System of Organizational Terms as a Theoretical Foundation for Team Management Automation

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ABSTRACT

The main scientific objective of the paper is to present a methodological concept called the system of organizational terms which could enable replacing human managers with algorithms. The research problem in the paper concerns a possibility of replacing human managers with robots in the field of team management. The research problem can be described by a research question, which should be answered before implementing team management automation. The question is: what does a team manager really do? The research problem entails a hypothesis: if we could know what a team manager really does, we could imitate them in managing their team. When this hypothesis is true, we could implement team management automation based on recorded managerial behavior. Going back to the classical point of view on management, this would be a real accomplishment of Drucker's words that in the future "computers" will not only make decisions but they will do much more. In order to solve this research problem the system of organizational terms was designed. The system of organizational terms is a (1) holistic, (2) coherent and (3) formalized methodological concept of management sciences, which allows to practice management sciences in such a way that some fields of team management could be automated. In this paper there are presented traditional theoretical approaches to team management as a foundation for a team management representation in a holistic, coherent and formalized methodological concept. There are also examples of its previous verifications aimed at team management automation.

CCS Concepts

• **Computing methodologies → Cognitive science • Computing methodologies → Cognitive robotics • Applied computing → Business process management systems • Human-centered computing → User models • General and reference → Metrics**

Keywords

System of organizational terms; Team management automation; Online management tools.

1. INTRODUCTION

More and more areas of human life are developed or replaced by machines and robots. After the first age of robotics in mechanical processes and manufacturing rapid development of computer science and the Internet gives opportunities to replace some cognitive operations done by team managers with algorithms. This idea can be shaped by the idea of an intelligent knowledge system in an organization. There are many different theoretical approaches to these issues. For example, knowledge management in organizations is defined as a process which enables creating, distributing and using knowledge in practical ways in order to develop efficiency of the organizations. Nowadays there are many information systems for knowledge management in organizations and teams focusing on sale, distribution or production. However, the idea of replacing human managers with algorithms is emerging in the organizational environment also in the field of consultancy, stock exchange or market analysis.

Nevertheless, there is still a lack of research in the field of team management automation. Despite the fact that it is common to track activities of Internet users or some online applications (e.g. Google apps, planners etc.), there is hardly any research aimed at data about managers' behavior. It seems there are several reasons for it – for instance, it is not easy to imitate human managers' behavior and it is completely impossible to employ an artificial manager yet.

Firstly, over the last decades several methodological problems in the management science have arisen. Such problems concern Koontz's "theory jungle" [18], large subjectivity in theories [14], "overproduction of the truth" [4], chaos in definitions and scientific language [15], building "islands of knowledge" instead of developing a stable model of reality [12]. Secondly, there is also a domination of the study of the organizational reality based on a situation at certain times, leading to a static and momentary evaluation of the reality as well as too much influence of the subjectivity of the theorists on the theory in the management sciences [26]. Thirdly, the disproportionate nature of the whole management science, especially in terms of methods of conducting research and interpretation of their results, does not help to build a stable knowledge of what a team manager really does [27].

The contradiction between the unstable nature of team management research and the opportunity coming from IT technologies creates a research problem, : whether it is possible to replace a human manager with a robot in the field of team management. It seems that from an implementation point of view there comes a research question which should be answered before implementing team management automation: what does a team manager really do? [25]

The research problem also entails a hypothesis: if we could know what a team manager really does, we could imitate them in managing their team. If this hypothesis is true, we could implement some kind of team management automation based on recorded managerial behavior. Going back to the classical point of view on management, this would be a real accomplishment of Drucker's words that in the future "computers" will not only make decisions but they will do much more [5].

In order to solve this research problem the system of organizational terms was designed. This is a (1) holistic, (2) coherent and (3) formalized methodological concept of management sciences, which allows to practice management sciences in such a way that some fields of team management could be automated.

In this paper there are presented (Section 2) traditional theoretical approaches to team management as a foundation for a team management representation in a holistic, coherent and formalized methodological concept (Section 3). There are also examples of previous verification if this concept aimed at team management automation (Section 4).

2. TRADITIONAL TEAM MANAGEMENT REPRESENTATION

The view of a manager's work has changed over the last one hundred years, however there are two main traditional approaches which had a significant influence on a view of a nature of team management. Firstly, in 1964 Koontz and O'Donnell launched a discussion on the meaning of managerial skills [19] and in 1974 Katz proposed an approach in which managerial skills represented managerial work [17]. The managerial skill was defined as an ability to work effectively as a team manager and to build cooperative effort within the team which the manager leads. Managerial skills were divided into three groups: technical, interpersonal and conceptual skills. Below are examples of published results on management skills over the last fifty years (year; topic; type of participants; number of participants; research method):

- 1967; The nature of the skills involved in managerial jobs; Managers in 32 manufacturing firms in the Madison-Milwaukee industrial area; 520; Survey [20]

- 1983; Relations between managerial roles and managerial skills; Managers employed in a mid-sized manufacturing company located in Southern California; 48; Survey [24]

- 1999; 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; 105; Survey [3]

- 2011; Empirical evidence of training on the personality traits of students which eventually has implications on the managerial skills and performance of them as professionals; Students aged between 20 and 29; 200; Survey [29]

- 2011; Female and male managers communication skills; Managers of an organization located in the San Francisco, Bay Area; 200; Survey [16]

- 2013; Global management skill sets and capabilities among multinational corporations; Senior executives from multinational organizations in North America and India; 56; Series of semi-structured interviews [1]

- 2014; Importance for each managerial role in using managerial skills; MBA students; 107; Survey [30]

- 2014; Competence (soft and hard skills) IT project manager to excel in to be able to take on common challenges; Managers from Saudis, Egyptian, Gordian, Pakistani, Indian teams; 31; Survey [6]

- 2014; Status of managerial skills, features of organisational climate and the interaction of managerial skills with organisational climate; Managers in educational service sector; 50; Survey [32]

- 2015; Importance of values and skills of managers; Senior lean experts employed by a single Dutch medium-sized management; 19; Dephi method [32]

- 2015; Importance of conceptual, interpersonal, technical skills of managers; Agro-managers (25 male and 25 female) from fifty Slovak agricultural and food enterprises; 50; Social Skills Inventory Survey [34]

- 2015; Management skills of retail companies; Team leaders in retail companies; 52; 360 feedback questionnaire [21]

Secondly, in 1980 Mintzberg concluded that the manager's work can be described in terms of ten managerial roles [22]. Managerial roles are defined as areas of job activities which are undertaken by a manager. Mintzberg introduced to the management science a typology of managerial roles which contains such roles as: a figurehead, a leader, a liaison, a monitor, a disseminator, a spokesman, an entrepreneur, a disturbance handler, a resource allocator, a negotiator. The concept of managerial roles was used in many research projects and the results were described in the literature, for example:

- 1982; 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; 180; Survey [23]

- 1993; Investigation into 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; 111; Survey [13]

- 2004; Importance of Mintzberg's roles in IS managers' work; Managers identified at each company in their MIS departments; 547; Survey [33]

- 2006; Perception of the role of the manager which contributed to changes in everyday managerial practices; CEOs of the companies employing between nearly 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 the study; 4; Observation [28]

- 2015; Direct associations between temporal distance and team performance as well as the mediating role of team interaction; College students; 264; Laboratory experiment [7]

- 2016; 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; 15000; Survey [25]

These two different representations of team management have influenced scientists and practitioners so much that most of the research on managerial work was designed either for managerial skills or managerial roles. On the basis of the abovementioned publications it is possible to draw a conclusion that managerial skills and managerial roles as traditional theoretical concepts are not sufficient to describe a team manager's work in order to make a manager's work automatized because these approaches still do not recognize what a team manager really does.

The answer to this question seems to be hidden in the relation between managerial roles and managerial skills. It is said that if a team manager could play managerial roles, they should have some managerial skills. It means that playing managerial roles within their managerial skills results in day-to-day activities undertaken by team managers. These activities can be named managerial actions. In this meaning the managerial action can be defined as a real activity, which a manager does in order to play a managerial role when they have a certain managerial skill.

The concept of the managerial action is based on a theoretical combinations of two different organizational terms, which are the main parts of the methodological concept called the system of organizational terms. This issue and an ability of recording managerial actions as certain organizational terms are described in Section 3.

3. THE SYSTEM OF ORGANIZATIONAL TERMS

The system of organizational terms is a methodological complex which consists of ontological and epistemological aspects designed for research team management aimed at team management automation [10]. 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" [2]. According to this approach the organizational reality can be represented by events and things. Specifically, as shown in Figure 1, each event and thing has the label n.m, in which n and m represent a number and a version of a thing, respectively. Event 1.1 causes thing 1.1, which in turn releases event 2.1, which creates thing 2.1. Thing 1.1 simultaneously starts event 3.1, which creates thing 3.1. Then, thing 3.1 generates a new version of the first event, i.e. event 1.2. In such a way, a new version of the first thing (1.1) is created and it is called thing 1.2.

Every event and thing is an organizational term, although the things are called primal organizational terms and the events are called derivative organizational terms. The way of labelling comes from the answer to a simple question: what would exist if a team manager stopped doing anything? The answer is: things would exist as they are more stable and coherent over time compared to events.

Things (primal organizational terms) in the organizational reality represent resources. Events (derivative organizational terms) in the organizational reality represent processes. By the same token, the system of organizational terms combines the resource approach and the process approach in the management science in such a way that team management processes result in team's resources.

Going back to what was defined in Section 2, that the managerial actions are a real activity, which a manager does in order to play a

managerial role when they have a certain managerial skill, the managerial action structure consist of, e.g. event 1.1 and thing 1.1. This is shown in Figure 1.

Figure 1. Fundamental structure of organizational reality based on occurring facts

Despite the fact that on the abstract level this approach is quite clear and easy to understand, a real problem concerns a method of measuring certain organizational terms. It is quite obvious that data which describe organizational terms should be recorded in such a way that allows for representing a team manager unambiguously, without any doubts or subjective conclusions. This problem can be described by two questions: (1) which organizational terms could we measure and (2) how to do it? The project of the system of organizational terms includes answers to both questions.

Firstly, it is possible to measure only things as effects of processes. Even when we try to measure a process, its parameters must concern a state of the world before and after the time when this process happens. This means that the parameters concern some kind of a resource which is being changed during this process. In team management this issue looks as follows.

As it is shown in Figure 2, when a team manager sets a goal (a team management process represented by Event 1.1 - setting 1.1), it is possible to measure features of goal 1.1 in content, time, and human relations domain. 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, they launch the next team management process. Then the features of this team management process are changed and represent the second version of this team management process (setting 1.2 and goal 1.2). The difference between features of goal 1.2 and goal 1.1. enable doing reasoning on the team management process, which happened in this period of time [10]. Such an approach to ontology of team management enables representing all such processes by standardized features vectors with data grouped in content, time and psychosocial domains [11].

Figure 2. The example of creating resources by processes in team management

Secondly, if it is only possible to measure things (e.g. goal 1.1), there should be a special research tool which could record the

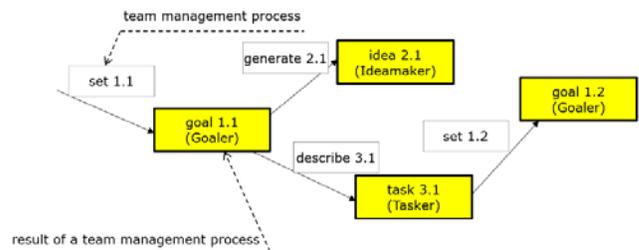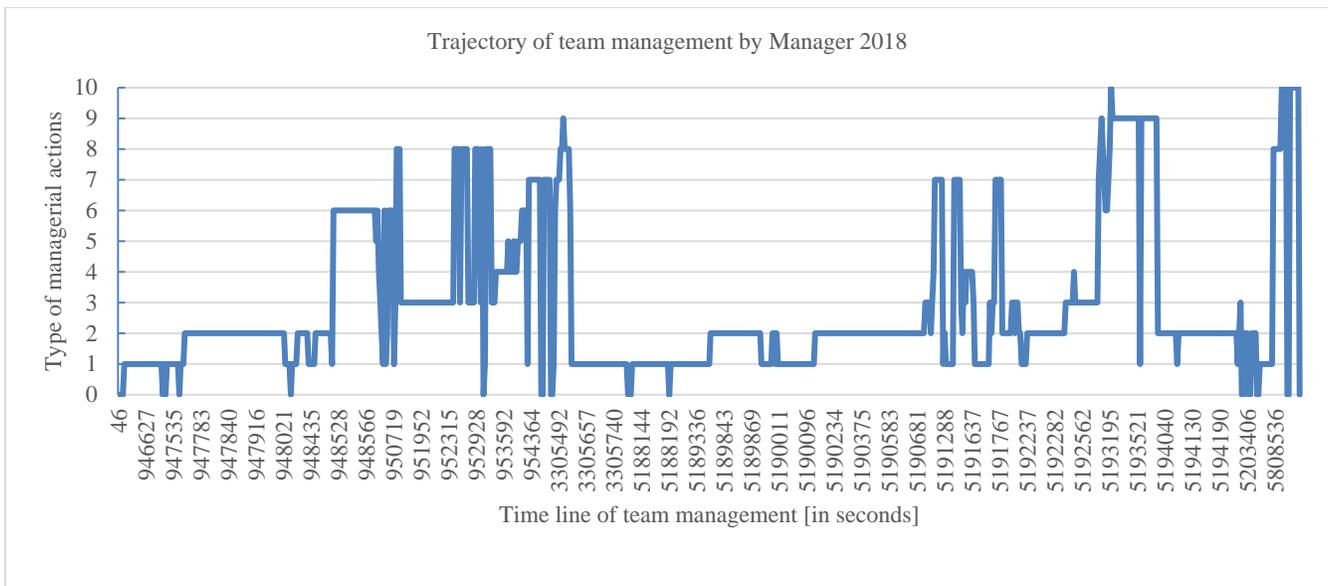parameters of goal 1.1 adhering to the rule of minimum influence on a team manager. The solution is a research tool built into a management tool, which a team manager uses during their day-to-day work [10]. In other words, when a manager does something (e.g. set a goal) with a certain tool, this very tool should also record the parameters of the goal during the managerial work (e.g. before and after setting).

In order to verify the assumptions of the system of organizational terms described above, the innovative online management tools were designed and implemented. They are on TransistorsHead.com research platform. This approach is partly based on a well-known method of time and motion study in management science. The author conducted several experiments on recording managerial actions on the basis of this approach [31]. The results of three of them are shown in Section 4. They show the potential of this concept in team management automation.

4. EXAMPLES OF RESEARCH ON MANAGERIAL ACTIONS

The results of three of the experiments aimed at verification of the approach presented above are shown below. In order to present flexibility of this methodology, the experiments concerned different management problems. In all of them team managers and their team members were using online management tools implemented in the TransistorsHead.com research platform. They were given different tasks in the field of team management. There were ten online management tools in TransistorsHead.com which covered and recorded ten different managerial actions: (1) setting goals, (2) describing tasks, (3) generating ideas, (4) specifying ideas, (5) creating options, (6) choosing options, (7) checking motivation, (8) solving conflicts, (9) preparing meetings and (10) explaining problems. All these managerial actions, taken by team managers, were recorded by the separate tools implemented in the TransistorsHead.com research platform. The numbers of managerial actions (from 1 to 10) were used in the presentation of team management trajectories in Figures 3, 4, and 5. (0) means that a manager did not take any managerial action.

The presented results come from the experiments conducted in 2017, 2018 and 2019. The presented team managers (chosen as examples from groups of managers) are labelled in Table 1 by the year of the experiment (e.g. Manager 2017). Table 1 presents general statistics of managerial actions taken by chosen managers and a period of their teamwork. A total number of managerial actions also contains repeated actions.

Table 1. General statistics of managerial actions taken by managers and a period of their teamwork

Manager no.	Total number of managerial actions	Period of teamwork (in seconds)
Manager 2017	532	551257
Manager 2018	861	5810790
Manager 2019	293	1207523

In 2017 the study was attended by 41 students of Management at the University of Economics in Katowice, Poland. They were divided into teams of 5-6 as a part of the Human Resources Management course. Each team identified a team manager who was leading their team during the experiment. The task for the observed teams was to prepare a training project containing three training programs on three different subjects for the administrative staff of the University of Economics in Katowice. As a result of the teamwork a pdf file containing a training project description was to be produced [9].

In 2018 business students from one of the Universities of Applied Sciences in Helsinki took part in the experiment. They were divided into seven teams, each of which consisted of five members and a manager. The teams got the task of preparing a training program for teachers of this University of Applied Science in Helsinki. The expected result of the participants' work was a report, which had to contain two parts: a training program and teamwork processes [8].

In 2019 students of Human Relations Management at the Faculty of Psychology at the University of Silesia in Katowice, Poland, took part in the experiment. They were to conduct a given project from an idea to a final presentation, which concerned organizational solutions in Polish universities aimed at development in scientific achievements of academics. The students were working in teams of 4-5, every one of which had a defined manager who was leading it. The students were assessed on the basis of, firstly, the content of their solution (its adequacy and innovation) and secondly, the intensity of their teamwork.

Figure 3. The trajectory of team management by Manager 2017

Figure 4. The trajectory of team management by Manager 2018
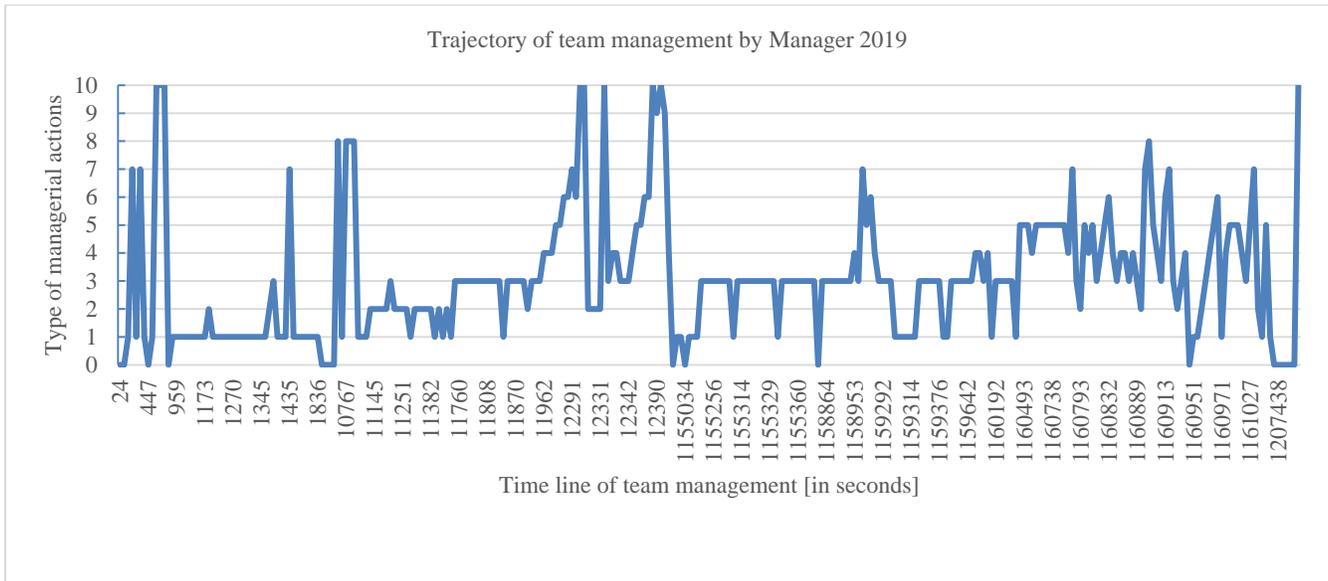

Figure 5. The trajectory of team management by Manager 2019

The team management trajectories of these team managers are presented in Figures 3, 4, and 5. As can be seen, all trajectories have different schedule of managerial actions over time. For example, at the beginning of the work different managerial actions mattered to Manager 2017 (1, 4, 8, 7, etc.) compared to Manager 2018 (1, 2, 6 etc.) and to Manager 2019 (7, 1, 7, 10 etc.). Every team manager had his own trajectory, which could be treated as their personal trait in team management.

5. CONCLUSIONS

The system of organizational terms enables distinguishing and labeling managerial actions taken by team managers. Its flexible and universal mechanism of creating new organizational terms, grouped into pairs as managerial actions, and the assumption of a measurement method make it possible to answer the research question in the defined research problem: what a team manager really does.

Nevertheless, there are many challenges to build an artificial manager right now. Despite the fact that the system of organizational terms can play a role of a theoretical foundation for team management automation, there are the following problems to be solved. Firstly, to define as many managerial actions (composed of primal and derivative organizational terms) in order to cover most activities taken by a team manager. Secondly, to design and implement managerial tools as online tools or mobile applications, which could allow taking these managerial actions by a team manager. On the one hand, these tools should help managers in team management, on the other hand, they should record all actions taken by managers as feature vectors of primal organizational terms. Thirdly, there is a significant question whether it is possible to define patterns of behavior either for a group of similar managers (e.g. working in the same company) or only for a single manager. Nevertheless, pattern recognition of managers behavior is crucial in imitating them by a machine.

These challenges would have to be faced if the idea of an artificial team manager were to come true and they will be a future scientific focus of the author.

6. ACKNOWLEDGMENTS

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