of the research, the paper was structured as follows. Section 2 presents and discusses the conceptual background of factors shaping team work effectiveness and leader efficiency. The set of hypotheses is built based on the theoretical research. In section 3 research design is described along with data and method. As a next step empirical, quantitative in character research is conducted to verify the existence of the predicted relationship and to reach the aim of the paper. The CAWI method is used on sample of 178 respondents working on IT projects in organizations operating in Poland. Findings and their theoretical and practical implications, along with limitations of research are presented respectively in sections 4 and 5.

2. Theoretical background and the development of the hypotheses

2.1. Leader's efficiency as a factor determining the effectiveness of teamwork in IT projects

Regardless of the mode of performing tasks (process or project approach) organizational success can never be reached without qualified and motivated personnel (Belout, Gauvreau, 2004). According to Yang et al. (2011) teamwork is positively related to project success, thus we can suppose that higher effectiveness of teamwork will be also translated more strongly into the project's success.

Literature research provides information on many factors determining effectiveness of teamwork. Most frequently mentioned are: team size, specialist and interpersonal skills of team members, a way of doing the work accepted by everyone, difficult but achievable goal, commitment and responsibility among team members (Katzenbach, Smith, 1993; Kożusznik, 2002). According to the K. Ćwik (2013), the factors are: a common goal, communication, friendly atmosphere and sense of belonging. Information qualities (field of study, time spent in the organization and team), personality and team composition with the same level of diligence but different seniority, experience and knowledge are also important (Piskorz, 2013). E. Masłyk-Musiał (2014) lists the members' attitude towards the product (not its functions), reducing the distance in relations, correct communication, flexible structure, control over processes and elements of tasks (not tasks itself). B. Tracy (2014) distinguishes five factors of effective teamwork - a common achievable goal, common principles of cooperation and respected values, common plans for carrying out tasks, regular meetings and discussions and a caring leader. Especially this last one factor seems to be of great importance. J. Kopeć (2013) points out that one of the most important factors influencing the effectiveness and efficiency of project implementation is the project manager. Its decisions, their quality and competences have an impact on the effectiveness of cooperation with individual stakeholders of the project,

and in particular on the effectiveness of the project team. This is confirmed by research of Ammeter & Dukerich (2002), Francik (2003), Springer (2013), Verner & Evanco (2005) or Wateridge (1997).

Teamwork effectiveness reflects the way the project manager runs the project and how tasks and responsibilities are divided. According to Westerveld (2003) team working habits are strongly influenced by leadership style and a way of co-operation in the project team. Efficient leaders are able to lead a team in such a way that each of its members can comprehensively use their skills, abilities and the possibility to carry out tasks the best he can (Dźwigoł, 2014). They not only communicate well with team members, achieve set of goals or resolve conflicts, but also make team members strive to achieve the goal (Igielski, 2015).

The efficiency of the leader can be assessed indirectly (by assessing his team work effectiveness) or directly. This can be done through the prism of the substantive tasks assigned to him - including the fulfilment of managerial functions, i.e. setting goals, defining tasks, developing and making the right decisions and motivating employees, creating conditions suitable for harmonious cooperation, as well as verifying the level of achieved results.

According to Camilieri (2011) IT projects can be classified to medium- or high-tech projects. This types of projects use technologies that are existing, but sometimes also new and may utilize some new technological features. Therefore, they are usually characterised by a medium or high level of uncertainty. Such a specificity imposes specific requirements on the project leader.

First of all it must be underlined that the leader in IT can take different roles - leading the project as project manager, leading the team as team leader or unit leader, or be responsible for technology choices as teach lead. Technologies and methodologies used have big impact on the leader's roles. Size of the organization also impacts the leader's responsibilities. In a case of a smaller organization, the leader's responsibilities are much broader. They include tasks which would be split between few managers with different specializations in bigger organizations (Jurga, 2022).

After consultations with business analytics, the leader assigns tasks priority and delegates them to team members. The difficulty and kind of given task must be taken into account. Too many repeating tasks may be tedious and boring which is not desired in creative work as IT. Tasks should stimulate team members to grow. Usually such list of tasks is being updated each two weeks. The amount of work needs to be considered: too long list of tasks can be discouraging, too short list can end before next consultations. The leader's responsibilities include short term planning - organizing tasks for given day, and long term planning - planning goals for next year, considering processes and issues that might block progressing towards the goals. During long term planning, order of tasks and choice of correct tools must be considered. The same goes for keeping spare time for project improvements, cleaning the source code and library upgrades. The leader's tasks include short daily meetings that allow team members to communicate what has been done lately and what is going to be done soon. There are also

longer and less frequent meetings summing up changes since last meeting of this kind, usually once each 2 weeks. In a case of hybrid office model, the leader is responsible for ensuring that whole team at the office during more important meetings.

The leader is also responsible for organizing or reorganizing the resources among team members. This includes both hardware like monitors and software like licenses. The leader decides which tools will be used by the team, who will gain the access to them in a case of limited licenses available, or which issues will have priority when contacting third party software providers. The leader assigns tasks to given team members allowing them develop their skills and grow their careers. The leader should take care of transferring the knowledge between team members and between different teams (Jurga, 2022). In this way, he can affect team work effectiveness. The more efficiently he manages the better team work effectiveness can be supposed. Therefore, following hypothesis may be formulated:
H1: There is a positive relationship between the project leader's efficiency and the team work effectiveness in IT projects.

2.2. The importance of the leader's hard and soft competencies for the leader efficiency and team work effectiveness in IT projects

The success of the organization is related to employment the best specialists and keeping them in the company. This, in turn, depends on the managers who, by managing human capital, have an impact on the career of employees (Kazak, 2017). The skills of IT managers are critical to the success of projects (Wateridge, 1997) as evidenced by research into practices leading to project success (Verner, Evanco, 2005). The effectiveness of project management significantly depends on the competences and skills of the team manager (Kopacka, 2015; Kopeć, 2013).

The competencies expected by companies on management positions can be analyzed on the basis of job offers (Werewka, Wietecha, 2015). The IT industry is dominated by project-based approach to the work, hence soft skills are indicated as indispensable and necessary for a success (Mtsweni et al., 2016). The expectations set by employers differ depending on the type of leader. Scrum master should know scrum methodologies, be agile and team working. Project manager and project owner should have both soft and hard skills such as project management, knowing agile manifest and programming knowledge. In the offers looking for a team leader, an ability to program is the first requirement, an ability to lead a team appears less often. In the case of a technical leader offers, almost only technical skills are required (Jurga, 2022).

The leader's soft skills are essential in achieving a success for both individual employees and the entire organization (Smółka, 2008; Konarski, 2008; Mitchell et al., 2010). Soft skills are needed by a leader whose daily duty is contact with people (Paszkiewicz, Silska-Gembka, 2013). C. Fournier notes that it is easy to wrongly assume that a leader position in IT projects is not a technical job (Fournier, 2018). It is also false to reason that if the leader is not responsible for software development, then hard skills are not needed. However, in order to

efficiently supervise the work of team members and to identify signals that indicate the technical condition of the team, knowledge of programming is needed. Although the manager himself does not have to deal with writing code, he is responsible for the implementation of tasks, including also technical one, thus the knowledge of code and technical tools that facilitate making changes to it is important. Moreover, the leader should be also able to catch valuable and important information from the general buzz (Kamiński, 2016) and understand the problems related to the work performed. In the IT industry, it means having the technical competence to be able to filter the information received or be able to reliably assess what the employee has achieved and what he has to work on. Without technical competences it is difficult to say whether a given code is performed correctly and the knowledge provided to other team members is clear and uncomplicated. Technical competences are also useful to formulate a correct working tip or when working with IT team members who often use specific, technical vocabulary to describe the encountered problems. The hard competencies of a leader help to define key qualifications and competencies needed in project team, and are essential to the successful recruitment of team members (Kisielnicki, 2011).

K. Frączkowski (2003) describing the project leader points that his role is a combination of the role of a businessman who works with the client, the role of a manager who has human resources in the area of its influence, but also the role of a technologist. The latter role is related to resource selection, technical innovation and adaptation of the operating method. Thus project leader does not necessarily have to be a "super specialist" in computer science, but he combines economic and technical issues, and from this point of view the technical competencies are needed.

Summarising, research on project team members indicates that the leader should have soft and hard competences (Sobczak, 2014), and apart from the increase in the demand for soft skills, there is also an increase in the demand for specialists with hard, technical competences (Butryn, Sobińska, 2019). Considering all the above, the following research hypotheses were formulated:

H2: There is a positive relationship between the project leader's soft competencies and his efficiency (a), and a team work effectiveness in IT projects (b).

H3: There is a positive relationship between the project leader's hard (technical) competencies and his efficiency (a), and a team work effectiveness in IT projects (b).

Competences (both hard and soft) are an important factor determining the effectiveness of the leader's actions in work processes. Therefore, the following hypothesis can be adopted:

H4: The project leader's soft competencies (a) and project leader's hard (technical) competencies (b) influence a team work effectiveness in IT projects (an indirect effect) trough project leader's efficiency (an intermediary variable).

2.3. Factors shaping the leader's hard competences

Hard competences are a certain type of professional qualifications, the possession of which allows for effective fulfillment of duties in a given position. These qualifications are often confirmed with appropriate certificates or diplomas and associated with specialist knowledge (Armstrong, 2006). They are inextricably linked with specialist and substantive requirements for a given position, therefore they are often referred to as technical competences (Fastnacht, 2006). In IT industry that hard skills can be expressed as knowledge of the tools, technologies, programming language or design patterns (Butryn, Sobińska, 2019). The hard competences include also the knowledge about a task or process, practical abilities to complete a task and motivation to complete a task with a given pattern (Branowska et al., 2011).

In IT industry it is often emphasised that hard skills arose on education or work experience. They can be developed by formal education, informal education and non-formal education (Maslowski et al., 2009) or trough experience in work processes (Kopacka, 2015), i.e. changing the workplace, self-growth, and contact with specialists in the field, reading industry articles and books, all of that impacts hard skills (Spychała, Branowska, 2019). Considering all the above, the following research hypotheses were adopted:

H5: There is a positive relationship between the project leader's technical (directional in IT) education and his hard (technical) competencies.

H6: There is a positive relationship between the project leader's technical experience in IT and his hard (technical) competencies.

Taking into account all the previous arguments on the impact of hard team leader competencies on his efficiency and the effectiveness of the teamwork, the following hypotheses can be formulated:

H7: The project leader's technical (directional in IT) education (a) and the project leader's technical experience in IT (b) influence a team work effectiveness in IT projects (an indirect effect) trough project leader's hard (technical) competencies and project leader's efficiency (an intermediary variables).

Fig. 1 presents the diagram illustrating the list of adopted research hypotheses.

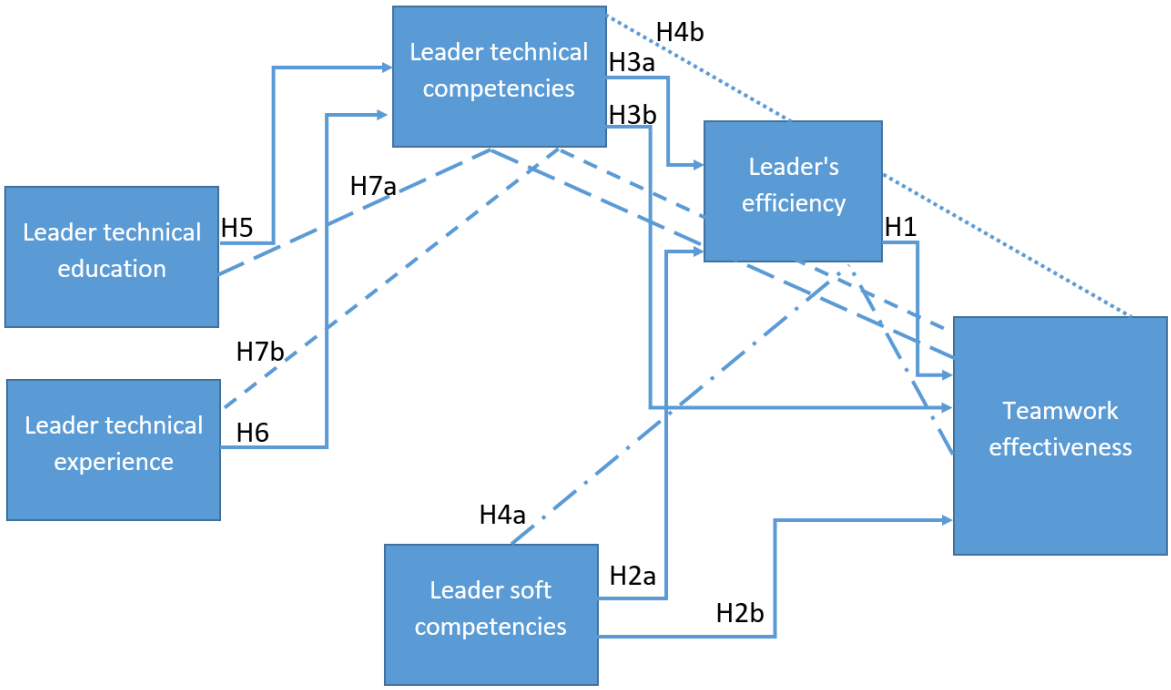

Figure 1. Project leader's hard (technical) competencies and project leader's efficiency as a mediators of relation between project leader's technical (directional in IT) education and the project leader's technical experience in IT, and the team work effectiveness in IT projects. Source: own research (based on (Jurga, 2022)).

3. Research methodology and the results of research

3.1. Data gathering process and characteristics of the research sample

Aiming to verify the proposed hypotheses quantitative research was conducted. The purpose of the research was to verify if the leader's technical competences and the leader's efficiency can be mediators of relation between team work effectiveness (the dependent variable) and technical (directional in IT) education and technical experience in IT of a leader (independent variables). The research was conducted to complete a master's thesis (Jurga, 2022). The study was conducted in April 2022 using the CAWI method. Google Forms and Survio tools were used to collect data. The questionnaire was published in the form of a post on three groups on Facebook associating programmers. The questionnaire was firstly filled by 141 respondents working in project teams in the IT industry for organizations located in Poland (which was the only limitation of the research sample), and then additionally sent to 8 teams in a software company operating in Poland and filled by 37 respondents. In total 178 responses were collected. The questionnaire was sent to both leaders, who could rate themselves, and to team members who could rate their leader (the questionnaires for both groups differed slightly - the questions were personalized, depending on a respondent role). The obtained results were

analyzed using Microsoft Excel and the SPSS statistical package with an overlay created by A. Hayes - the PROCESS macro.

The sample was selected using a non-random method. According to the data gathered by Eurostat, at the end of 2020, almost 554'000 people has been working in IT industry in Poland (Eurostat, 2022). Unfortunately, there is no data on how many of that people have formal education related to IT. A formula was used to assess whether the sample is representative (Szewczyk, Ciesielska, 2010):

$$N_{min} = \frac{N\alpha^2 f(1-f)}{Ne^2 + \alpha^2 f(1-f)} \quad (1)$$

where:
N_{min} is minimum sample size,
N is the size of the studied population,
α is trust level,
f is fraction size,
e is maximum error.

It is not known what part of the IT sector employees has higher technical education so we have to take f equal to 0.5. In order to achieve representative sample with confidence level equal to 95% and maximum error equal to 5% minimum 384 questionnaires should be obtained. For 178 respondents participating in the study and the confidence level equal to 95% the quantity given in a sample is representative of the maximum error 7%.

The distribution of the respondents with the division into roles and working time in a given team is presented in Table 1.

Table 1.
Distribution of the responders grouped by role and seniority in the team

Role / Time in this team	Leader	Team member	Σ
Up tp 2 years	26	75	101
From 2 to 5 years	23	36	59
More than 5 years	15	3	18
Σ	64	114	178

Source: (Jurga 2022).

Among all responders, 104 (58%) leaders have technical education related to the IT industry, 52 (29%) leaders have technical education related to different technical fields and 35 (20%) leaders have no technical education. 60 leaders were leading an IT team for up to 2 years. 74 leaders were leading for between 2 to 5 years. 44 leaders were leading an IT team for more than 5 years.

3.2. Variables measurement

In order to verify the proposed hypothesis the following variables were defined: Leader technical education, Leader technical experience, Leader technical competencies, Leader soft competencies, Leader efficiency and Team work effectiveness.

Leader technical education was a dichotomous variable with values of *yes*, *no*. Respondents were asked to indicate whether they have formal IT education.

To build *Leader technical experience* variable 2 items were used. Respondents assessed how much experience a leader has as a programmer and when was the last time the leader worked with the code. Each item was rated on a 4-point scale.

Variable *Leader technical competencies* was measured using 5 items describing, how much the leader has developed hard skills. The scales were built on the basis of literature (Spychała, 2013; Fournier, 2018; Butryn, Sobińska, 2019). They were rated on the 5-points' Likert scale (from *fully agree* to *fully disagree* with middle point *I have no opinion*).

Leader soft competencies was measured using 9 items describing, how much the leader has developed soft skills. The scales were built on the basis of literature (Ahmed et al., 2012; Mirska, 2012; Fournier, 2018). They were rated on the 5-points' Likert scale.

Building *Leader efficiency* variable 10 items were used in the case of questionnaire directed to a team member and 8 - in the case of questions directed to the leader. The scales were built on the basis of literature (Igielski, 2015; Fournier, 2018). Items were rated on the 5-points' Likert scale.

To build *Team work effectiveness* variable 14 items assigned into 4 groups (technical efficiency, team performance, attitude and behavioural results) were used. The scales were built on the basis of literature (Hackman, Morris, 1975; Fournier, 2018). Here again 5-point scale was used.

3.3. Descriptive statistics and reliability analysis of scales

At the beginning of a research process, the reliability of scales of each variable was verified. Cronbach's coefficient (α) was computed to test the reliability and internal consistency of the responses. The results of the analysis of the reliability of the measurement scales are presented in tab. 2. All of the α values for constructs are above 0.7 (most over 0.8), indicating a high degree of internal consistency in the responses.

Table 2.
Defined variables along with the results of the reliability analysis of scales

Variables	n	CR	M	SD
Leader technical education	-	-	-	-
Leader technical experience	2	0.767	3.311	1.012
Leader technical competencies	5	0.950	4.224	1.086
Leader soft competencies	9	0.882	4.231	0,693
Leader efficiency	8	0.836 for leaders	3.942	0.785
	10	0.907 for team members		
Teamwork effectiveness	14	0.823	4.029	0.529

Source: own study (based on (Jurga 2022)).

The questionnaire was completed by two groups of employees: leaders and team workers. Moreover, the leader efficiency was measured differently in two groups of respondents. So a natural question arose whether the opinions of these two groups of employees could be used in the further research process. Thus in a first step of analysis a smaller sample collected from one particular software company was used to verify whether the evaluation of the leader's efficiency and teamwork effectiveness differs in the eyes of the leaders themselves and their team members. Then this analysis was extended to the entire sample. The equality of means test (Student t-test for independent samples) has been performed. It turned out that there are no statistically significant differences between the both groups in the evaluation of the leader efficiency ($t(178) = -0.433$; $p = 0.666 > 0.05$) and teamwork effectiveness ($t(178) = -0.089$; $p = 0.929$) as well. The rating of the leader's efficiency and team work effectiveness assessed by leaders and team members is consistent and this measurement method can be taken into account in the following research.

3.4. Research results

The next step of the analysis was the correlation analysis between studied variables. To verify the proposed hypothesis an r-*Pearson* correlation analysis has been conducted. The results can be found in Table 3.

Table 3.
Correlation analysis between studied variables

	Leader technical experience	**Leader technical competencies**	**Leader soft competencies**	**Leader efficiency**	**Team work effectiveness**
Leader technical education	**0.314**** ($p < 0.001$) N = 160	**0.305**** ($p < 0.001$) N = 163	0.076 ($p = 0.333$) N = 163	0.109 ($p = 0.166$) N = 163	0.041 ($p = 0.601$) N = 163
Leader technical experience	-	**0.770**** ($p < 0.001$) N = 172	**0.253**** ($p < 0.001$) N = 172	**0.336**** ($p < 0.001$) N = 172	0.142 ($p = 0.063$) N = 172
Leader technical competencies	**0.305**** ($p < 0.001$) N = 163	-	**0.497**** ($p < 0.001$) N = 178	**0.551**** ($p < 0.001$) N = 178	**0.369**** ($p < 0.001$) N = 178
Leader soft competencies	**0.253**** ($p < 0.001$) N = 172	**0.497**** ($p < 0.001$) N =	-	**0.724**** ($p < 0.001$) N = 178	**0.623**** ($p < 0.001$) N = 178
Leader efficiency	**0.336**** ($p < 0.001$) N = 172	**0.551**** ($p < 0.001$) N = 178	**0.724**** ($p < 0.001$) N = 178	-	**0.606**** ($p < 0.001$) N = 178

Note: **Correlation is significant at the 0.01 level (two-sided).

Source: own study (based on (Jurga 2022).

The results showed that:

- variable *Team work effectiveness* is statistically significantly correlated with:
  - *Leader efficiency* ($r(178) = 0.606^{**}$, $p < 0.001$), which is the basis for positive verification of the hypothesis H1,

  - *Leader soft competencies* (r(178) = 0.623**, p < 0.001), which is the basis for positive verification of the hypothesis H2b,
  - *Leader technical competencies* (r(178) = 0.369**, p < 0.001), which is the basis for positive verification of the hypothesis H3b, although it must be noticed that the correlation is moderate here;
- variable *Leader efficiency* is statistically significantly correlated with:
  - *Leader soft competencies* (r(178) = 0.724**, p < 0.001), which is the basis for positive verification of the hypothesis H2a,
  - *Leader technical competencies* (r(178) = 0.551**, p < 0.001), which is the basis for positive verification of the hypothesis H3a;
- variable *Leader technical competencies* is statistically significantly correlated with:
  - *Leader technical education* (r(162) = 0.305**, p < 0.001), which is the basis for positive verification of the hypothesis H5, although it must be noticed that the correlation is moderate here,
  - *Leader technical experience* (r(172) = 0.770**, p < 0.001), which is the basis for positive verification of the hypothesis H6.

As it can be seen, correlations are positive and in almost all cases strong.

As a final step of research, in order to verify hypotheses H4(a,b) i H7(a,b) mediation analysis was performed using Process macro for IBM SPSS Statistics. According to Cohen & Cohen (1983) mediating effects are inferred when the independent variable is significantly related to the intervening variable (mediator) and the intervening variable (mediator) is significantly related to the dependent variable (what was already checked in correlation analysis), that is when separate tests for all paths are jointly significant. The analysis was carried out using the stepwise method, in each step always only one of the four different paths were considered to verify derived hypotheses.

First mediation model was built to verify the H4a for *Leader soft competencies* as an independent variable and *Team work effectiveness* as a dependent variable. *Leader efficiency* was tested as a mediator in the model. The results of analysis can be found in Table 4.

Table 4.
Leader efficiency as a mediator of relationship between *Leader soft competencies* and *Team work effectiveness*

predictors	s.e.	t	p	F	df1;df2	R2	p
Model 1							
Leader soft competencies	0.0589	13.9245	<0.001	193.891	1;176	0.5242	<0.001
Model 2							
Leader soft competencies	0.0627	4.7299	<0.001	68.4083	2;175	0.4388	<0.001
Leader efficiency	0.0554	3.9548	<0.001				

Source: own study.

The obtained research results showed that the built regression model with the mediator was valid and statistically significant (F(2,175) = 68.4083, R2 = 0.4388, p < 0.001). Furthermore, *Leader efficiency* were a statistically significant mediator of the model (p < 0.001, coeff. = 0.3898, se = 0.0485). To confirm it, the Sobel test was calculated (Z = 3.8, p < 0.001), which confirmed that *Leader efficiency* significantly carries the influence of an independent variable to dependent variable. The obtained model showed that *Leader efficiency* is a mediator of relationship between *Leader soft competencies* and *Team work effectiveness*. Therefore, hypothesis H4a can be accepted.

Second mediation model was built to verify the H4b for *Leader technical competencies* as an independent variable and *Team work effectiveness* as a dependent variable. *Leader efficiency* was tested as a mediator in the model. The results of analysis can be found in Table 5.

Table 5.
Leader efficiency as a mediator of relationship between *Leader technical competencies* and *Team work effectiveness*

predictors	s.e.	t	p	F	df1;df2	R2	p
Model 1							
Leader technical competencies	0.0454	8.7632	<0.001	76.7942	1;176	0.3038	<0.001
Model 2							
Leader technical competencies	0.0351	0.6983	0.4859	51.1213	2;175	0.4388	<0.001
Leader efficiency	0.0485	8.0320	<0.001				

Source: own study.

The obtained research results showed that the built regression model with the mediator was valid and statistically significant (F(2,175) = 68.4083, R2 = 0.4388, p < 0.001). Furthermore, *Leader efficiency* were a statistically significant mediator of the model (p < 0.001, coeff. = 0.3898, se = 0.0485) and relationship between *Leader technical competencies* and *Team work effectiveness* has become statistically insignificant (p = 0.486, coeff. = 0.0245, se = 0.0351). To confirm it, the Sobel test was calculated (Z = 5.92, p < 0.001), which confirmed that *Leader efficiency* significantly carries the influence of an independent variable to dependent variable. The obtained model showed that *Leader efficiency* is a mediator of relationship between *Leader technical competencies* and *Team work effectiveness*. Therefore, hypothesis H4b can be accepted.

Third mediation model was built to verify the H7a hypothesis for *Leader technical education* as an independent variable and *Team work effectiveness* as a dependent variable. *Leader technical competencies* and *Leader efficiency* were tested as the mediators in the model. The results of analysis are presented in table 6.

Table 6.
Leader technical competencies and *Leader efficiency* as a mediators of relationship between *Leader technical education* and *Team work effectiveness*

predictors	s.e.	t	p	F	df1;df2	R2	p
Model 1							
Leader technical education	0.1732	4.0703	<0.001	16.5677	1;161	0.0933	<0.001
Model 2							
Leader technical education	0.1154	-0.9869	0.3252	36.9619	2;160	0.3160	<0.001
Leader technical competencies	0.0500	8.4343	<0.001				
Model 3							
Leader technical education	0.0740	-0.7140	0.4785	32.3927	3;159	0.3793	<0.001
Leader technical competencies	0.0384	1.0740	0.2844				
Leader efficiency	0.0505	7.5386	<0.001				

Source: own study.

The obtained research results showed that the built regression model with the mediators was valid and statistically significant ($F(3,159) = 32.3927$, $R2 = 0.379$, $p < 0.001$). Furthermore, *Leader efficiency* is a statistically significant mediator of the model ($p < 0.001$, coeff. = 0.3809, se = 0.0505). However, although *Leader technical competencies* is a statistically significant mediator of the model 2 ($p < 0.001$, coeff. = 0.4218, se = 0.0500), which was also confirmed by the Sobel test (($Z = 3.65$, $p < 0.001$) that confirmed that *Leader technical competencies* significantly carries the influence of an independent variable (*Leader technical education*) to dependent variable (*Leader efficiency*)), it is not statistically significant mediator of the model 3 ($p = 0.2844 > 0.05$, coeff. = 0.4213, se = 0.0384). The obtained results showed that the hypothesis that was not formulated in the paper (that the technical competences of the leader mediate the relationship between his technical education and efficiency) could also be adopted. Summarizing all above, we can observe the full mediation here and hypothesis H7a can be accepted.

Fourth mediation model was built to verify the H7b for *Leader technical experience* as an independent variable and *Team work effectiveness* as a dependent variable. *Leader technical competencies* and *Leader efficiency* were tested as the mediators in the model. Table 7 presents the results of the analysis.

Table 7.
Leader technical competencies and *Leader efficiency* as a mediators of relationship between *Leader technical experience* and *teamwork effectiveness*

predictors	s.e.	t	p	F	df1;df2	R2	p
Model 1							
Leader technical experience	0.0526	15.7211	<0.001	247.1542	1;170	0.5925	<0.001
Model 2							
Leader technical experience	0.0777	-2.2522	0.0256	41.1098	2;169	0.3273	<0.001
Leader technical competencies	0.0723	7.3406	<0.001				
Model 3							
Leader technical experience	0.0509	-2.3787	0.0185	35.6087	3;168	0.3887	<0.001
Leader technical competencies	0.0536	2.2322	0.0269				
Leader efficiency	0.0496	7.4466	<0.001				

Source: own study.

The obtained research results showed that the built regression model with the mediators was valid and statistically significant ($F(3,168) = 35.609$, $R2 = 0.389$, $p < 0.001$). Furthermore, *Leader technical competencies* and *Leader efficiency* were a statistically significant mediators of the model ($p = 0.0269$, coeff. = 0.1196, se = 0.0536) and ($p < 0.001$, coeff. = 0.3697, se = 0.0496) respectively. Additionally, the Sobel test was calculated ($Z = 6.65$, $p < 0.001$) for the first part of mediation model, which confirmed that *Leader technical competencies* significantly carries the influence of an independent variable (*Leader technical experience*) to dependent variable (*Leader efficiency*). Therefore, hypothesis H7b can be accepted. Partial mediation can be observed here.

4. Discussion

Leaders of the projects (project managers, project owners, scrum masters, technical leaders) are responsible for meeting the project objectives according to assigned them roles in order to achieve successful project completion (DiVincenzo, 2006; Baca, 2007; Gillard 2009). The play the crucial role in this process (Fioravanti et al., 2020). In theirs day-to-day operations they work with various groups of project stakeholders trying to reconcile their requirements. One of the most important tasks in their work is to ensure the effectiveness of the project team. A literature overview showed that project leader should be equipped with both hard and soft skills (Sampson, 2007; Van Ingen, 2007; Gillard, 2009; Magano et al., 2020), however those 'hard' skills are understood rather as an ability of schedules or budgets creating, conducting risk analyses, scenario analysis making, fighting against scarcity of resources, and rapidly changing technology etc., than technical know-how. However specificity of IT projects imposes specific requirements on the project leaders forcing them often to manage technical challenges. From that point of view technical competencies in IT should be needed. Responding to this demand the paper was devoted to analyzing the role of technical, IT related education and technical experience (in programming) of the leader in shaping of the team work effectiveness in IT projects.

The results show that there is no direct correlation between the leader's technical IT related education or the leader's technical experience and the team's efficiency. However, it is still worth to have a leader with technical IT related education and technical, directional experience, because the leader's hard competencies are correlated to them, although leaders experience are twice as important as formal education of leaders. Thus, if there is a choice between a leader with technical IT related education and a leader with technical, directional experience, then latter is a better pick as regression analysis showed that experience has bigger impact on hard skills than education. It seems that technical experience may have more impact on hard competencies, compared to formal technical education, because experience gives the leader

more chances to encounter practical real-life problems compared to theoretical problems tackled during formal education.

It has been shown that there is indirect relationship between the dependent variable (team work effectiveness) and independent variables (technical education and technical experience in IT of a leader), and the mediators of this relationship are leader's technical competences and the leader's efficiency.

Comparing soft and hard skills of the leader's it turns out that the leader's efficiency is much stronger correlated with the leader's soft competencies than hard competencies. The same goes for the team's effectiveness that is much stronger correlated with the leader's soft- than hard competencies. This results clearly confirms universally accepted thesis on the importance of soft skills for management success (Konarski, 2008; Smółka, 2008; Mitchell et al., 2010; Kazak, 2017). However, it does not mean that the leader's hard (technical) competencies are useless. There is still a correlation between the leader's hard competencies and the leader's efficiency or the team's effectiveness, although weaker than in the case of soft skills. Considering the effectiveness of the project team as a success in the role of project manager, it must be underline that it cannot be attained with a technical skill set only. However, technical skills are being recognized as one of the minimal requirements for a project IT manager. They are built mainly by experience, and to a lesser extent also by formal education.

5. Conclusions

The purpose of the paper was to investigate the relationship between technical (directional in IT) education and experience of a leader, and team work effectiveness in IT projects, recognized as one of the predictors of the project's success. The results showed that although there is no direct correlation between the leader's technical IT related education or the leader's technical experience in IT and the team work effectiveness, it is still worth to have a leader with technical, directional experience and formal education in IT, because the basic relationships being under study is mediated by leader's technical competencies and leader's efficiency in the implementation of managerial roles. The obtained results also highlighted the role of the leader's soft skills in shaping the effectiveness of the project team's work.

The performed research contributes to the body of academic knowledge on of human resources and project management literature confirming that among various groups of factors determining team work effectiveness in IT projects both soft and hard (technical) competencies are important. The obtained results contribute to practice of management by demonstrating the meaning of the technical education and experience of a leader for team work effectiveness in IT projects. This can be of practical importance when recruiting team leaders. HR departments,

apart from paying attention to very important nowadays soft skills, should also verify the experience and technical skills of potential candidates.

However, the performed research has some limitations. The analysis is based on a limited number of cases in particular groups and only in one business context. It should be treated rather as a pilot study and verified in further research. In order to generalize the results in future research larger samples should be collected.

References

1. Alias, Z., Zawawi, E.M.A., Yusof, K., Aris, N.M. (2014). Determining critical success factors of project management practice: A conceptual framework. *Procedia-Social and Behavioral Sciences, 153,* 61-69
2. Ammeter, A., Dukerich, J. (2002). Leadership, Team Building, and Team Member Characteristics in High Performance Project Teams. *Engineering Management Journal, 14(4),* pp. 3-10.
3. Andersen, E.S., Birchall, D., Jessen, S.A., Money, A.H. (2006). Exploring project success. *Baltic Journal Of Management*.
4. Armstrong, M. (2006). A Handbook of Human Resource Management Practice. London–Philadelphi: Kogan Page Publishers.
5. Baca, C.M. (2007). Project manager! Who? Me? *Machine Design, 79(20),* 64-66.
6. Belassi, W., Tukel, O.I. (1996) "A new framework for determining critical success/failure factors in projects". *International Journal of Project Management, Vol. 14, No. 3,* pp.141-51.
7. Belout, A., Gauvreau, C. (2004). Factors influencing project success: the impact of human resource management. *International Journal Of Project Management, 22(1),* 1-11.
8. Branowska, A., Siemieniak, P., Spychała, M. (2011). *Workers' occupational competencies in a modern enterprise.* Poznań: Publishing House of Poznan University of Technology.
9. Butryn, B., Sobińska, M. (2019). Znaczenie kompetencji miękkich w obszarze IT współczesnych organizacji. *Zeszyty Naukowe Politechniki Poznańskiej. Organizacja i Zarządzanie, Tom 79,* pp. 35-45.
10. Camilleri, E. (2011). Project Success. Critical Factors and Behaviours. *GOWER, 6,* 12-14.
11. Chan, A.P., Ho, D.C., Tam, C.M. (2001). Design and build project success factors: multivariate analysis. *Journal Of Construction Engineering And Management, 127(2),* 93-100.
12. Cohen, J., Cohen, P. (1983). *Applied multiple regression/correlational analysis for the behavioral sciences.* Hillsdale, NJ: Erlbaum.

13. Cooke-Davies, T. (2002). The "real" success factors on projects. *International journal of project management, 20(3),* 185-190.
14. Ćwik, K. (2013). *Praca zespołowa, Nowoczesność i doświadczenie*. Wrocław: Akademia rozwoju kompetencji pracowników HS Wrocław Sp. z o.o.
15. DiVincenzo, T. (2006). Project managers stay in charge and out front. *Occupational Outlook Quarterly, 50(2),* 19-25.
16. Dźwigoł, H. (2014). Menedżerowie przyszłości a zarządzanie strategiczne. *Zeszyty Naukowe. Organizacja i Zarządzanie, Tom 70,* pp. 93-104.
17. Fastnacht, D. (2006). Miękkie kompetencje w zarządzaniu. *Zeszyty Naukowe Wyższej Szkoły Zarządzania Ochroną Pracy w Katowicach, 1(2),* pp. 109-114.
18. Fioravanti, M.L., Sena, B., Barbosa, E.F. (2020, October). *Assessing the Development of Soft Skills for Project Management using PBL: A Case Study.* In 2020 IEEE Frontiers in Education Conference (FIE) (pp. 1-8). IEEE.
19. Fournier, C. (2018). *Od inżyniera do menedżera. Tajniki lidera zespołów technicznych*. Gliwice: Helion
20. Frączkowski, K. (2003). *Zarządzanie projektem informatycznym: projekty w środowisku wirtualnym. Czynniki sukcesu i niepowodzeń projektów*. Wrocław: Oficyna Wydawnicza Politechniki Wrocławskiej.
21. Francik, A. (2003). *Sterowanie procesami innowacyjnymi w organizacji*. Kraków: Akademia Ekonomiczna.
22. Garbharran, H., Govender, J., Msani, T. (2012). Critical success factors influencing project success in the construction industry. *Acta structilia, 19(2),* 90-108.
23. Gillard, S. (2009). Soft skills and technical expertise of effective project managers. *Issues in informing science & information technology, 6,* pp. 723-729.
24. Hackman, J., Morris, C. (1975). Group Tasks, Group Interaction Process, and Group Performance Effectiveness: A Review and Proposed Integration. *Advances in Experimental Social Psychology, Tom 8*, pp. 45-99.
25. Haffer, J. (2013). Commitment of Project Executors as a Key Factor of Project Success. *Organization and Management, 155,* 145.
26. Igielski, M. (2015). *Wpływ menedżera na efektywność pracowników we współczesnym przedsiębiorstwie.* Gdańsk: Uniwersytet Gdański.
27. Jurga, M. (2022). *Wpływ wykształcenia technicznego i doświadczenia lidera na efektywność pracy zespołu w projektach informatycznych, master thesis* (supervisor: Ph.D. Eng. Anna Zabłocka-Kluczka) - unpublished work. Wrocław: Wroclaw University of Science and Technology.
28. Kamiński, D. (2016). Znaczenie lidera w procesie budowania zespołu programistów. In: J. Werewka (ed.), *Wybrane Zagadnienia Zarządzania Projektami w Przedsiębiorstwach Informatycznych.* Kraków: Akademia Górniczo-Hutnicza im. Stanisława Staszica w Krakowie, pp. 165-177.

29. Katzenbach, J., Smith, D. (1993). *The Wistom of Teams*. Boston: Harvard Business School Press.
30. Kazak, M. (2017). Kompetencje menedżerskie we współczesnej organizacji. *Journal of Modern Management Process, 1(2),* pp. 89-99.
31. Kisielnicki, J. (2011). *Zarządzanie projektami*. Warszawa: Wolters Kluwer.
32. Konarski, S. (2008). Kluczowe znaczenie kompetencji społeczno-psychologicznych we współczesnych koncepcjach i praktyce systemów edukacji ekonomistów i menedżerów. In: S. Konarski (ed.), *Kompetencje społeczno-psychologiczne ekonomistów i menedżerów*. Warszawa: Oficyna Wydawnicza SGH, pp. 7-21.
33. Kopacka, P. (2015). Rola lidera w efektywnym zarządzaniu zespołem projektowym. In: A. Rogozińska-Pawełczyk (ed.), *Gospodarowanie kapitałem ludzkim. Wyzwania organizacyjne i prawne*. Łódź: Wydawnictwo Uniwersytetu Łódzkiego, pp. 129-144.
34. Kopeć, J. (2013). Role menedżera projektu. *Przedsiębiorczość i Zarządzanie, XIV(11),* pp. 77-87.
35. Kożusznik, B. (2002). *Zachowanie człowieka w organizacji*. Warszawa: PWE.
36. Magano, J., Silva, C., Figueiredo, C., Vitória, A., Nogueira, T., Pimenta Dinis, M.A. (2020). Generation Z: Fitting project management soft skills competencies - A mixed-method approach. *Education Sciences, 10(7),* 187.
37. Maslowski, R., Breit, H., Eckensberger, L., Scheerens, J. (2009). Conceptual framework on informal learning of active citizenship competencies. In: J. Scheerens (ed.), *Informal learning of active citizenship at school: an international comparative study in seven european countries*. Dordrecht: Springer Science & Business Media B V, pp. 11-24.
38. Masłyk-Musiał, E. (2014). *Organizacja w zmianach. Perspektywa konsultanta*. Warszawa: Oficyna Wydawnicza Politechniki Warszawskiej.
39. Mitchell, G., Skinner, L., White, B. (2010). Essential Soft Skills for Success in the Twenty-first Century Workforce as Perceived by Business Educators. *The Delta Pi Epsilon Journal, Tom 52,* pp. 43-53.
40. Mtsweni, E., Hörne, T., Andrew van der Poll, J. (2016). Soft Skills for Software Project Team Members. *International Journal of Computer Theory and Engineering, 8(2),* pp. 150-155.
41. Paszkiewicz, A., Silska-Gembka, S. (2013). Rola kompetencji miękkich w pracy księgowego – wyniki badań empirycznych. *Studia i Prace Kolegium Zarządzania i Finansów, Tom 130,* pp. 89-112.
42. Piskorz, Z. (2013). Wyznaczniki efektywności zespołów pracowniczych. *Przedsiębiorczość i Zarządzanie, XIV(11),* pp. 155-169.
43. Radujković, M., Sjekavica, M. (2017). Project management success factors. *Procedia engineering, 196,* 607-615.
44. Sampson, B. (2007). Get with the project. *Professional Engineering, 20(12),* 41-42.

45. Sanchez, O.P., Terlizzi, M.A. (2017). Cost and time project management success factors for information systems development projects. *International Journal of Project Management, 35(8),* 1608-1626.
46. Shokri-Ghasabeh, M., Kavoousi-Chabok, K. (2009). Generic project success and project management success criteria and factors: Literature review and survey. *WSEAS Transactions on Business and Economics, 8(6),* pp. 456-468.
47. Smółka, P. (2006). Jak skutecznie szkolić umiejętności interpersonalne? In: B. Kaczmarek, A. Kucharski, M. Stencel (eds.), *Komunikowanie się. Problemy i perspektywy*. Lublin: Wydawnictwo UMCS, pp. 247-259.
48. Smółka, P. (2008). *Kompetencje społeczne. Metody pomiaru i doskonalenia umiejętności interpersonalnych.* Warszawa: Wolters Kluwer Polska.
49. Sobczak, A. (2014). Wpływ kompetencji kierownika projektu na sukces zarządzania projektem. *Przedsiębiorczość i Zarządzanie, XV(6),* pp. 243-254.
50. Springer, A. (2013). Kompetencje wymagane wobec kierowników zespołów projektowych – ocena potencjału pracowników. *Przedsiębiorczość i Zarządzanie, XIV(11),* pp. 193-206.
51. Spychała, M., Branowska, A. (2019). Czynniki kształtujące kompetencje menedżerskie. Zeszyty Naukowe Politechniki Poznańskiej. *Organizacja i Zarządzanie, Tom 79,* pp. 181-192.
52. Szewczyk, M., Ciesielska, M. (2010). *Podstawy statystyczne badań marketingowych*. Opole: Oficyna Wydawnicza Politechniki Opolskiej.
53. Tracy, B. (2014). *Motywowanie*. Warszawa: MT Biznes.
54. Trocki, M. (2012). *Nowoczesne zarządzanie projektami.* Warszawa: PWE.
55. Van Ingen, S. (2007). Leadership of project teams. *Chemical Engineering, 114(1),* 55-58.
56. Verner, J., Evanco, W. (2005). In-house software development: what project management practices lead to success? *IEEE Software, 2(1),* pp. 86-93.
57. Wateridge, J. (1997). Training for IS/IT project managers: a way forward. *International Journal of Project Management, 5(5),* pp. 283-288.
58. Werewka, J., Wietecha, M. (2015). Impact analysis of soft skills in transition from software developer to project manager positions. *Business Informatics, 4(38)*, pp. 64-93.
59. Westerveld, E. (2003). The Project Excellence Model®: linking success criteria and critical success factors. *International Journal of project management, 21(6),* 411-418.
60. Yang, L.R., Huang, C.F., Wu, K.S. (2011). The association among project manager's leadership style, teamwork and project success. *International journal of project management, 29(3),* 258-267.