

# IT PROJECT TEAMS CREATION AND ANALYSIS IN C<sup>2</sup>NIWA ENVIRONMENT

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**Abstract:** Teams are the basic unit of the C<sup>2</sup>NIWA community, which – using the technical capabilities of this environment – focuses on the implementation of various projects. This article presents one of the competitions carried out within the framework of a C<sup>2</sup>NIWA project called *Uwaga! Upadek!* [*Attention! Fall!*], used as an example of a collaborative project for which analyses related to the assessment of teamwork based on the input-process-result model were carried out. The aim of the article is to present the obtained results in terms of the teamwork climate and confidence within the team at the first stage of cooperation.

**Keywords:** teamwork, team trust, team climate, virtual teams, C<sup>2</sup>NIWA

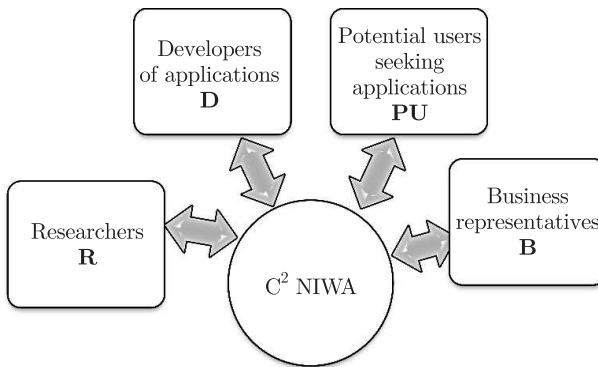
## 1. Introduction – C<sup>2</sup>NIWA as an environment for team cooperation

The feasibility study of the project indicates that one of the main areas of C<sup>2</sup>NIWA activity, located in CI TASK (oriented for distributed and parallel calculations), is to create a community by expanding the number of users of the shared infrastructure and creating an environment enabling cooperation and implementation of e-Science achievements into social practice. The users of the C<sup>2</sup>NIWA represent four main groups to which the Centre directs its specific offers of applications and services [1]:

- developers of applications, *i.e.* professionals or enthusiasts working on the creation of new applications to whom the C<sup>2</sup>NIWA offers support in building project teams, for example by sharing the Redmine open system, whereby teams can be created and teamwork can be supervised, or by providing professional support through training and e-learning, as well as three high-performance platforms and the BPEL environment;
- potential users seeking applications who can use the repositories of ready solutions and avail of the advice related to their selection: recipients of the

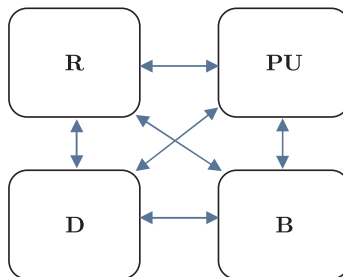
services offered on the C<sup>2</sup>NIWA platforms and the resources of the institutional repository, as well as the projects implemented earlier in Redmine;

- researchers to whom the Centre offers the possibility of sharing knowledge, sourcing IT support for the implemented research projects, gaining access to the platforms which enable processing and integrating complex data requiring very large amounts of scientific resources, as well as creating virtual teams which carry out research projects between remote sites;
- business representatives who will find in the C<sup>2</sup>NIWA innovative solutions that can be applied with the support of the Centre experts, depending on their organizations' needs, as well as the ability to model business processes and design their improvements through the use of the BPMN technology or gain access to an interdisciplinary team of experts and scientists interested in the commercialization of their achievements.



**Figure 1.** Users of C<sup>2</sup>NIWA

The C<sup>2</sup>NIWA also assumes the creation of a community involving all audiences in order to build relationships between each other and with representatives of the Centre, which in turn implies the creation of a network of relations of cooperating stakeholders involved in the development of the community and the C<sup>2</sup>NIWA itself at the same time.

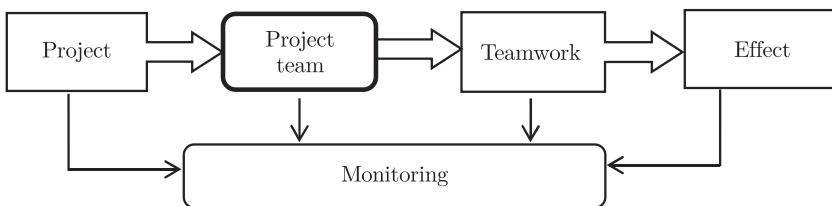


**Figure 2.** C<sup>2</sup>NIWA community

The basic units of the C<sup>2</sup>NIWA community are project teams which integrate the stakeholders around the implementation of specific projects, the performance of which requires access to the resources of the Centre. It is assumed that most of these teams will be virtual or hybrid (combining the aspects of traditional and network solutions) – they will be characterised by a geographical, temporal and organizational spread, as well as by the use of information technology in the process of cooperation [2–5]. The most serious challenge in the process of creating this type of teams are the interpersonal processes which, depending on the level of virtuality understood as the fraction of communication based on information technology in relation to direct communication, as well as the type of applied IT solutions, are exposed to the consequences of anonymity, a sense of isolation and lack of non-verbal signals [6–8]. Creating a climate of effective cooperation, the most important elements of which are the involvement of team members and their mutual trust, constituting a source of coherence, synergy and innovation [5, 8, 9], are the basic conditions for the effectiveness of teams, which are also expected in the C<sup>2</sup>NIWA environment. Therefore, a team work analysis model was developed within the framework of the project, allowing the monitoring of elements having key significance for a climate of cooperation in teams, as well as for assessing their impact on the results of teamwork.

## 2. Model of C<sup>2</sup>NIWA project teams analysis

The analysis of teamwork was based on the Unsworth and West process model of group work [10] in which the most important elements determining the effectiveness of a team include the input (task, team composition, working conditions) and the processes associated with teamwork (leadership, communication, decision-making, consistency). The result of teamwork is evaluated at three levels: the effect achieved, productivity and work climate. It has been also assumed that the driver of the team formation in C<sup>2</sup>NIWA will be projects requiring the use of this environment, around which teams undertaking cooperation and creating certain effects will be formed (Figure 3). Such elements of the model have been used to develop tools enabling the measurement of the indicators of each of its stages.



**Figure 3.** Project teams analysis

The projects are defined by their purpose, delivery time, tools (*e.g.* the C<sup>2</sup>NIWA platforms needed for their execution), as well as conditions of cooperation (virtual, hybrid or direct). A tool for collecting information on the characteristics

of a project is its registration in the Redmine system or the determination of the conditions of the competitions or tasks ordered by the C<sup>2</sup>NIWA. The key pieces of information monitored on the team stage include its composition and structure, as well as the intellectual capital of members (knowledge and skills), their personal qualities and team roles. The measurement of these indicators requires using self-esteem questionnaires, psychological tests and biographical data. The processes relevant for the assessment of team work include leadership, communication, decision making and working atmosphere based on trust (having key significance for virtual teams) [3, 11]. Their assessment is possible thanks to the developed team work evaluation questionnaires (trust questionnaires, work climate questionnaire) and the registration of event logs based on the Redmine project management system used by teams to communicate (definition of the leader, artist and tester roles; registration of events such as *e.g.* task assignment or completion, the activity of individuals or gaps in the implementation, as well as error notifications). The evaluation of team work results takes into account the subjective factor, *i.e.* the group member satisfaction, the growth of knowledge in the team, as well as the objective factor measured in terms of attaining the pursued objectives, the opinion of stakeholders, timeliness or the quality of task implementation.

It was assumed that these indicators would be monitored at different stages of teamwork: the phase of initial registration of members includes their participation in predisposition tests (referring *e.g.* to styles of interpersonal communication or team roles) and collecting demographical data, whereas the assessment of cooperation in view of climate teamwork and trust takes place at the beginning of the project, during the middle stage of implementation and after the completion of the task. On the other hand, event log monitoring accompanies the whole process of project implementation, while the subjective and objective evaluation of the results takes place upon the completion of cooperation. The model of C<sup>2</sup>NIWA team monitoring is presented in Figure 4.

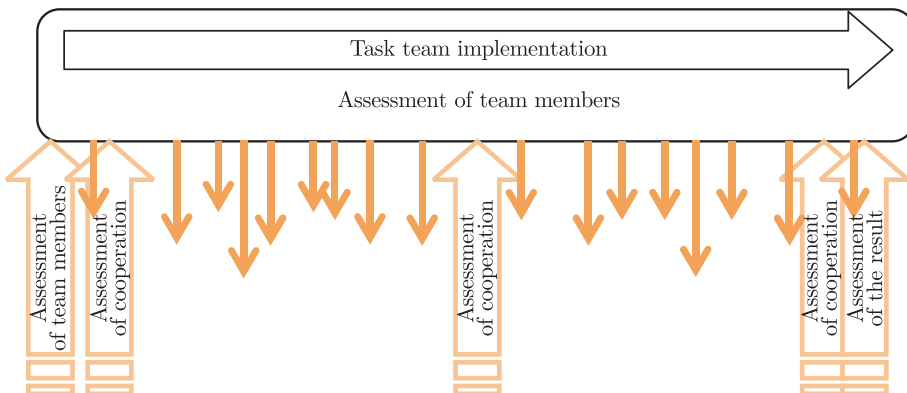


Figure 4. C<sup>2</sup>NIWA team monitoring model. Arrows pointing down represent event logs

The most important challenge was to prepare tools for measuring and evaluating the process of cooperation. The basis for their development was a model of teamwork climate, understood as general team staff perception of processes, practices and behaviour patterns that arise during the implementation of tasks and are interpreted in the context of personal satisfaction with the participation in the team [12]. The key dimensions of team work climate include [13, 14]:

- confidence arising from open relationships, honesty, integrity, kindness, open flow of information, taking part in discussions and conviction of the competence of the leader and fellow team members;
- sense of security achieved by building close relationships within the team, stability of conditions or team cohesion;
- commitment, or the personal significance of the tasks undertaken by the team for each of the participants;
- motivating by setting challenges for team members and emphasizing their role in carrying out the tasks, as well as providing fair rewards;
- active conflict resolution and using their potential;
- stimulating and openness for innovation, acceptance of risky situations, organizational support for the implementation of innovations;
- a sense of support from each other and from the team leader, strengthening the sense of cohesion;
- clarity of vision, ambitious and realistic goals;
- focus on objectives, clearly defined individual scopes of responsibility and standards of work quality assessment;
- co-responsibility built on the basis of autonomy but also the interdependence of the performed tasks.

The source of questions for the questionnaire measuring the level of confidence was, in turn, the 10-factor ITTI model (International TeamTrust Indicator) [15] and the 6-factor Nolan model [16, 17].

The 10-factor model includes the following dimensions of trust:

- competence – confidence is based on the belief that other members of the team have the appropriate competence to perform a task;
- the compatibility of values and attitudes – the belief that we can rely on others because of a similar system of values, community of goals, beliefs and interests, as well as the use of a common language;
- goodwill – trust stems from the belief that the cooperation participants act for the common good and the well-being of other team members;
- integrity and keeping promises;
- consistency and predictability – trust based on the perception of the actions of others as internally consistent and constant and on the compliance with group norms;
- well-being – the belief that the team members do not threaten us, as well as that mistakes will be treated as a normal part of development;



- inclusion – resulting from the observation that the team members are involved in pursuing its goal and appreciate the importance of the other members of the group for achieving the results, while decision making is based on previous consultations;
- openness with information – sharing information and reliance on the information received from the other team members;
- accessibility: contacting team members also outside the project, sharing their own feelings and personal information;
- reciprocity: belief in trust of other team members and their willingness to cooperate.

In this case, the optimum level of confidence in the team is reflected by the highest score in each of these dimensions.

The 6-factor model includes the following dimensions of trust:

- Risk – assessment of the risk level used by other team members, related to losing unique information or other losses;
- Utility value – the belief that without teamwork the task would be impossible, that other team members bring the capital necessary to complete the task;
- Benefit – the belief that teamwork brings personal benefits;
- Power – being convinced that one of the team members has a greater impact on others and a stronger position because of their access to information or unique competencies;
- Interest – the feeling of interest in the contributed information and ideas on the part of other team members and the respect shown by other team members;
- Effort – assessment of one's efforts as contribution to the team work.

According to the authors of the model, the ideal state for confidence in the team entails a low level of effort and risk assessment and a high level of other dimensions assessment. The relationships between the assessment of individual dimensions that shape themselves depending on the stage of a virtual team collaboration are also important. The model characteristic for the initial phase is presented later in this article (Figure 10).

The projects that have been used to create the C<sup>2</sup>NIWA community include the competitions organized by the Centre, motivating people implementing IT projects to use the C<sup>2</sup>NIWA environment while promoting it among potential users. The project included two major competitions, assuming the use of the different C<sup>2</sup>NIWA platforms to perform the tasks:

- the *Uwaga! Upadek!* competition aimed at creating the best application for detecting human falls registered in a video stream [18];
- the *Digital Triathlon*, on the other hand, included three contests: (1) a programming marathon aimed at developing a game for any platform which would promote the activities and mechanisms of the C<sup>2</sup>NIWA, (2) a contest for development of competition themes and a concept of solving a participant-selected problem related to digital exclusion of older people, implemented under the



Huwawei's "Seeds for the Future" programme, (3) Wiki-WS contest for the best picture vectorization algorithm of hand-drawn diagrams, aimed at developing and implementing a web service offering the web vectorization algorithm of hand-drawn diagrams [19].

Out of these contests, one relates to an individual task, "Seeds for the Future", whereas the rest are implemented in 3–4 person teams, whose work is monitored in accordance with the model shown above.

### 3. The *Uwaga! Upadek!* contest as an example of team motivation enterprise

The main objective of the *Uwaga! Upadek!* contest, organized at the Technical University of Gdańsk in the period 27.02–20.06.2015, is, according to its rules, "Developing an algorithm which would automatically recognize a person fall in the video recording and implementing the developed solution as a service based on the KASKADA supercomputing platform<sup>1</sup>". The task may taken up by teams of 3–4 individuals who will jointly develop an algorithm that analyses real-time video stream (*e.g.* from a camera monitoring system) and detects a person's fall. The final product of the competition is to be a service that runs on the KASKADA platform. The teams carrying out the competition task are to use the Redmine system and git repository available in the C<sup>2</sup>NIWA system [18].

In order to raise the potential contractors' interest in the task and in the participation, a motivational system was developed. It included:

- Defining the task in a way that would meet the criteria related to the needs of potential customers – the focus interviews conducted earlier showed *i.e.* that the attractiveness of the task is increased by its social usefulness. As a result, the task was presented as important from the point of view of modern monitoring systems, which are used *e.g.* in monitoring mass events, where the detection of a fall could facilitate the appropriate services' reaching the individual who has fallen because of the danger to their life or health;
- A package of attractive prizes: 10 000 PLN for the winning team and in-kind prizes for the second and third place (their adequacy was also earlier diagnosed in the target group of the competition);
- A proposal of a certificate confirming the implementation of an IT project that can be presented to prospective employers;
- A package of training and e-learning courses related to KASKADA and C<sup>2</sup>NIWA for competition participants;
- Activities related to the promotion of the competition task and the competition itself, which included: (a) the design of the contest logo and the distribution of promotional materials announcing the competition task, schedule and prizes in the competition, (b) contest promotion on the C<sup>2</sup>NIWA website and on YouTube (Figure 5) and (c) the promotional campaign of the competition, which was held

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1. KASKADA is a supercomputing platform allowing the processing of multimedia streams.





**Figure 5.** The promotional campaign of the competition, source: <http://tv.task.gda.pl/?p=2101>



**Figure 6.** Presentation of the competition on YouTube, [https://www.youtube.com/watch?v=Hps3zo\\_j-zM](https://www.youtube.com/watch?v=Hps3zo_j-zM)

on 3 March 2015 and during which the judo section of the Gdańsk University of Technology taught students falling down safely while gathering video material for use during the competition (Figure 6).

In addition, the students of the Faculty of Electronics, Telecommunications and Informatics of the Technical University of Gdansk will have the opportunity to receive 3 ECTS credits for developing solutions that will take the first three places in the competition.





The result of the activities promoting the competition were the entries of 17 teams, out of which 15 fully registered themselves and became qualified to participate in the contests. The participants of the *Uwaga! Upadek!* competition in addition to the competition task were required to participate in the tests of their predisposition to teamwork and to complete teamwork evaluation surveys supplied by the organizer of the competition three times.

The next chapter presents the results obtained in the first stage of the analysis of the team within the assessment of motivation to join the competition as well as the climate of teamwork and the level of trust in the competition team.

#### **4. Team motivation and climate evaluation** – research results

The initial stage of the study, which was carried out within two weeks from the start of the competition, was attended by 42 members representing 15 competition teams: two consisting of 4 individuals and fourteen consisting of 3 members (in four teams not all participants completed the electronic assessment surveys and the predisposition tests). The aim of the study was to assess the work climate, the level of trust in the team and the motivation of the contestants at the initial stage of cooperation.

The teamwork climate assessment was based on a 10-factor climate model. Each of the factors assessed by means of one questionnaire question was evaluated by the respondents in a 7-point Likert scale, where 1 was “definitely not” and 7 – “definitely yes”. The higher the score, the higher the rating of the given climate dimension in the team. The highest results were obtained for assessment of trust in the team (average 6.36), whereas the lowest for the indicator of active conflict resolution (5.88). It was the only score of less than 6 points, which indicates that all the contest participants evaluated the work climate in their teams positively. The average score for all the climate dimensions was as high as 6.15. It is worth noting that the measurement was made at the team formation stage, or “break-in”, characterized by a relatively high concentration on the task, getting to know each other, dividing roles and developing cooperation, which is not always conducive to a positive atmosphere [20]. The selection of the competition team members was based on the participants’ own preferences – most of them knew each other well before the start of cooperation, which could influence such a high result.

The detailed assessments of the work climate in competition teams are presented in Figure 7.

One of the dimensions of the climate is the motivation of the team members to engage in the task. The assessment questionnaire contained a question about the motivators that mobilized the participants to create a team and join the competition task (a multiple choice question). The most frequently mentioned reason for participation in the competition was the fact that the competition task was seen as an interesting IT challenge (90% of participants), as well as that the competition topic itself was interesting (69%). 52% of the respondents



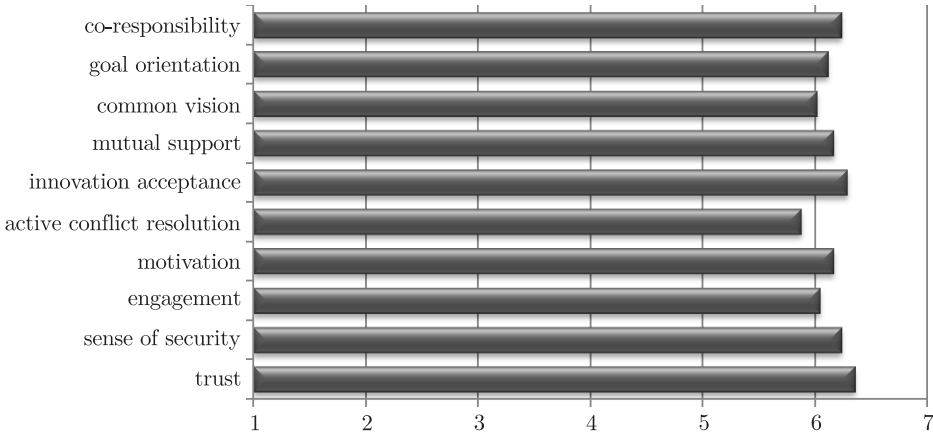


Figure 7. Assessment of work climate in competition teams, source: own work

were persuaded to take part in the competition by friends, 57% were tempted by interesting prizes and 57% said that the contest was an opportunity to gain professional experience.

The team trust assessments were made in 16 scales resulting from the previously mentioned models. Two questions were prepared for each factor – the respondents were asked to provide their evaluation on a 7-point Likert scale, where 1 was “definitely not” and 7 “definitely yes”, while the measure of performance for each factor was the average score obtained from a pair of respective statements. The results obtained by the competition participants in the ten dimensions of the ITTI model are presented in Figure 8.

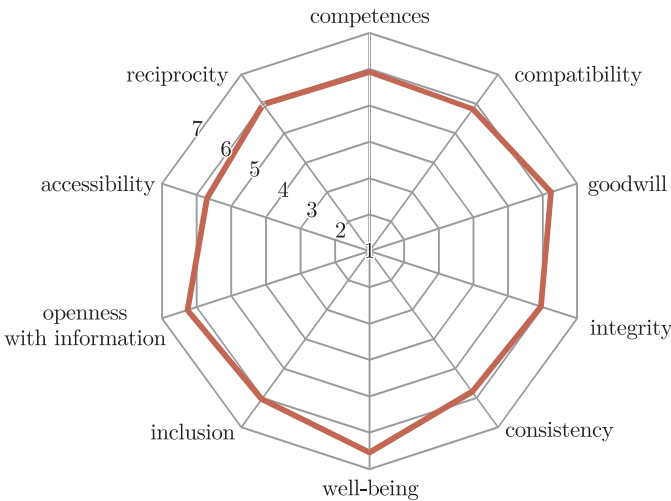
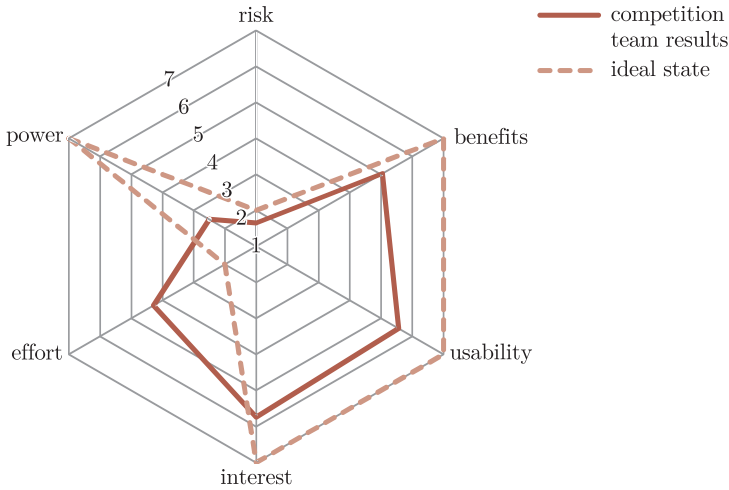


Figure 8. The rating of 10 dimensions of trust, source: own work

The results of all trust dimensions correlated significantly with the overall assessment of trust (as a dimension of teamwork climate) – the correlations were

at  $r = 0.6\text{--}0.7$ , and only in the event of competence  $r = 0.3$  ( $p < 0.5$ ). A sense of security assessment was rated highest (average 6.54), whereas availability was rated lowest (but still high – average 5.7).

The results for the dimensions of trust in the 6-factorial relational model are presented in Figure 9.

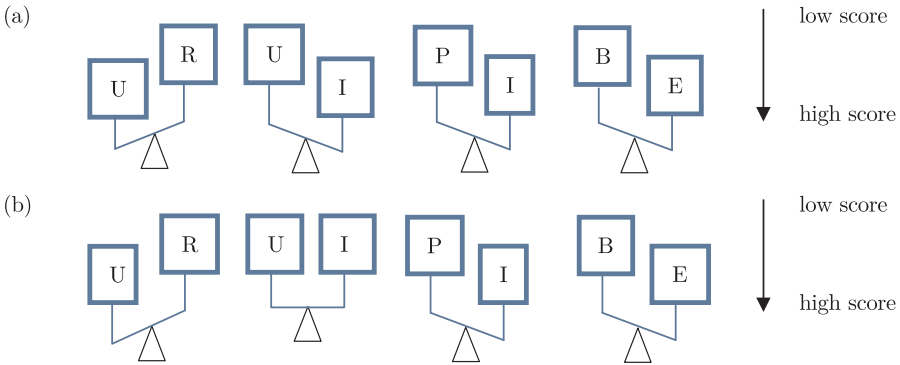


**Figure 9.** The assessment of trust dimensions in the Nolan model, source: own work

The comparison of results with the state of perfect trust in a virtual team allows noticing that the shape of the graph presenting the respondent ratings differs significantly in the case of evaluation of the effort put into the task, which the participants assessed at the average level (average 4.29), whereas for the remaining dimensions it is similar to the model graph. In the case of the Nolan's model it is far more important, however, to compare the results in the individual dimensions with each other. Figure 10 shows a model typical for the team construction initial phase of with proportions obtained in the conducted study.

The relations between the assessment of the usefulness and risk, between the value of personal gain and the effort put into the task, as well as between the domination and interest were consistent with the model typical for the initial stage of cooperation. The relations between the assessment of the usefulness and personal benefits were typical for the next, middle stage of the team's work.

The obtained results indicate that the studied teams recognize the value of cooperation for obtaining the solution of the competition task, while feeling the interest of other participants in their own person. They also feel safe in the team and although at this stage the effort seems to them greater than personal benefits, such benefits are equivalent to the appreciation of the value of the whole team. The respondents seem not to notice the domination of any of the team members, which may mean that the division of team roles, including the role of the leader, has not yet been clearly established.



**Figure 10.** The dimensions of confidence in the Nolan model: (a) a state typical for the initial phase, (b) the results obtained; U – utility value, R – risk, B – personal benefits, P – power, I – interest, E – the effort, source: own work on the basis of [17]

The correlation between the various dimensions of the Nolan model and the generalized assessment of the level of confidence in the competition teams is absent only in the case of domination. In other cases, it ranges from  $r = 0.48$  to  $0.59$ , while in the case of risk level assessment it is negative and amounts to  $r = -0.65$  for  $p < 0.05$ , which is consistent with the assumptions of the model. There is also a correlation between the dimensions of the 10-factorial and 6-factorial model – the relevant correlation matrix is presented in Table 1.

**Table 1.** The correlations between trust dimensions ( $p < 0.05$ ), source: own work

Trust dimension	R	B	U	I	E	P
Reciprocity	-0.37	<b>0.51</b>	0.43	<b>0.62</b>	0.23	0.00
Goodwill	<b>-0.56</b>	0.27	0.46	<b>0.76</b>	0.24	-0.16
Competence	-0.33	0.23	0.37	<b>0.51</b>	0.28	-0.36
Compatibility	<b>-0.55</b>	0.45	0.3	0.39	0.16	-0.14
Integrity and keeping promises	<b>-0.56</b>	0.32	0.47	<b>0.83</b>	0.39	-0.11
Consistency of behaviour	<b>-0.56</b>	0.33	<b>0.54</b>	<b>0.72</b>	0.25	-0.21
Well-being	<b>-0.63</b>	0.13	0.35	0.44	0.07	-0.2
Inclusion	<b>-0.54</b>	0.29	0.47	<b>0.64</b>	0.32	-0.22
Openness with information	<b>-0.65</b>	0.26	0.32	<b>0.69</b>	0.33	-0.32
Accessibility	-0.4	0.13	0.28	0.49	0.26	-0.27

The correlations above 0.50 are highlighted in the table to emphasize the most important dependencies between the variables from both models. The strongest correlations with the 10-factorial model refer to risk (R) and interest (I), which leads to the conclusion that the high assessment of ITTI trust dimensions is strongly linked to low perception of risk and high rating of attention and respect from the other members of the group. At this stage of cooperation the assessment

of personal gain correlates with the belief that one is a person trusted by others, whereas the usefulness of teamwork is associated with the belief that the behaviour of partners in cooperation is consistent, independent of the situation and based on respect for principles (of ethics and related to teamwork).

## 5. Conclusions

C<sup>2</sup>NIWA is an environment dedicated to the implementation of team projects. An important element of the project is the development of recommendations for the teams (especially virtual ones) implementing other projects in this environment, related to ways of selecting team members, the elements of cooperation worth paying attention in the context of building a positive working climate and the trust that is a difficult challenge in conditions of virtual communication. This can be achieved by testing the model of virtual teams work, which was developed within the project and whose verification is based on an analysis of the work of competition teams using C<sup>2</sup>NIWA. The above results of the evaluation of climate and trust in the work of teams working on a task within the *Uwaga! Upadek!* competition showed a high level of preliminary assessment of these dimensions – however, they should be treated only as a starting point for further analyses. The study has revealed that an important factor motivating the team members to engage in the performance of tasks in the innovative environment of C<sup>2</sup>NIWA is primarily the nature of the task itself and its topic.

At the first stage of cooperation an assessment of the suitability of the team members has been performed. It will be presented in the next article and used for further stages of analyses. The next research step will be the assessment of the work climate and trust in competition teams halfway through the work and after its completion. The assessment will be accompanied by opinion questionnaires related to the competition task, satisfaction and subjective evaluation of the effectiveness of the group. In addition, the analysis of the event log will be carried out for events recorded in the Redmine system according to scheme presented in the second part of the article. At the final stage of the competition the jury will assess the substantive value of the solutions developed by the teams, which will allow verifying the relationships between the predispositions of team members, the climate of teamwork and efficiency. The independent variable verified in the process of research will also be the level of team virtuality, measured by the share of electronic communications in the process of building relationships within the team.

Similar analyses will be conducted for other competition projects implemented within the C<sup>2</sup>NIWA and other projects carried out by users of the Centre. The correlations between the results at different stages of analysis will allow the development of advisory services dedicated to virtual teams and their leaders. Another open issue is the assessment of the KASKADA platform, and in particular the friendliness of the tools it has to offer.



It should be emphasized that the development of the model is also implemented using the C<sup>2</sup>NIWA resources, as collecting, archiving and processing such multidimensional data requires the support of modern technologies.

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