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System of Organizational Terms as a Methodological Concept in Replacing Human Managers with Robots

Olaf Flak^(✉)

Faculty of Radio and Television, University of Silesia in Katowice,
Katowice, Poland
olaf.flak@us.edu.pl

Abstract. Although IT systems fill and automate more and more areas of human life, and thus, manager's work, one can ask why, at the end of the second decade of the 21st century, one cannot hire a robot as a manager? The paper presents the reasons for such a gap in applying algorithms and robots to business life and the possible solution to this problem. The reasons are the methodological problems in management sciences such as H. Koonst's "theory jungle", large subjectivity in theories, "overproduction of the truth", chaos in definitions and scientific language, building "islands of knowledge" instead of developing a stable model of reality. The solution for these obstacles in building real knowledge on manager's behavior, which is the necessary foundation of work automation, is the system of organizational terms. This is a methodological concept of research introduced by the author together with original research tools which are on-line management tools at transistorshead.com. Both innovations in management research let conduct several research project on manager's behavior. There were also attempts of recognizing patterns in manager's behavior. The examples of results are presented in the paper.

Keywords: System of organizational terms · On-line management tools · Manager's behavior · Work automation · Team management automation

1 Introduction

The last over a dozen years have been the time of rapid development of information technology and robotics, as well as a process of replacing people's work with machines or algorithms. Also managers commonly work with electronic tools that facilitate their work, register it and indirectly register the operation of their organization [1].

There are more and more publications about the vision of replacing a manager with computer software and, as a result, creating robot managers [2]. It should be emphasized that already in 1967, P. Drucker wrote that computer systems (then—"computers"—author's note) would not only serve to collect information, but the algorithms written in them would be able to replace managers over time [3]. Despite the passage of several decades, this has not happened so far, although IT systems fill and automate more and more areas of human life, and thus, manager's work. So one can ask why, at the end of the second decade of the 21st century, one cannot hire a robot as a manager?

There seem to be several conditions that have not yet been met sufficiently to allow this to happen. The unfilled conditions are:

- predictability of behavior of people who cooperate with one another, in this case the manager-robot and participants of the organization [4],
- the ability of the robot manager to exert real influence on the participants of the organization and vice versa [5],
- the existence of a common basis for communicating knowledge about organizational reality between the manager-robot and participants of the organization (this is not just about the language used to communicate—author's note) [6].

However, the basic problem in replacing a manager with a robot seems to be the lack of a unified scientific research methodology—the basis for meeting the above conditions—in building reliable knowledge about the behavior of managers [7].

Therefore, the aim of the paper is to present an original methodological concept called the system of organizational terms which let collect information on manager's behavior and describe some patterns necessary in replacing human managers with robots. It will let in the nearest future replace human team managers with robots and develop the performance of organizations and companies.

The system of organizational terms as a methodological concept in management sciences is, in the intention of the author, a way to meet the above conditions by unifying the individual areas of the organizational reality research. Its task is to perform a similar role as the SI system in the case of the automation of physical phenomena [8].

In Sect. 2 of the paper it is described the methodological problems in building knowledge on manager's behavior and methodological and metrological solutions to these problems based on the concept of the system of organizational terms. In Sect. 3 there is a description of preliminary research on manager's behavior aimed at application of artificial managers.

The proposed managerial action representation, designed in the system of organizational terms, creates the first step to design several applications for the business practice. Basing on our experience in working with managers and companies it can be seen at least three such applications.

Firstly, the management patterns are usual practical problem in big companies where the managers, i.e. team leaders or project managers, should work with external or internal clients delivering them specified results. Especially big companies put a lot of effort to standardize employees' work and their results which can be automated and done by algorithms. As it is shown on Fig. 1, some of managerial actions could be managed by an artificial team manager. In other cases some advice could be given to human managers about their typical habits or previous actions.

Secondly, the next application concerns the recruitment process to any organization. In some cases of managerial position there is organized assessment center for candidates. It is usually a place with a conference room where a few candidates have to solve a problem together during 2–3 days. They are observed by HR specialist, psychologists, experienced managers etc. However, the results of such observations are quite qualitative and vague. If the candidate could work not only with sheets of paper but also some online management tools which would record his actions, there would be an opportunity to assess how much their style of management fit to the requirements on

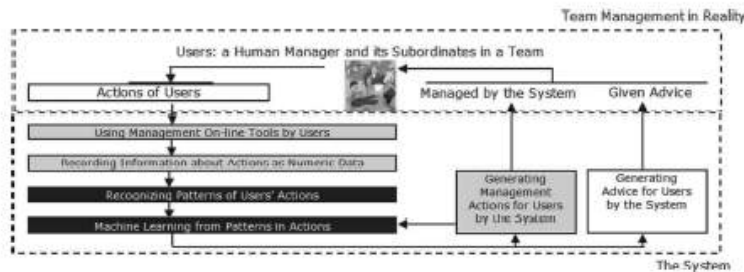


Fig. 1. The cycle of team management automation

the vacated positions. This assessment would much more precise and detailed than done by a traditional assessment method. In the end can be done automatically.

Thirdly, the system of organizational terms introduces a model of managerial actions in any situation and of any kind such setting goals, describing tasks, generating ideas, creating options, checking motivation etc. Recording managerial actions based on this representation method is essential to get data useful in concluding on the dominating habits of a certain managers and his behavior. This lets build a model of his personal managerial style and to apply this model when we want to pretend such a manager in a real life. This leads inevitably to replacement of human managers with robots in certain types of managerial work, such as setting goals and planning tasks, preparing meetings, checking motivation of a team etc.

2 Knowledge of Manager's Behavior

2.1 Methodological Problems in Building Knowledge on Managers' Behavior

The discussion about the identity of management sciences and their methodological assumptions dates back to 1961, when H. Koonst stimulated the awareness of organizational reality researchers with the concept of "the management theory jungle" [9], meaning a disordered way of practicing management sciences and the ontological and epistemological controversies growing in these sciences. Although several decades have passed since then, "we are still dealing with the jungle of management theory, and it's more extensive and more vivid than ever" [10].

Some authors emphasize that the current situation of the management sciences shows a crisis of this science, especially their philosophical and methodological foundations. This crisis is considered to be systemic and permanent to the extent that it undermines even the *raison d'être* of management sciences as an independent scientific discipline [11]. It is even written that it does not have "theories or laws, or even a substitute for a scientific method" [12].

The problem of eclecticism in management sciences raised by the same author seems to strengthen the tendency to disperse the efforts to maintain the scientific nature

of research of the organizational reality. This is despite the fact that many researchers of organizational reality are united around the efforts to create a methodology of management sciences of a measurable and optimizing nature [13]. An example of an attempt to combine methodological approaches is combining the exchange paradigm and the paradigm of value [14] in economic sciences and by analogy combining the resource approach and the process approach in management sciences.

In management sciences, there are a few main problems, which are the obstacles in building true knowledge on managers' behavior and in the end replacing human managers with robots.

First of all, it is not entirely certain whether management sciences belong to idiographic or nomothetic sciences [15]. The solution to this dilemma affects many decisions during the scientific research, ranging from the choice of a qualitative or quantitative approach, through the selection of research objects, and finishing with the research tool and the way the results are interpreted.

Secondly, in the management sciences, the study of organizational reality dominates based on the situation at certain moments of time, which leads to a static and only temporary assessment of this reality [16]. This problem is quite complicated and has two aspects. The first aspect concerns the fact that longitudinal research is not usually carried out, but only a single registration of the studied phenomenon. One cannot infer how the researched phenomenon would change in the function of time. The second aspect is that, even if longitude studies are conducted, the time intervals between studies are too long, which in effect also amounts to a single registration of the studied phenomenon.

Thirdly, many theories in management sciences are created under the clear influence of the researcher's valuing the elements of these theories, which in the perspective of the development of science is an unfavorable phenomenon [17]. At present, it is easy to formulate "new management theories" that have not been properly verified, and the influence of subjectivity of researchers on the theories in management sciences is too large [18].

Fourthly, there are two rather critical approaches in management science to the realm of knowledge about organizational reality. On the one hand, one can find the view that the positivist striving to discover the truth about the organizational reality and to achieve the certainty of cognition is a utopia and consists of an attempt to create a better social order, because of implementing the idea of scientific management [19]. On the other hand, there phenomenon of an "overproduction of truth" about the organizational reality in the form of hundreds of millions of scientific publications exists, and the degree of its certainty cannot be accurately determined [20].

Fifth, in management science one can notice the phenomenon of the increasing diversification of the understanding of concepts and the introduction of new concepts, despite the fact that a common and coherent language is a basic element of the existence of a scientific discipline [21].

Sixth, despite the fact that in the literature of management sciences the view prevails that in these sciences there is a cumulative model of creating knowledge about organizational reality, which is related to the deepening of science as a whole [22], theories, concepts and management methods do not form one coherent research

perspective [23]. Such a large variety of approaches, paradigms and methodological concepts prevents the full use of the cumulative model of knowledge creation.

Seventh, the problem of incommensurability of the entire scientific discipline is clearly visible in management sciences, especially in the field of methods of research and interpretation of their results. This issue seems to be particularly visible, when it contrasts with the qualitative (interpretative) approach with the quantitative (neopositivist) approach. Due to the phenomenon of incommensurability of research results carried out even under the same approach, they cannot be compared with each other, which leads to the formation of "islands of knowledge" [24].

The methodological concept called the system of organizational terms is an attempt of solving these methodological problems and it consists of theoretical foundations and metrological solutions allowing to capture managerial actions in a data base.

2.2 Theoretical Foundations in Building Knowledge on Manager's Behavior

The theoretical foundation of solutions to the problems mentioned above is a view of manager's work which has been changed over one hundred years. At the beginning of scientific management, the picture of a manager in an organization was defined by his classical functions, such as a reflective planner, an organizer, a leader and a controller [25]. However, for more than 50 years a view of a nature of a manager has been dominated by two approaches.

Firstly, in 1964 Koontz and O'Donnel launched a discussion on the meaning of managerial skills [26]. In 1974 Katz proposed an approach in which managerial skills represented managerial work. 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 [27]. The dominating typology of managerial skills divides skills into 3 groups: technical, interpersonal and conceptual skills. Technical skills were regarded as most important for supervisors, interpersonal skills for middle managers, and conceptual skills for executives [28]. One of the latest typologies of managerial skills of managers contains such needed skills as critical thinking, problem solving, an ability to organize data, conceptual thinking, evaluating ideas, persuasive skills etc. [29].

Secondly, in 1980 Mintzberg concluded that the manager's work can be described in terms of 10 roles within interpersonal, informational and decisional areas which were common to the work of all types managers. Managerial roles are defined as areas of job activities which are undertaken by a manager [30]. Mintzberg introduced to management sciences 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 [30]. 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 [31] or an explorer, an organizer, a controller, an adviser [32].

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. However, such approaches still do not recognize what really a team manager does [33] so that it is not possible to recognize team

managerial action patterns in (1) a time domain, (2) a content domain and (3) a human relations domain. Such patterns seem to be necessary when we think of replacing human managers with robots.

The answer to the question about what a team manager does seems to be hidden in the relation between managerial roles and managerial skills, because it is said, in order for a manager to play managerial roles, they should have some managerial skills [34]. 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 when he has a certain managerial skill [35].

Then it is another question: how to describe managerial action in a universal and scalable way? The answer comes from the philosophical foundation of Wittgenstein's vision of the world which includes assumptions that the world consists of facts (the only beings in the world) and their "states of facts" [36]. In the system of organizational terms this concept was extended and it was proposed that managerial actions can be organized by events and things.

In the ontology of organizational reality, according to the system of organizational terms, it is assumed that every fact in the organizational reality can be represented by the organizational term [37]. The organizational term is a symbolic object which can be used as an element of the organizational reality model [38]. The organizational term 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 other hand, it derives from causal relations or occurrence relations with other organizational terms [39]. When the organizational term appears, it can be changed quantitatively, qualitatively, mereologically, and substantially [40].

According to the logical division, organizational terms are divided into two classes: primal and derivative organizational terms. Facts, which are resources in the organizational reality [41], are represented by primal organizational terms. Facts, which are processes in the organizational reality, are represented by derivative organizational terms. 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 [34]. In addition, the next logical division creates different types. The number of types is not defined.

Main principles of the ontology of the organizational reality in the system of organizational terms are as follows [42]:

- The ontology of the organizational reality consists of facts.
- The facts represent managers' work.
- There are two different classes of facts: things (factT, represented by a primal organizational term) and events (factE, represented by a derivative organizational term).
- In any moment of time only one relation between facts appears (there are two classes or relations: "creates" and "starts").

- Between facts there are such relations: factE creates fact, factT starts factE, factE starts factE.
- All relations appear in a considered period of time.
- Every relation between facts appears one by one within time (according to the assumption that “human activities are mostly serial”).

The pair of facts—factT and factE (represented by the primal organizational term and the derivative organizational term; in the common language of management by a process and a resource)—is just called a managerial action and it appears one after another, creating the managerial action. The examples of managerial actions are described in Sect. 3.

From a philosophical point of view, as shown in Fig. 2, each event (a process) and thing (a resource) have the label I.J, in which I and J represent a number and a version of a thing, respectively. Event 1.1 causes thing 1.1, which in turn releases event 2.1 that creates thing 2.1. Thing 2.1 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 is created, which is called thing 1.2.

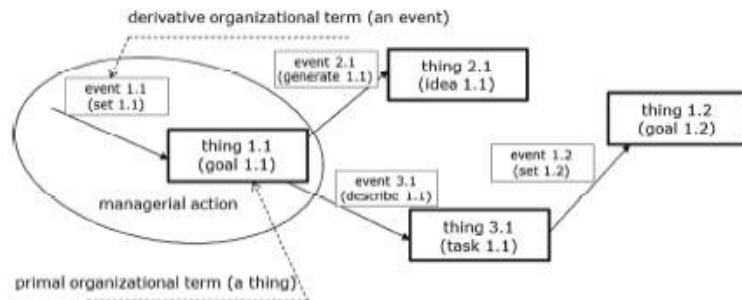


Fig. 2. Fundamental structure of managerial actions

From a practical point of view, as shown in Fig. 2, when a team manager sets a goal, in a certain moment of time a managerial action occurs represented by setting 1.1 (an event) and goal 1.1 (a thing). Specifically, as shown in Fig. 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. What is important, goal 1.1 has features in time, content and human relations domains.

If later (e.g. after the next managerial action—describing 1.1 and task 1.1) this team manager does the next setting of the same goal, he launches the next managerial action. As the result of it the features of this goal are changed (goal 1.1 changed into goal 1.2) and represent the second version of this managerial action (described by the pair of the event and the thing: setting 1.2 and goal 1.2). The difference between managerial action features (goal 1.2 and goal 1.1) let do reasoning on the events which happened in this period of time. Other words, what this team manager really did.

Besides two classes of organizational terms, there are two important terms in this concept. The first is a dimension of the organizational term and the second is a measured entity. The dimension of the organizational term is a general feature of a fact. A measured entity shows how much two facts differ from one another or one fact differs from itself in the function of time. In the language of management, it means how two resources or processes differ from one another or how they differ from themselves in the function of time. The dimensions of organizational terms consist of one or more measured entities. In other words, the measured entities are the measures of resources or processes in an organizational reality.

By the same token, the system of organizational terms combines the resource approach and the process approach in management sciences. It combines processes which effect in resources. In pairs they create managerial actions. As it was mentioned above, 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. This enables to track a team manager by creating a map of detailed features vectors describing “who”, “what”, “when” and the “how” [43].

This approach lets solve the main methodological problems in management science generally and in building knowledge on manager’s behavior particularly. However, in order to get data on managerial actions there is a strong need of a unique data recording method on manager work. In Sect. 2.3 such a method enriched in research tools will be presented.

2.3 Metrological Solutions in Building Knowledge on Manager’s Behavior

The system of organizational terms is an original theoretical construct in which the organization performance is tracked and recorded. In order to do so, observation techniques are used along with the online management tools.

According to the theoretical background of the research tools described in Sect. 2.2, 10 online management tools have been created. They were implemented and available with the website browser. The platform with the tools was called TransistorsHead (transistorshead.com).

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

- according to the idea of an “unit of behavior” [44] every online management tool tracks and records one specific managerial action (as it was described in Sect. 2.2),
- when a manager uses any online management tool it is equal to an event occurring in organizational environment which effects in a thing, another words, equal to a process which results in a resource, respectively [45] (as it is shown in Fig. 1),
- every tool is useful for recording a certain managerial action [42].

There are also two more prepositions. Firstly, any management tool should cover all essential features which could describe the resource (represented by the primal organizational term). Secondly, any management tool should be as simple as it is possible. Users should want to use them during the research as research tools without any external motivation.

At present there are 10 different tools for different management techniques, such as: setting goals, describing tasks, generating ideas, specifying ideas, creating options, choosing options, checking motivation, solving conflicts, preparing meetings and explaining problems. The main scientific role of every management tool is recording a managerial action. The gathered data is divided into two parts: (1) a time domain and (2) a content domain. In the time domain (1) all button clicks are registered in the function of time. Therefore it is possible to conclude what a manager did.

Figures 3 and 4 show the dashboard of TransistorsHead with the example of the managerial action called SET GOALS (the name of the goal: FICC 2019). It is divided into several parts. At the top where managers can choose working with tools (TOOLS default), administer members of their teams (TEAM), hide some created items (derivative organizational terms) into archive (ARCHIVE) and read instructions how to use the tools (TELL ME ABOUT). There are also functions like login, logout and changing password, etc. The main menu consists of 10 different tools for team management, e.g. set goals, describe tasks, specify ideas, create options, etc.



Fig. 3. Dashboard of the management tools platform



Fig. 4. Goal named "FICC 2019" being edited in the "set goals" tool

With these management tools, it is possible to record each managerial action and describe it with a t -dimensional feature vector. This feature vector consists of two parts. The first one, which has a stable length, describes managerial in time domain ("when, "who" etc.). The second part of the vector describes the content of the managerial action (especially, a derivative organizational term) answering to the wide and complex question "what".

In the left of the dashboard there is the ADD NEW function which means that in every tool a manager can create a new item, e.g. a new goal in SET GOALS. Below this button there is a list of items created in the chosen tool, e.g. lists of goals in SET TOOLS.

In the middle vertical part is the universal area containing the same buttons for every tool (VIEW, EDIT, SHARE, DELETE, HIDE). Below this area there are also universal buttons of action confirmation where a manager can save the item in the tool (the derivative organizational term) or close the tool without saving. Save confirmation uploads the data base with new data about the item, e.g. new goal parameters in the SET GOALS, and it creates the representation of a particular managerial action. In the right vertical part there is an area for forms, buttons, text areas or combo lists which a manager uses to establish the content of the tool item, e.g. a goal's name, deadline and measures. This vertical part contains different elements for every tool depending of the designed derivative organizational term parameters.

TransistorsHead platform, containing 10 different management tools, covers main managerial actions in team management. All items created in tools a team leader can share with team members and they can implement and save any changes in goals, tasks, ideas descriptions etc.

The architecture of t -dimensional feature vector which contains data on time domain and content domain of every managerial action depends on this managerial action. The length of the part which included time description of the managerial action (time domain) is stable and defined. The length of another part of this vector, containing features of the manager action (content domain), is different from every managerial action. Such construction of the feature vector is universal and it lets to plug in other measurements not only implemented as online management tools but also focused on recording some other areas of managerial actions such as tone of voice, location, face recognition etc.

In the last few years several research projects were done along with the system of organizational terms and TransistorsHead research tools. In the Sect. 3.1 there are examples of research results in different areas of manager's behavior.

3 Preliminary Research on Manager's Behavior Aimed at Application of Artificial Managers

3.1 Examples of Research Based on the System of Organizational Terms

The first experiment based on the system of organizational terms was done along with the non-participating observation technique from beginning of April to the end of June 2013.

The observation group consisted of students of Managing within the managerial specialization at the University of Economics in Katowice, who were tasked with preparing a complex project of management innovation consisting of a managerial tool in its IT version and a description of the techniques of using this tool. To determine the

objectives and tasks in this project, participants used managerial tools—Goaler (set goals) and Tasker (describe tasks), respectively—which are the measurement tools of primary organizational values: the goal and the task.

In the conducted observation, the activity of 8 managers was registered and data on two primary organizational quantities were obtained, which allowed to visualize the primal and derivative organizational terms in the form of an organizational reality model as a graph. Despite the fact that the participants of the experiment planned the same undertaking, the actions undertaken (the process of setting goals and the process of determining tasks) of each of them had a different course in time. This meant that individual organizational terms appeared at different times and in different order [46].

The collected data allowed not only to check in which order organizational terms appear in the function of time, but also contained information about the values of measured terms that were assigned to objectives and tasks as primal organizational terms. As a result of editing previously set goals or tasks, values of the measured terms also changed as a function of time. In this way it was possible to observe causal relations or relations between co-occurrences between the values of measured terms, although the collected data did not allow to clearly state which of these relations was present. It was also not possible to depict these relations as mathematical functions [47].

After the experiment, the participants were asked about how they perceived their work and what they remember about the course of their work. Differences, between the perception of one's work and the actual actions taken by the participants in the experiment, were quite significant. For example, one of the participants in the experiment believed that each of its team members received other tasks to accomplish, aimed at achieving the set goals. In reality, the manager assigned all tasks to the same person. Similar mistakes related to, for example, the number of objectives set, the frequency of their correction, the assessment of the degree of changes in the content of goals (i.e. the value of the measured organizational terms), etc. [48].

The comparison of managers' opinions with the results of observation of their work allowed to validate two hypotheses set in the study. The first was that managers are not fully aware of their activities during the management process they create. This means that in the organizational reality, primal and derivative organizational terms appear which are a result of a greater degree of unconscious, rather than the conscious actions of the manager. As a result, of the verification of the second hypothesis, it was assumed that the size of the managed enterprise, measured by the number of processes performed (in the system of organizational terms—the number of derivative organizational terms created in a given time interval) does not affect how much the manager is aware of the actions taken [48].

The results of the study confirmed the thesis that the memory about a human behavior is related to the objects (primal organizational terms) that man creates and this memory somehow fits in the relations between these objects and in the relationship between man and these objects [49]. A comparison of managers' opinions with the results of observations also revealed the weaknesses of traditional research techniques, such as questionnaire technique or intelligence technique, used in the field of manager's behavior testing.

The second research started in 2015. It was conducted among 64 students of Management at the University of Economics in Katowice working in groups of 4 persons (a team leader and 3 team members).

The main conclusions derived from such an analysis were as follows:

- the more thought processes the participants had to perform, the more precise their descriptions of the goal or task were. They were placed in managerial tools, which means that more measured terms of these primal organizational terms were registered by the managerial tool, and that the accuracy of the values of particular measured terms was bigger,
- in a situation where the project to be carried out was given in a very unstructured manner, the reconstruction of specific tasks and objectives to be performed was a fairly complex mental process and consumes a relatively long time of managers,
- the more details the task included, the less details the participants included in the final effect (the latest versions of the objectives and tasks), while creating themselves the content not appearing in the task [50].

Participants of the experiment received a comprehensive case study of a company intending to change the existing office to another, together with the characteristics given by the experimenter. This venture had to be planned by the participants by the means of the Goaler (set goals) and Tasker (describe tasks) management tools.

After completing the experiment, a linguistic analysis of the value of measured terms, aimed at assessing the integrity of the intertext of the task, which was given to the participants of the experiment with the effects they achieved at the end of the experiment. These effects were the latest versions of objectives and tasks to be implemented in the undertaking (primal organizational terms).

It can be added that the accuracy of the description of the objective or task in the project increased with the increase in the number of thought processes that participants had to perform.

The same experiment allowed answering the research question, if there are dominant linguistic models in planning of the same project by different managers. As a result of the collected data consisting of the value of the size of measured goals and tasks (primal organizational terms), it was possible to formulate a response that such data were not present in the collected data [51]. However, to conduct further research in this area, it was concluded that a CCC linguistic analysis model (correspondence, consistency, correctness) may be useful [52].

The third research based on the system of organizational terms was also conducted in 2015. The participants came from one of Silesian business schools and their goal was to plan an implementation of a new salary system in a company.

Students worked in groups of three or four, represented by a selected person who was using managerial tools. The aim of the experiment was to check whether the application of the goal management method, used together with the Goaler (set goals) and Tasker (describe tasks) management tools, would measure the effectiveness of the team.

Primal organizational terms—the goal and the task—have become indicators of the team's effectiveness in this project. To assess the effectiveness of the team's work, a group of parameters describing the appearance of individual primal organizational

terms being a result of the operation of these teams was selected. Table 1 presents these parameters and their values on the example of two teams participating in the experiment.

From the experimentally recorded data regarding the primal organizational terms presented in Table 1, it could be concluded that team 2 worked more effectively than team 1 because:

Table 1. Parameters of the team's effectiveness and results of the experiment on the example of two teams

Parameter	Meaning of parameters	Team 1	Team 2
A	Number of created objectives	3	4
B	Number of created tasks	6	7
C	Number of created operations	215	172
D	Worktime of the team from the first to the last login (in minutes)	60847	48987
E	Worktime of the team with the managerial tools (in minutes)	253	246
F	Number of the fractions of worktime of the team from the first to the last login	7	4
G	Number of the modifications of objectives	16	14
H	Number of the modifications of the tasks	33	26
I	Ratio of the modification of objectives (number of modifications for one objective)	2.67	1.75
J	Ratio of the modification of tasks (number of modifications for one task)	2.75	2.0

Source [54]

- worked shorter, both in terms of worktime from the first to the last login (parameter D), as well as the worktime with managerial tools (parameter E),
- in a shorter time set more goals and tasks (parameters A and B),
- had smaller values of ratio of the modification of objectives and tasks (parameters I and J), which indirectly indicated a smaller workload in determining them [53].

It should be added that the above parameters do not indicate which plan was more realistic or would have better results. Neither the effects of the plan's implementation nor the content of the plan were analyzed. Only the effectiveness of the project planning process was examined.

The fourth of experiments was focused also on planning projects. The participants of the experiment were, as before, students of Management in one of private business schools. The students of this university prepared their diploma theses in a rather unusual way, working on them in three-person teams. In the experiment, they were

given the task of planning, with the use of management tools, Goaler (set goals) and Tasker (describe tasks) for a real undertaking that stood in front of them—a team preparation of the diploma thesis.

The aim of the experiment was to assess the impact of management tools on the project planning process and attempt to find hidden rules in the way of planning the same project by 10 groups of students that could be identified with participants of 10 different organizations in the organizational reality. During the experiment, the participants first received a blank piece of paper and a pen as a “management tool”, and when they decided that the plan had already been drawn up, they were given access to the management tools: set goals and set tasks. The experiment time was limited for all groups and was 120 min.

The assessment of the impact of management tools on the work of teams has been achieved in two ways. First of all, the final versions of goals and tasks prepared in the set goals and set tasks tools by each group were compared with the record of goals and tasks in the first “management tool”—on a blank piece of paper. Secondly, the participants were asked by the means of a survey method for their opinions on the change in the way of planning due to the use of Goaler and Tasker management tools compared to the “blank piece of paper” tool. General conclusions summarizing the test results are provided in Table 2.

Table 2. Features of project planning with and without managerial tools

Assessment criterion	Planning without managerial tools	Planning with managerial tools
Planning time	Short	Long
Results (primal organizational terms—objectives and tasks)	Unclear and chaotic values of the measured terms	Precise and clearly described values of the measured terms
Flexibility of planning	Low	High
Availability of the created primal organizational terms (objectives and tasks)	Full	Full
Creativity of a group in a planning process	High	Low

Source [55]

An attempt to find the hidden rules in the way the same project was planned by 10 groups of students did not result in a dominant planning pattern. It was all the more puzzling that each of the 10 groups participating in the experiment planned the same real and feasible project. Yet the quantitative results regarding the number, nature and occurrence of primal organizational terms (objectives and tasks) in a function of time, despite some small similarities, did not allow to determine the dominant pattern of behavior of participants in the experiment.

In 2016 it was the fifth experiment based on the system of organizational terms. It was also focused on assessment how the management tools influence on the planning process and its content.

The selected parameters of group managers' work were compared in the situation of using online manager tools and without these tools, but only with a "blank piece of paper". These experiments confirmed that management tools strongly influenced the course of the planning process as well as the content of the objectives and tasks written in the project plan [55].

Based on data from this experiment in 2017, theoretical work on the search for a method of measuring the similarity of managers, whose activity can be registered, based on the designed features of the system of organizational terms through management tools, posted on TransistorsHead (transistorshead.com), was initiated. The aim of this work was to develop a method of automatic search for similarities between management methods undertaken by team managers. The assumption was made that the team manager could be described by his activity possessing a certain vector of traits.

Using the achievements of the field of pattern recognition in images [56], the method of calculating the degree of similarity of team managers has been developed, which has been positively verified by comparison to the classical statistical analysis of activities undertaken by managers. However, compared to the classic statistical analysis, this method, called "manager partial matching", allows to perform real-time calculations on any large or growing data set, and also indicates the similarity of managers on a scale from 0 (a completely different way of action) to 1 (identical way of operation) [35].

The sixth research was conducted in spring 2017. I was attended by 41 students of the Faculty of Management at the University of Economics in Katowice. They were divided into 5–6 people teams as a part of the subject Human resources management. Each of 7 teams identified a team manager who led the team during the observation. The teams started working on May 18th 2017 at 22:18:01 (the first time one of team managers logged in) and ended on May 30, 2017 at 20:19:12 (logged out by another team manager). The study was conducted by the means of the non-participant, long-term observation. The goal of the study was to recognize participative and authoritarian managers in the research group.

In this research it was distinguished 6 main managerial actions which described participative and authoritarian styles of managing. These managerial actions were recorded by 6 online management tools. It was analyzed these features by ratios between particular managerial actions of a team managers and all his team members. The results in percentage for one team are presented in Fig. 5 (team managers—blue color, team members—green color).

Team manager 1 were nearly fully authoritarian in setting goals (Goals 84.13%) and much participative in preparing meetings (Communication 23.08%). Comparing the results of each team manager to one another it comes the conclusion that the individual styles of management were completely different.

The seventh study was conducted between 26th of September and 20th of December 2017 among 50 BA business students at Haaga-Helia UAS, in Helsinki, Finland. The aim of the study was to answer the following research questions:

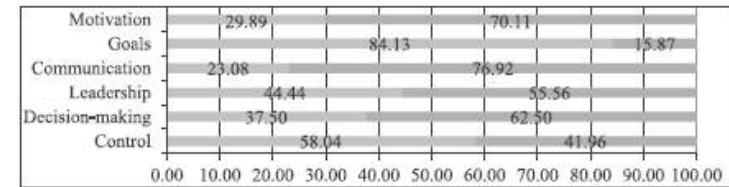


Fig. 5. Ratio between managerial actions of a team manager 1 and all his team members

- how does culture of the team members influence their communication?
- how does communication in multicultural teams influence generating solutions?
- do culturally homogenous teams communicate better than culturally heterogeneous teams?
- is there a correlation between the level of communication and the number of generated solutions?

Students were divided into eight purposeful teams of five. Three teams were homogenous culturally and linguistically. Five teams were heterogeneous both culturally and linguistically. The common working language was English. Their task was to generate ideas for a development project aimed at improving communication among their teachers, both during planning and implementing semester modules. The result of the teams' work was a written report containing two parts: training programme details (number of participants, venue, duration, goals of the project, benefits for the participants, training methods) and teamwork process (individual reflections on the work process, possible difficulties, benefits). To complete the assignment, the students were asked to use managerial tools, available from TransistorsHead (transistorshead.com).

This study expanded the above mentioned findings by investigating the impact of communication. It showed that communication in hetero- and homo-cultural teams influences generating solutions. Three homo-cultural teams, from low-context cultures, communicated more effectively and generated most solutions. However, four international, hetero-cultural groups showed frequent communication during the observation, but did not generate many solutions. The study revealed a weak correlation between the intensity of communication and the number of generated solutions. Although the intensity of communication process was high in some cases, the number of solutions was low. Additionally, the culture of the team members played a significant role in their communication. Mono-cultural teams, sharing native language, did not use management tools too often but achieved high output results. Conversely, in multi-cultural teams the intensity of communication was high, but the output of results was low.

This series of research based on experiment and long-term observations let check the usability of the system of organizational terms as a theoretical concept in managerial actions research. The research tools implemented as online management tools in TransistorsHead recorded data, which let to conclude about some patterns of managers' behavior. However, even having such data about real managerial actions there are still several problems in implementing artificial managers in practice. These challenges were described in Sect. 3.2.

3.2 Challenges in Application of Artificial Managers

There are 5 main research challenges in the implementation of an artificial manager.

First of all, one should answer the question how to build measuring tools useful in the non-participant observation method [57], which was used as the main research method in the system of organizational terms.

Secondly, there is the problem of how to avoid the effect that during the scientific research the researcher constructs a measuring tool expecting certain features of the phenomenon (in the system of organizational terms—values of measured terms), which narrows the scope of information collected about the examined reality [58]. In other words, due to this effect, some of the phenomena in the organizational reality, potentially described by organizational terms, may never be investigated, despite the fact that they will occur.

Thirdly, one can ask who should be the initiator of creating management tools, which are measuring tools [59]. It should be added that in the system of organizational terms, the choice applies to the manager, participants of the organization, users of the study or the researcher.

The fourth research problem that arises from the literature on the subject of automation of human activities is whether in the case of solving organizational problems in the organization it will work well—as in other areas of life—the method of imitation by the manager-robot of the current behavior of the manager-man [60].

The last, fifth research problem arises from the fact that the manager-robot would face a solution to the organizational problem, some of which are a significant obstacle to the manager-robot learning behavior of the human. Namely, organizational problems are characterized by:

- unstable parameters describing a given problem and undefined requirements as to its solution,
- high complexity of relations between elements of the problem,
- particularly large dependence on human activity [61].

The ability of an imitation depends on the ability to repeat the behavior of an original object [62]. In the literature on the subject, two types of imitation of the original object can be distinguished. The first type means accurately reproducing the original behavior in a given situation, without analyzing the context of this situation [63]. The second type requires analysis of both the behavior of the original and the object to which this behavior is manifested [64]. Because it seems that the imitation skill is crucial for the manager-robot to be able to interact with the participants of the organization [65], a research question arises, which kind of imitation of the manager's activity is possible to be implemented in the IT system, which is also the organization's management system.

Thus, a research question arises, how should an IT system, being a manager-robot, learn from a manager-man? The question, though linguistically simple, carries many detailed questions in areas of knowledge such as pattern recognition [66] and machine learning [67].

It seems that solving these research problems determines further work on replacing the manager's work with a robot.

4 Conclusions

The summing up the above outline of further directions of research using the system of organizational terms aiming at the manager's work automation, it should be emphasized that these studies are not about creating a human-like manager and at the same time being its higher evolutionary copy (in original "sophisticated superhuman machine"—author's note) [62].

The aim of the above-mentioned research problems is to improve already existing IT systems used in management, which, however, currently seem to occupy only lower levels in the hierarchy of management systems (in original "system of control"—according to S. Beer) [68].

There are also many other possibilities of using this methodology in business, science and arts. Firstly, in business in Human Resources Management there is a problem of people performance measurement. It is claimed that a subject of human work has always come to a simple question: what makes a man at work? [33]. Using the presented method of manager representation in area of representing work of any employee gives great opportunities in comparison of employee performance in order to us the results:

- systems of employee measurement,
- motivating systems,
- recruitment and development systems,
- time and production management systems.

If the similarities between people working on the similar positions are able to describe, it would be possible to design more efficient methods of paying for their job, motivate employees with similar needs characteristic by non-financial factors, conduct more adequate recruitment for similar positions. The advantage of this methodology would also increase time accuracy in production lines and let compare physical workers to one another.

Secondly, in science there is a strong need of conducting more efficient scientific research with less funds, achieving better and more accurate results. The question is what is the most efficient method of scientific research in a certain discipline which results in most cited and relevant publications?

If two or more scientists in the same discipline could be tracked what they really do, there could be some similarities in their work discovered by this methodology. Of course, another question is what kind of measure tools could be used for tracking scientists work; especially abstract work of designing, reasoning or drawing conclusions. The tools implemented in the TransistorsHead are not enough, because they use only the web page technology. There is a need of designing other tools which could measure changing location, an acceleration of a body, barometric pressure for a blood pressure, an ambient body temperature, a heart rate or a skin conductance. However, the methodology of representing work or other issues of activities is the same as it was describe in the paper.

Thirdly, in arts, especially in movie and television production there is a lack of concrete and stable knowledge how to design and produce movies and tv programs.

Tracking directors or producers work could be useful to formulate the best practices in fields, which are still covered under the misty art performance.

It is said that in approximately 125 years all human jobs will be automated in the term of "High-level machine intelligence" (HLMI) which means the state when unaided machines can accomplish every task better and more cheaply than human workers [69]. Despite the fact that the managerial profession is not listed in these jobs, the preliminary research on the use of the system of organizational terms as a concept of management sciences, however, provides the basis for formulating a vision of the development of management sciences, in which the gradual automation of the manager's work may be an important element, and probably in the future, now undetermined, form of competition between the manager-man and the manager-robot [67].

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