Knowledge Acquisition on Team Management Aimed at Automation with use of the System of Organizational Terms

Olaf Flak[1][a]
[1]*University of Silesia in Katowice, 3 Pawla Str., Katowice, Poland*
olaf.flak@us.edu.pl

Keywords: knowledge acquisition, team management automation, system of organizational terms.

Abstract: The aim of the paper is to present a new approach to knowledge acquisition on team management based on the original methodological concept called the system of organizational terms. The topic of knowledge acquisition on team management is important because of a lack of development in managerial work automation in recent years. The scientific problem is how to acquire knowledge on team management in the holistic, coherent and formalized way and how to represent team management in order to automate it. Both aspects of this scientific problem are described in this paper. On the one hand there is a common perspective met in management studies, and on the other hand also the original perspective of the system of organizational terms was presented. In the paper there is also a short description of a solution for this scientific problem and examples of previous research verifying the system of organizational terms as a method of knowledge acquisition on team management and team management representation aimed at automation this area of human life.

1 INTRODUCTION

After the first age of robotics in mechanical processes and manufacturing, rapid development of computer science has given opportunities to make some more sophisticated work automated (McAfee and Brynjolfsson, 2016). Especially, the last twenty years there has been a rapid change of information technology and an increase of replacing human work with machines or algorithms. However, it still not possible to employ a robot on a managerial position of a team. Why?

The first reason seems to be the characteristics of managerial work. Team managers do not have the luxury of standing back or outside of a situation in which they act. They have to take actions in the context of the situation. Despite the fact that an effective teamwork becomes more and more important for companies (Hoegl and Parboteeah, 2007), managerial actions lead to the consequences which managers are not able to foresee (Segal, 2011). A team manager and team members are the warp and woof of the dynamic fabric of cooperation. They cannot exist without each other combined together by managerial actions (Sohmen, 2013).

The second reason consists of three not-existing conditions: (1) a mutual basis for communication for an artificial manager and team members (shared concepts and their meanings) (Clark and Brennan, 1991), (2) prediction methods of human behavior in teamwork (Klein, Feltovich, Bradshaw and Woods, 2005), (3) a possibility of a real influence of an artificial manager on team members (Christoffersen and Woods, 2002).

Both reasons are equally important in the scientific problem of knowledge acquisition on managerial work aimed at team management automation and replacing human managers with robots (Flak, 2017b).

In this perspective the crucial issue of knowledge on team management has always come to a simple question: what does a team manager really do? (Sinar and Paese, 2016) Therefore, the scientific problem concerns (1) a succession of managerial actions done one after another by a team manager, and (2) their content.

As the result of defining this scientific problem there is a research question: can it be a holistic, coherent and formalized methodological concept of management sciences, which allows to build real

[a] https://orcid.org/0000-0001-8815-1185

knowledge on team management aimed at team management automation?

The aim of this paper is to present the answer to this research question in the perspective of team management knowledge acquisition and representation. In Section 2 there are the literature review of knowledge acquisition in management science and team management representation. In Section 3 there are a description of a methodological concept called the system of organizational terms together with research tools which are the main contribution in the area of knowledge acquisition and representation. Section 4 contains examples of building knowledge on team management ready to use in team management automation. Section 5 is focused on challenges and further directions of studies in the field of team management automation.

2 KNOWLEDGE ON TEAM MANAGEMENT

2.1 Traditional knowledge acquisition models in management science

Knowledge on any issues can concern a few dimensions of reality named by questioning pronouns: what, how, who, when, where, why? It is also possible to distinguish knowledge called "knowledge: what" and "knowledge: how". This first type of knowledge is also named as theoretical knowledge and the second type is used to be seen as practical knowledge (El-Sayed, 2003).

In the management studies we can find a wide range of approaches to creating knowledge on team management. One of the main division in this context contains two types of knowledge: tacit and explicit knowledge (Matos, Lopes, Rodrigues and Matos, 2010). This is the way of creating tacit knowledge as a result of team work and it is based on an intellectual capital of team members. Explicit knowledge is created by the processes taken by team members on the ground of tacit knowledge.

The second method of knowledge acquisition presents the model of El-Sayed. This model contains four stages of creating tacit knowledge changing into explicit knowledge and on the other way. This process is extremely dynamic and it proceeds as it follows. Tacit knowledge on team management changes into explicit knowledge by the means of socialisation processes and creating physical things by teamwork. After this combination explicit knowledge on organizational reality appears. Then, by the process of learning, team members acquire new tacit knowledge which are represented by socialisation processes and physical things created by team members etc. This cycle can last forever (El-Sayed, 2003).

The third way of knowledge acquisition in management science comes from B. Russel, who created a term "knowledge by description". This type of knowledge acquisition concerns a set of rules which we combine with a certain physical or mental thing in the organizational reality. This type of knowledge can be used in description rather than in finding fundamental laws of the world (Amijee, 2013). Comparing to tacit and explicit knowledge this way of knowledge acquisition does not lead to any innovations and new achievements (Aligica, 2003).

The fourth division of approaches in knowledge acquisition in management science is presented in Table 1. This is possible to distinguish two approaches: functionalism and constructivism Darmer 2000).

Table 1: Functionalism and constructivism in knowledge acquisition

	Functionalism	Constructivism
Ontology	realism	relativism
Epistemology	narrow objectivity	subjectivity
Methodology	experiments	mixed methods
Main question	what effective management means?	what is management?
Goal	development of management	cognition of management
Results	normative	descriptive

The fifth group of knowledge acquisition approaches are based on ontological and epistemological assumptions in organizational reality research. In these two important areas of every science there are two main questions: (a) from ontological point of view – do theories describe the reality, (b) from epistemological point of view – do theories lead to the truth? (Kilduff, Mahra and Dunn, 2011). Based on that four approaches to knowledge acquisition are presented in Table 2.

Table 2: Ontological and epistemological questions in knowledge acquisition

		Epistemology: do the theories lead to the truth?	
		Yes	No
Ontology: do the theories describe the reality?	Yes	realism	following paradigms
	No	foundationalism	instrumentalism

The sixth approach to knowledge acquisition in management science is a model of internal and external knowledge. This model is quite similar to the model which contained tacit and explicit knowledge, however, internal and external knowledge is stable in time (Jaime, Gardoni and Mosca, 2006).

The similar approach is the seventh one presented by Chalmeta and Wrangel (2008). They define target knowledge which is a result of tacit and explicit knowledge. They claim, similarly to Matos, Lopes, Rodrigues and Matos (2010), that tacit knowledge is hidden in people's minds and explicit knowledge is placed in organizational documents.

As it can be reckoned from this short review of approaches to knowledge acquisition on team management, there are not effective approaches of building precise knowledge on the organizational reality which would be holistic, coherent and, what is more important, formalized in order to use it in team management automation. Therefore, the original approach to knowledge acquisition, which meets these three parameters, was designed and it is presented in Section 3.

2.2 Dominating team management representations

As there is a lack of a stable and reliable approach to knowledge acquisition in management science, the same situation concerns team management representation. The view of managerial work has been changed since the scientific management was born. At the beginning of 20th century the picture of a manager was defined by his classical functions (set of activities), such as a planner, an organizer, a motivator and a controller (Fayol, 1916). 50 years later a view of a manager was dominated by two approaches and it has lasted until today.

Firstly, in 1964 Koontz and O'Donneil (1964) launched a discussion on the meaning of managerial skills. A few years later an approach in which managerial work was represented by managerial skills was proposed (Katz, 1974). The managerial skill was than defined as an ability to work effectively as a team manager in order to build cooperative effort within the team (Katz, 1974). A dominating typology of managerial skills divides skills into 3 groups: technical, interpersonal and conceptual. Technical skills were regarded as most important for supervisors, interpersonal skills for middle managers, and conceptual skills for executives (Kaiser, Craig, Overfield and Yarborough, 2011). This approach to skills has been developed over decades and one of the latest typologies contains such skills as critical thinking, problem solving, an ability to organize data, conceptual thinking, evaluating ideas, persuasive skills etc. (Ullah, Burhan and Shabbir, 2014).

Secondly, in 1980 Mintzberg concluded that the managerial work in a team can be described in terms of 10 roles within interpersonal, informational and decisional areas which were common to the work of all types managers. He defined a managerial role as an area of job activities which is undertaken by a manager (Mintzberg, 1980). Mintzberg introduced to the management science a typology of managerial roles which contains such roles: a figurehead, a leader, a liaison, a monitor, a disseminator, a spokesman, an entrepreneur, a disturbance handler, a resource allocator, a negotiator (Mintzberg, 1980). Other researchers of team management proposed other divisions of roles, such as a leader, a peer, a conflict solver, an information sender, a decision maker, a resources allocator, an entrepreneur, a technician (Pavett and Lau, 1982) or an explorer, an organizer, a controller, an adviser (McCan and Margerison, 1989).

Managerial skills and managerial roles have influenced scientists and practitioners so much, that most of research on managerial work was designed as a research either on managerial skills or managerial roles. The examples of published results of such studies during last 50 years:

- The nature of the skills involved in managerial jobs; Managers in 32 manufacturing firms in the Madison-Milwaukee industrial area (McLennan, 1967).
- Measuring the process of managerial effectiveness in relations with specific behaviour and activities characteristic of managerial work; Managers from 6 companies in the US (Morse and Wagner, 1978).
- Importance of Mintzberg's roles across several different functional areas, including a relatively ignored segment of the managerial population—namely, the general manager;

Managers and executives representing a wide variety of private sector service and manufacturing firms in southern California (Pavett and Lau, 1982).

- Investigation on the managerial roles of the chief information officer (CIO) based on Mintzberg's classic managerial role model; Companies randomly selected from the 1991 listing of Fortune 1000 companies (Grover, Jeong, Kettinger and Lee, 1993).
- Relationships between creativity style, as measured by the Kirton Adaption Innovation Inventory (KAI) and the self and other ratings on a 360-degree feedback instrument, the Management Skills Profile (MSP); Managers who were mid-career MBA students attending a part-time evening programme in a medium-sized south-eastern state university in the United States (Buttner, Gryskiewicz and Hidore, 1999).
- Employees' attitudes and performance as measures of managerial effectiveness. Middle managers in numerous US facilities of a large, high-technology, non-traditional firms (Shipper and Davy, 2002).
- Perception of the role of the manager which contributed to changes in everyday managerial practices. CEO of the companies employed between slightly fewer than 2,000 persons to almost 15,000 persons and the combined market value of the three listed companies exceeded US$12 billion at the time of study (Tengblad, 2006).
- Female and male managers communication skills; Managers of an organization located in the San Francisco, Bay Area (Kaifi and Noori, 2011).
- Global management skill sets and capabilities among multinational corporations; Senior executives from multinational organizations in North America and India (Ananthram and Nankervis, 2013).
- Status of managerial skills, features of organisational climate and the interaction of managerial skills with organisational climate; Managers in educational service sector (Vandana and Dhull, 2014).
- Importance for each managerial role in using managerial skills; MBA students (Ullah, Burhan and Shabbir, 2014).
- Importance of values and skills of managers; Senior lean experts employed by a single Dutch medium-sized management (van Dun, Hicks and Wilderom, 2015).
- Management skills of retail companies; Team leaders in retail companies (Mihalcea and Mihalcea, 2015).
- Actions of great leaders, the definition of an effective leader, factors need to be considered to identify the right leaders who can successfully transition into higher-level roles; Team leaders in 300 organizations, 20 industries and 18 countries (Sinar and Paese, 2016).

Based on the review presented above, it is possible to draw a conclusion that managerial skills and managerial roles are traditional theoretical concepts commonly used to represent team management. However, these terms still do not recognize what a team manager really does (Sinar and Paese, 2016). So that, it is not possible to recognize (1) a succession of managerial actions done one after another by a team manager, and (2) their content. The answer to this question is presented in Section 3 and it is the main contribution in this paper to the problem of knowledge acquisition on team management aimed at automation.

3 THE SYSTEM OF ORGANIZATIONAL TERMS METHODOLOGY

3.1 Knowledge acquisition based on the system of organizational terms

The first aspect of the scientific problem mentioned in Section 1 concerns achieving a precise and coherent view of team managerial work which could be efficiently used in team management automation. There comes a challenge, how to represent a succession of different types of managerial actions one after another done by a team manager. The pioneering answer to this challenge is the system of organizational terms, which is a complex of ontological and epistemological aspects designed for managerial action patterns research (Flak, 2013; Flak 2020).

The ontological assumption of the system of organizational terms is that every fact in the organizational reality can be represented by the organizational term (Zalabardo, 2015). The organizational term is a symbolic object which can be used as an element of the organizational reality model (Rios, 2013) and it is a close analogy to a physical quantity in the SI unit (length, mass, time etc.).

It is assumed that the organizational terms are abstract objects which are used to represent the facts which appear in the organizational reality. The features of the organizational term, on the one hand, come from its definition and, on the another hand, derives from causal relations or occurrence relations with other organizational terms (Backlund, 2000).

The philosophical foundation of the system of organizational terms is based on Wittgenstein's philosophy: his theory of facts (the only beings in the world) and "states of facts" (Brink and Rewitzky, 2002). According to this approach managerial actions can be organised by events and things. Specifically, as shown in Figure 1, each event and thing have the label n.m, in which n and m represent a number and a version of a thing, respectively. Event 1.1 (set 1.1) causes thing 1.1 (goal 1.1), which in turn releases event 2.1 (generate 2.1) that creates thing 2.1 (idea 2.1). Thing 1.1 (goal 1.1) simultaneously starts event 3.1 (describe 3.1) which creates thing 3.1 (task 3.1). Then, thing 3.1 (task 3.1) generates the second version of the first event, i.e. event 1.2 (goal 1.2). So, the managerial action structure consist of, e.g. event 1.1 and thing 1.1 (in the system of organizational terms called a derivative and primal organizational term, respectively).

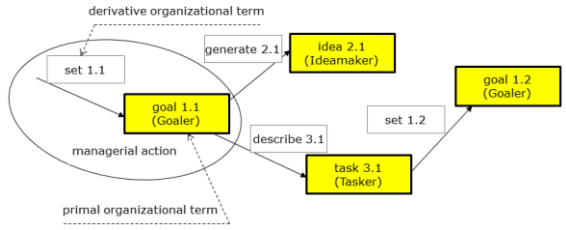

Figure 1: Fundamental structure of managerial actions

According to the logical division, organizational terms are divided into two classes: primal and derivative organizational terms. Facts, which are things (primal organizational terms) in the organizational reality, represent resources (Barney, 1991). Facts, which are events (derivative organizational terms) in the organizational reality, represent processes in the organization (Brajer-Marczak, 2016). By the same token, the system of organizational terms combines the resource approach and the process approach in the management science. It combines processes which effect in resources. In pairs they create managerial actions.

Features of managerial actions are grouped in time, content and human relations domains. They show how much two managerial actions differ from one another or one managerial action differs from itself in the function of time.

Such an approach to ontology of team managerial work lets represent all managerial activities by standardized features vectors with data grouped in time and content (Flak, Yang and Grzegorzek, 2017).

Comparing this approach to the team management representation described in Section 2 it is possible to assume that the answer to the question "what does a team manager really do?" seems to be hidden in the relation between managerial roles and managerial skills. In order to play managerial roles a team manager should have some managerial skills (Pavett and Lau, 1983). It results in understanding playing managerial roles within their managerial skills by day-to-day activities of managers effects in the managerial actions, which these managers make. Therefore, the managerial action can be defined as a real activity, which a manager does in order to play a managerial role and have a certain managerial skill (Flak, Yang and Grzegorzek, 2017).

3.2 Research tools aimed at building knowledge on team management

The second aspect of the scientific problem mentioned in Section 1 concerns focusing on the content of the managerial actions. This challenge needs a special method of gathering data on team managerial actions. The data should be recorded in a way, which allows to represent a team manager by managerial actions, that take place in a team, which he leads. That is why, the content of managerial actions should be represented by a scalable vector. The best way of recording team managerial actions by research tools is using online management tools or other electronic devices, which a team manager and his team members use during day-to-day work (Flak, 2017a). The innovative tools of recording information in time and content domains are embedded in the TransistorsHead.com platform, which is a complex of online management tools designed for a modern and contemporary method of time and motion study.

In order to get such data about managerial actions, one of the epistemological assumption of the system of organizational terms is, that the main research method is an objective long-term observation (Midgley, 2003). The measurement of a managerial action is defined as an assignment of a certain set of values to a certain set of managerial action features (Mari, 2005). It is designed so that the features of any managerial action can be measured by a research tool which gathers data about the primal organizational

term (a thing in the fundamental structure of a managerial action – Figure 1 – which means a resource in the organizational reality) (Chopraa and Gopal, 2011).

As it is shown in Figure 1, when a team manager sets a goal (a managerial action represented by event 1.1 - setting 1.1 and thing 1.1 - goal 1.1), the research tool called "Goaler" records features of goal 1.1 in time and content domains. If later (e.g. after describing a task – describing 1.1 and task 1.1) this team manager does the next setting of the same goal, he launches the next managerial action. Then the features of this managerial action are changed and represent the second version of this managerial action (setting 1.2 and goal 1.2). The difference between managerial action features of goal 1.2 and goal 1.1. let do reasoning on the events which happened in this period of time (Flak, 2017a).

From the theoretical point of view online management tools have such features:

- according to the idea of an „unit of behaviour" (Curtis, Kellner and Over, 1992) every online management tool tracks and records one specific team managerial action,
- when a team manager uses any online management tool it is equal a process which results in a resource, respectively (Flak, 2017a),
- every management tool is designed for recording a certain team managerial action (Flak, 2017a).

Such online management tools were implemented as online management tools called TransistorsHead.com available at the website browser. This platform was designed by the author of this paper and it consists of 10 different tools to track 10 separate managerial actions (Flak, Hoffmann-Burdzińska, Yang, 2018). Table 3 contains the names of online managerial tools, their numbers (which are necessary to read the Figures 2, 3, 4), and names of managerial actions. In Table 4 there are functions of the online management tools.

Table 3: TransistorsHead.com structure

Name of managerial tools in TransistorsHead	Number of managerial actions	Name of managerial actions
set goals	1	set goals
describe tasks	2	describe tasks
generate ideas	3	generate ideas
specify ideas	4	specify ideas
create options	5	create options
choose options	6	choose options
check motivation	7	check motivation
solve conflicts	8	solve conflicts
prepare meetings	9	prepare meetings
explain problems	10	explain problems

Table 4: Functions of online management tools

Tool	Application of the tool during teamwok
Set goals	Agreeing on the goals of the project, actions to be taken, etc. (what is the overall goal of the project?).
Describe tasks	Describing tasks that will have to be performed in order to achieve the overall goals.
Generate ideas	Generating ideas (brainstorming) about performing the tasks (who, how, when, where) and solving potential problems.
Specify ideas	Describing in detail the ideas and solutions.
Create options	Creating options for decision making (deciding which options are the best and which options the team will choose as the final ones).
Choose options	Selecting and deciding which options will be chosen as the most beneficial for the participants according to criteria that determine this (what is the most important aspect/criterium).
Check motivation	Checking the level of motivation of the team members according to Maslow's theory of basic needs.
Solve conflicts	Analyzing reasons for potential conflicts among the team members, coming up with possible solutions to these conflicts.
Prepare meetings	Preparing agenda for a meeting based on the law of demand and supply, known in economy. The agenda allows for using the potential in the team and knowledge of participants.
Explain problems	Explaining business problems or tasks by analysis of keywords in sentences.

4 EXAMPLES OR RESEARCH RESULTS

4.1 Knowledge on succession of managerial actions

In the last few years there were a dozen experiments aimed at checking if the system of organizational terms can be a new knowledge acquisition method useful in team management automation.

Concerning the first aspect of the scientific problem mentioned in Section 1 (a succession of managerial actions done one after another by a team manager) it is possible to show results of one of such experiments. In 2019 students of Human Relations Management at the Faculty of Psychology at the University of Silesia in Katowice, Poland, were to conduct a given project from an idea to a final presentation. The students were working in teams of 4-5, every one of which had a defined manager who was leading it.

Firstly, Table 5 shows how many separate managerial actions were taken by every manager, when they started and finished their work and how much time their teamwork took in this project.

Table 5: General statistics on managerial actions taken by managers

Manager no.	Total number of managerial actions	Date of start dd.mm hh:mm	Date of finish dd.mm hh:mm	Period of teamwork (in seconds)
Manager 1	293	14.05 10:55	28.05 10:20	1207523
Manager 2	328	14.05 10:53	28.05 21:57	1249484
Manager 3	446	14.05 10:53	01.06 18:13	1581591

Secondly, managers were managing teams by online management tools that recorded their managerial actions. Owing to the fact, it is possible to present the trajectory of 10 recorded managerial actions on a timeline in histograms of team management. The trajectories of all managers are presented in Figures 2 to 4, respectively. Numbers in types of managerial actions mean: 0 – no managerial action, 1 – set goals, 2 – describe tasks, 3 – generating ideas, 4 – specifying ideas, 5 – creating option s, 6 – choosing options, 7 – checking motivation, 8 – solving conflicts, 9 – preparing meetings, 10 – explaining problems. The figures shows 100 chosen moments of managerial actions recorded approximately in the middle of the team work period shown in Table 5.

As it can be recognized, all team managers had different trajectory of their managerial actions even than they were working on the same projects. The succession of managerial actions done one after another by every team manager was completely different. This shows that the system of organizational terms together with special measurements tools (which is separate problem and area of design) lets us solve the first aspect of the scientific problem shown in Section 1. We can achieve a knowledge on a succession of managerial actions done one after another by a team manager.

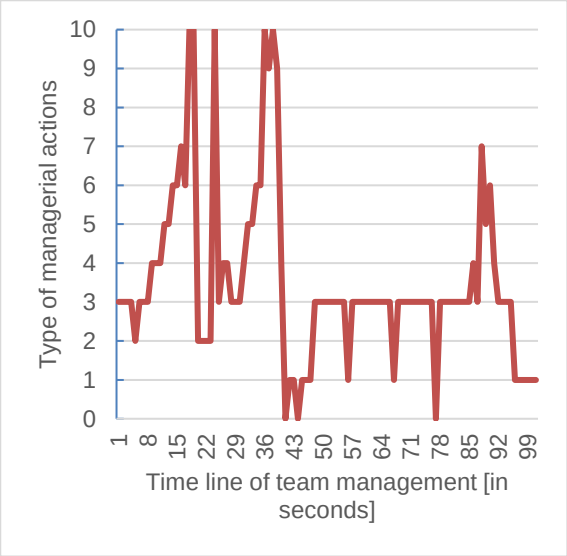

Figure 2. Trajectory of team management by Manager 1

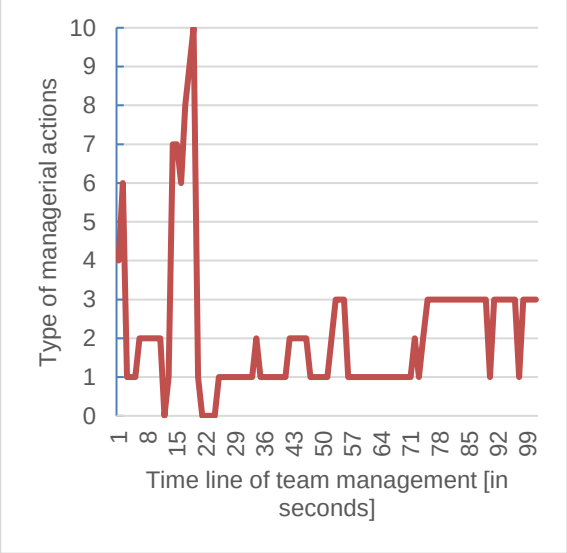

Figure 3. Trajectory of team management by Manager 2

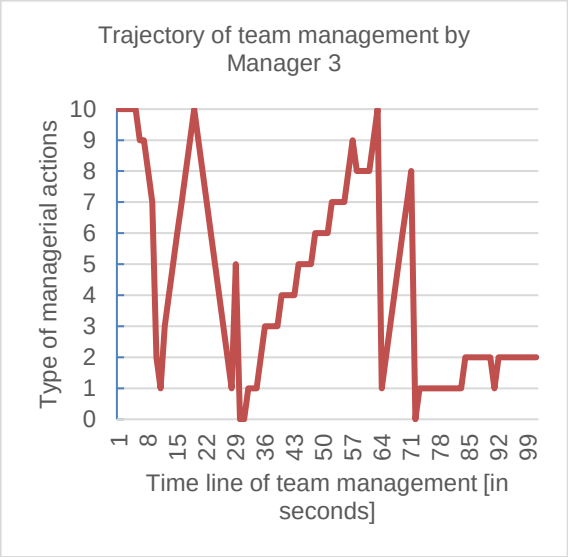

Figure 4. Trajectory of team management by Manager 3

4.2 Knowledge on managerial actions content

Concerning the second aspect of the scientific problem mentioned in Section 1 (content of managerial actions) as an example can be the results of the experiment which was conducted in 2018. Business students from one of the universities of applied sciences in Helsinki took part in it. They were divided into seven teams, each of which consisted of five members and a team manager. The teams got the task of preparing a training program for teachers of their university (Flak, 2018).

In Table 6 there is content of a goal set by one of the participants of the research in the first and the second version. According to Figure 1, the manager set this goal 1.1. and then reset it – we have a goal 1.2. How this goal changed during the time of team management (which happened between the first and the second version) it is shown in Table 6. This shows that the system of organizational terms lets us also solve the second aspect of the scientific problem presented in Section 1. We record not only a succession of managerial actions but also a content of every managerial action. This gives us knowledge what are parameters of managerial actions in their feature vectors.

Table 6: Content of a goal in two following versions

Number of a goal	1	1
Version of a goal	1	2
Future vision after achieving a goal	We employ young, ambitious people to new project groups called C-LAB and to new projects of a company. A brand of our company is well known on the market.	We employ young and ambitious employees. We have no project groups called C-LAB.
Name of a goal	Workshops for teenagers	Workshops for teenagers
Way of setting a time of achieving a goal	period	period
hours	0	0
days	0	0
weeks	0	0
months	0	5
years	1	0
Measurer 1	Finding cheap employees	Low salary for employees
Measurer 2	Increase of peoples knowledge on animation	Middle experience of participants
Measurer 3	3 innovations in social media	1 innovation in social media
Measurer 4	Employment of new workers to project groups	New advertisement in radio
How much is this goal real to achieve?	Mostly yes	Completely
How much does this goal belong to your duties?	Partly	Mostly no
What is the business area of this goal?	Human resources management	Human resources management
Is this goal shortterm or longterm?	longterm	shortterm
Is this goal operational or strategic?	operational	strategic
Who is responsible for this goal?	My team	My team

5 CONCLUSIONS

The system organizational terms as a method of knowledge acquisition on team management can help to solve the scientific problem of getting real knowledge what the manager really does. In this concept the source of cognition is an observation of the organisational reality in independent of the cognition subject.

It is assumed that the source of information is the fact which occurs in the organisational reality. That information can be converted into data, while data can be turned into knowledge about organisational reality. Therefore knowledge about the organisational reality can be largely objective. It is normative knowledge and it is represented by sentences formulated in a language.

As it was shown in Section 4, both succession of team managerial actions and their content can be capture by using the system of organizational terms together with dedicated measurement tools. This type of knowledge acquisition is the first step to answer to the research question "what does the team manager really do?" aimed at automation of these managerial actions.

The next step towards team management automation and effective replacement human managers with robots is to implement some pattern recognition techniques and machine learning techniques which could lead to launch automated managerial actions in team management.

REFERENCES

Aligica, P. D. (2003). *Prediction, Explanation and the Epistemology of Future Studies*. *Futures, 35*, 1027-1040.

Amijee, F. (2013). The Role of Attention in Russell's Theory of Knowledge. *British Journal for the History of Philosophy, 21*(6), 1175-1193.

Ananthram, S., & Nankervis, A. (2013). Global managerial skill sets, management development, and the role of HR: an exploratory qualitative study of north American and Indian managers. *Contemporary Management Research, 9*(3), 299-322.

Backlund, A. (2000). The definition of system. *Kybernetes, 29*(4), 444-451.

Barney, J.B. (1991). Firm resources and sustained competitive advantage. *Journal of Management, 17*(1), 99-120.

Brajer-Marczak, R. (2016). Elements of knowledge management in the improvement of business processes. *Management, 20*(2), 242-260.

Brink, C. & Rewitzky, I. (2002). Three dual ontologies. *Journal of Philosophical Logic, 31*(6), 543-568.

Buttner, E. H., Gryskiewicz, N., & Hidore, S. C. (1999). The Relationship between styles of creativity and managerial skills assessment. *British Journal of Management, 10*, 228-238.

Chalmeta, R., & Wrangel, R. (2008). Methodology for the Implementation of Knowledge Management Systems. Journal of the American Society for Information Science and Technology, 59(5), 742-755.

Chopraa, P. K., & Gopal, K. K. (2011). On the science of management with measurement. *Total Quality Management, 22*(1), 63-81.

Christoffersen, K., & Woods, D. D. (2002). How to make automated systems team players. *Advances in Human Performance and Cognitive Engineering Research, 2*, 1-12.

Clark, H. H., & Brennan, S. E. (1991). Grounding in communication. In L. B. Resnick, J. M. Levine, & S. D. Teasley (Eds.), *Perspectives on Socially Shared Cognition* (pp. 127-149). American Psychological Association.

Curtis, B., Kellner, M., & Over, J. (1992). Process modelling. *Communications of the ACM, 35*(9), 75-90.

Darmer, P. (2000). The subject(ivity) of management. *Journal of Organizational Change Management, 13*(4), 334-351.

El-Sayed, A. Z. (2003). What can Methodologist Learn from Knowledge Management? *The Journal of Computer Information Systems, 43*(3), 109-117.

Fayol, H. (1916). *Administration industrielle et generate*. Paris: Dunod.

Flak, O. (2013). Theoretical foundation for managers' behavior analysis by graph-based pattern matching. *International Journal of Contemporary Management, 12*(4), 110-123.

Flak, O. (2017a). Methodological foundations of online management tools as research tools. In: V. Benson, F. Filippaios (Eds.), *Proceedings of the 16th European Conference on Research Methodology for Business and Management Studies ECRM2017*, 113-121.

Flak, O. (2017b). Selected Problems in Team Management Automation. Acta Universitatis Nicolai Copernici - Zarządzanie, 4, 187-198, ISSN 1689-8966

Flak, O. (2020). System of organizational terms as a methodological concept in replacing human managers with robots. W: Advances in information and communication. Proceedings of the 2019 Future of Information and Communication Conference (FICC), 471-500.

Flak, O., Hoffmann-Burdzińska, K., & Yang, C. (2018). Team Managers Representation and Classification Method based on the System of Organizational Terms. Results of the Research. Journal of Advanced Management Science, 6(1), 13-21.

Flak, O., Cong, Y., & Grzegorzek, M. (2017). Action Sequence Matching of Team Managers. In: *Proceedings of the 5th International Conference on Pattern Recognition Applications and Methods ICPRAM*, February 24-26, Porto, Portugal, 386-393.

Grover, V., Jeong S-R., Kettinger, W.J., & Lee, C.C. (1993). The chief information officer: a study of managerial roles. *Journal of Management Information System, 10*(2), 107-130.

Hoegl, M., & Parboteeah, K.P. (2007). Creativity in innovative projects: how teamwork matters. *Journal of Engineering and Technology Management, 24*(1–2), 148-166.

Jaime, A., Gardoni, M., & Mosca, J. (2006). From Quality Management to Knowledge Management in Research Organisations. *International Journal of Innovation Management, 10*(2), 197-215.

Kaifi, B. A., & Noori, S. A. (2011). Organizational behavior: a study on managers, employees, and teams. *Journal of Management Policy and Practice, 12*(1), 88-97.

Kaiser, R. B., Craig, S. B, Overfield, D. V., & Yarborough, P. (2011). Differences in managerial jobs at the bottom, middle, and top: a review of empirical research. *The Psychologist-Manager Journal, 14*(2), 76-91.

Katz, R. L. (1974). Skills of an effective administrator. *Harvard Business Review, 52*(5), 90-102.

Kilduff, M., Mahra, A., & Dunn, M. B. (2011). From Blue Sky Research to Problem Solving: A Philosophy of Science Theory of New Knowledge Production. *Academy of Management Review, 36*(2), 297-317.

Kimberley, A., & Flak, O. (2018). Culture, Communication and Performance in Multi and Mono-Cultural Teams: Results of a Study Analysed by the System of Organisational Terms and Narrative Analysis. In: Proceedings of the 17th European Conference on Research Methodology for Business and Management Studies ECRM2018, 199-207.

Klein, G., Feltovich, P. J., Bradshaw, J. M., & Woods, D. D. (2005). Common ground and coordination in joint activity. In W. R. Rouse & K. B. Boff (Eds.), *Organizational Simulation* (pp. 139-178). John Wiley & Sons.

Koontz, H., & O'Donneil, C. (1964). *Principles of management*. New York: McGraw-Hill.

Mari, L. (2005). The problem of foundations of measurement. *Measurement, 38*(4), 259-266.

Matos, F., Lopes, A., Rodrigues, S., & Matos, N. (2010). Why Intellectual Capital Management Accreditation is a Tool for Organizational Development? *Electronic Journal of Knowledge Management, 8*(2), 235-244.

McAfee, A., & Brynjolfsson, E. (2016). Human work in the robotic future: Policy for the age of automation. *Foreign Affairs, 95*(4), 139-150.

McCan, D., & Margerison, Ch. (1989). Managing high-performance teams. *Training & Development Journal, 10*, 53-60.

McLennan, K. (1967). The manager and his job skill. *Academy of Management Journal, 10*(3), 235-245.

Midgley, G. (2003). Science as systemic intervention: some implications of systems thinking and complexity for the philosophy of science. *Systemic Practice and Action Research, 16*(2), 77-97.

Mihalcea, A., & Mihalcea, D. (2015). Management skills assessment using 360° feedback - MSF 360. *Procedia - Social and Behavioral Sciences, 187*, 318-323.

Mintzberg, H. (1980). *The nature of managerial work*. New York: Prentice-Hall.

Morse, J. J., & Wagner, F. R. (1978). Measuring the process of managerial effectiveness. *Academy of Management Journal, 21*(1), 23-35.

Pavett, C. M., & Lau, A. W. (1982). Managerial roles, skills, and effective performance. *Academy of Management Proceedings*, 95-99.

Pavett, C. M., & Lau, A. W. (1983). Managerial work: the influence of hierarchical level and functional specialty. *Academy of Management Journal, 26*(1), 170-177.

Rios, D. (2013). Models and modeling in the social sciences. *Perspectives on Science, 21*(2), 221-225.

Segal, S. (2011). A Heideggerian perspective on the relationship between Mintzberg's distinction between engaged and disconnected management: the role of uncertainty in management. *Journal of Business Ethics, 103*, 469-483.

Shipper, F., & Davy, J. (2002). A model and investigation of managerial skills, employees' attitudes, and managerial performance. *The Leadership Quarterly, 13*, 95-120.

Sinar, E., & Paese, M. (2016). The new leader profile. *Training Magazine, 46*, 46-50.

Sohmen, V.S. (2013). Leadership and teamwork: Two sides of the same coin. *Journal of Information Technology and Economic Development, 4*(2), 1-18.

Tengblad, S. (2006). Is there a 'New Managerial Work'? A comparison with Henry Mintzberg's Classic Study 30 years later. *Journal of Management Studies, 43*(7), 1437-1461.

Ullah, F., Burhan, M., & Shabbir, N. (2014). Role of case studies in development of managerial skills: evidence from Khyber Pakhtunkhwa Business Schools. *Journal of Managerial Sciences, 8*(2), 192-207.

Ullah, F., Burhan, M., & Shabbir, N. (2014). Role of case studies in development of managerial skills: evidence from Khyber Pakhtunkhwa Business Schools. *Journal of Managerial Sciences, 8*(2), 192-207.

van Dun, D. H., Hicks, J. N., & Wilderom, P. M. (2015). Values and behaviors of effective lean managers: Mixed-methods exploratory research. *European Management Journal, 35*(2), 174-186.

Vandana, B. K., & Dhull, P. I. (2014). An exploration of managerial skills and organizational climate in the educational services. *Journal of Services Research, 4*(1), 141-160.

Zalabardo, J. (2015). *Representation and reality in Wittgenstein's Tractatus*. Oxford: Oxford University Press.