# Intelligent Systems and Applications

## Proceedings of the 2020 Intelligent Systems Conference (IntelliSys) Volume 2

Springer

ISSN 2194-5357 ISSN 2194-5365 (electronic)
Advances in Intelligent Systems and Computing
ISBN 978-3-030-55186-5 ISBN 978-3-030-55187-2 (eBook)
https://doi.org/10.1007/978-3-030-55187-2



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The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

# Estimated Influence of Online Management Tools on Team Management Based on the Research with the Use of the System of Organizational Terms

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**Abstract.** The paper aims at presenting results of the research which allows estimating a level of this influence and which concerns team management. The research problem in the paper concerns a possibility of replacing human managers with robots in the field of team management. If the managerial actions should be recorded by the management tools in order to launch machine learning of robots, there comes a research question: to what extent does a managerial tool influence the team management launched by a manager? The research problem entails a hypothesis: (H1) the use of the online management tools creates much less primal organizational terms than all actions taken in human-computer interaction and (H2) the use of the online management tools changes an order of managerial actions in team management. The paper contains theoretical foundations of human-computer interaction research (Sect. 2), theoretical foundations of the system of organizational terms (Sect. 3), research results (Sect. 4) and conclusions (Sect. 5).

**Keywords:** Team management · Management tools · System of organizational terms · Team management automation

## 1 Introduction

This happens when more and more fields of our life are developed or replaced by machines and robots. The first age of robotics concerned mechanical processes and manufacturing, but now rapid development of computer science gives us opportunities to replace more sophisticated work with robots [1]. The idea of replacing human managers with robots can be shaped by the idea of an intelligent knowledge system in an organization [2]. However, there is still an essential research problem as to how to acquire detailed knowledge what a team manager really does [3].

The theoretical foundation of solving this problem was published in several papers of the author [4] and it is presented briefly in Sect. 3. The main idea is to implement research tools in management tools used by managers in order to record their activities and behaviors [3]. It will allow recognizing patterns of behavior and implementing team management automation including automated managerial actions and advice for human managers in real time as it is presented in Fig. 1.


K. Arai et al. (Eds.): IntelliSys 2020, AISC 1251, pp. 56–72, 2021.
https://doi.org/10.1007/978-3-030-55187-2_6

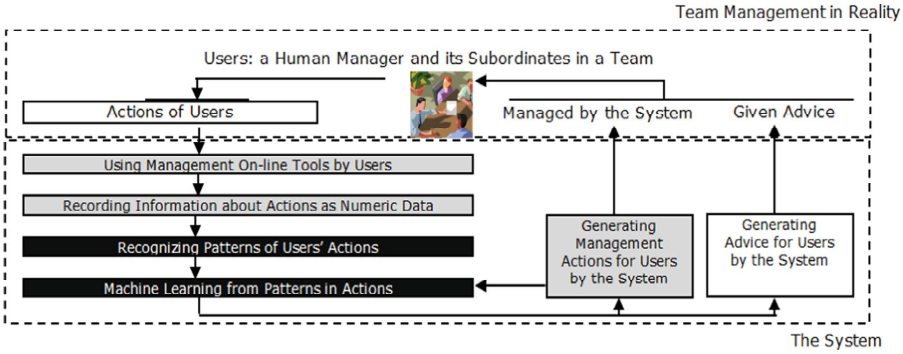


**Fig. 1.** Team management automation including automated managerial actions and advice for human managers in real time. Source: Own evaluation

However, if there is an aim of a solution to the team management automation problem, described in Fig. 1, and if the managerial actions should be recorded by the management tools in order to launch machine learning of robots, there comes a research question: to what extent does a managerial tool influence the team management launched by a manager?

The answer to this question would let design such online management tools which could give as little bias of this influence as it is possible from a methodological point of view. The influence of a research tool is a well know problem in any social research, especially, if the aim is to automate managerial actions this problem should be examined and taken into consideration by researcher and programmers.

Solving this problem can help previous research on human-interaction research, which has been developing since the mid 1940's. It started with a prophetic essay "As We May Think" written by Vannevar Bush published in 1945 [5], then the term "human-computer interaction" was introduced by Card, Moran and Newell [6], until the present time when hundreds of papers on apps usability are being published every year. The main problem in estimating the influence of online management tools on real team management is that it is hardly possible to estimate exactly the level of this influence in numbers or qualitative parameters [7].

Therefore, this paper aims at showing results of the research which allows to the research question mentioned above by estimating a level of this influence on team management. The hypothesis derived from the research question is as follows:

H1: The use of the online management tools creates much less primal organizational terms than all actions taken in human-computer interaction.
H2: The use of the online management tools changes an order of managerial actions in team management.

The research was conducted from 14th May 2019 to 4th June 2019. The managers were students of Human Relations Management at the Faculty of Psychology at the University of Silesia in Katowice. They were focused on solving a given organizational

problem working in six groups. They were given instructions on what to do one managerial action after another as it used to be done in academic coursebooks. They were using online managerial tools in the TransistorsHead platform, which recorded their behaviour. Because of the number of groups and a number of managerial actions recorded by 10 online managerial tools the study is limited only to this focus groups and only to the recorded managerial actions. The results of the research allow for verification of the hypothesis enunciated above and an answer to the research question in this research environment.

The paper contains theoretical foundations of human-computer interaction research (Sect. 2), theoretical foundations of the system of organizational terms (Sect. 3), research results (Sect. 4) and conclusions (Sect. 5).

## 2 Related Work on Human-Computer Interaction Research

The term "human-computer interaction" was coined in 1983 when "The Psychology of Human-Computer Interaction", a book of Card, Moran, and Newell, was published. This was also a time when the first practical use of this knowledge was implemented in such products as the Apple Macintosh [8]. However, the real roots of HCI was a moment when Special Interest Group on Social and Behavioral Computing (SIGSOC) in 1969 was formed [9]. Until the beginning of the 80's the number of scientific papers sent only to the ACM (Association for Computing Machinery) HCI conference multiplied 10 times and it is still increasing.

From the very beginning there were two key concepts in HCI - (1) perceived ease of use and (2) perceived usefulness. They were examined in terms of their role within the framework of the Technology Acceptance Model [10]. In this (1) perspective the perceived ease of use can be defined as a level of an individual believes that using a computer system can be completely effortless. (2) The perceived usefulness as a level to which users can say that using computers professionally will increase performance of their job [11]. Within mainstream HCI it was proved that the perceived ease of use and the perceived usefulness are possible to be validated [12].

The other two main research themes within HCI are (1) the provision of software support for the specification and generation of software artefacts, and (2) the modelling of human-computer tasks and activities. It is necessary to underline that in any human-computer interaction humans take actions using their sensors, brain, and manipulators (hands, legs, mouths etc.) to do things. When these three elements work together, human performance arises [8].

As far as the human sensors are concerned, people have a feeling that they know their environment despite the fact that their sensory system is limited. People know much more than it appears considering only the capacity of sensors [13].

In 1983, when the modern HCI was created, Card, Moran and Newell described the Model Human Processor. It was a simple view of the human processing involved in interacting with computer systems. Model Human Processor consisted of three subsystems: perceptual system, motor and cognitive systems. Each of them seems to have a processor and memory. Model Human Processor also included some principles of human actions which could be done together with a computer [6].

In addition to these two approaches, there is also a descriptive model of the human actions containing a time scale of human actions. It works by positioning different types of human actions in timeframes. The model has four dimensions of time scale: biological, cognitive, rational band, and social one [14]. In this context there are four types of actions: physical actions, conceptual actions, perceptual actions, functional actions [15, 16].

HCI constructs should be understandable to users (such as motivating people or setting a goal [17]. Construct knowledge-based systems need the appropriate computer representation of knowledge and methods for knowledge manipulation based on human-computer interaction [18]. In Fig. 2, there are main elements which can be used in a process of designing the human-computer interface aimed at building a knowledge-based system.


**Fig. 2.** Two key elements: system requirements and user's concerns. Source: Alonso-Valerdi L.M, Mercado-García V.R.: Enrichment of Human-Computer Interaction in Brain-Computer Interfaces via Virtual Environments, Computational Intelligence and Neuroscience, 33–54 (2017).

Computer knowledge systems are certainly unique, because they often play a role of facilitating or helping human cognition. One of their features is an ability to perform cognitive tasks autonomously. This is the reason why computer knowledge systems can support human cognitive actions [19].

There are many traditional principles for computer tools and tool features which have to be fulfilled. Firstly, the design of a user interface should be easy to operate [20].

Secondly, the tool purpose should be very precise as well as the possible inputs and outputs [21]. Thirdly, minimum complexity should be kept in order to express nontrivial system behavior [22]. Fourthly, behavior of a user interface should be possible to be describe without focusing on the way in which it will be implemented [23]. Additionally, specification of a tool should be closely related to the user's mental model of the system itself [17].

In the TransistorsHead platform, whose online management tools were used in the research described in this paper, the tools have also the following features:

- every tool is for one understandable task [24],
- every tool is to reduce memory load for a user [25],
- every tool reminds users of some actions and refreshes their memory [26],
- every tool prevents errors [27].

Human-computer interaction concerns an interdisciplinary area, including engineering, psychology, ergonomics, design etc. This theoretical term also deals with the theory of design, implementation, and evaluation of how people use and interact with electronic devices [28]. Therefore there are many areas of research on human-computer interactions, such as:

- the design of adaptable customizable tools [28, 29],
- a technology and user experience (UX) design influence on learning [29],
- natural and intuitive actions including hand gestures [30], face recognition [31], eye tracking [32], biosignal analysis [31], speech recognition [33],
- action recognition [34] and their consequences [7].

There are many methodologies for analyzing HCI requirements and system requirements, including task analysis [35], ConcurTask-Tree [36] and the Scenario-Based Requirement Analysis Method (SCRAM) [37].

Despite the fact so many research approaches to "human-computer interaction" it is still difficult to estimate the influence of online management tools on real team management quantitatively in numbers or qualitative parameters [7]. Therefore most of results of such research are based on qualitative or semi-quantitative analysis. The same approach was used in this paper, where there are some quantitative statistics describing team management. Nevertheless, the most important role plays graphs showing the trajectory of teamwork which is a novel approach to measure managerial actions at work.

## 3 The Theoretical Foundations of the System of Organizational Terms

The foundation of management tools as research tools derives from the classical approach to examining worktime used in the last few decades. This approach was a foundation for the methodological concept which is called a system of organizational terms [38–41].

The ontological assumption of the system of organizational terms is that the organizational term represents every fact in the organizational reality [42]. This is also a

symbolic object used as an element of the organizational reality model [43]. A close analogy to the organizational term is a physical quantity in the SI unit (length, mass, time etc.). On the one hand, every feature of the organizational term can come from its definition. However, on the other hand, it derives from causal relations or occurrence relations with other organizational terms [44]. The organizational term can be changed in four ways: quantitatively, qualitatively, mereologically, and substantially [45].

The system of organizational terms has its philosophical background in Wittgenstein's work. He wrote his theory of facts, which were the only beings in the world and could be described by "states of facts" [46]. According to this approach a managerial action consists of an event and a thing. Each event and each thing has the label *n.m*, where *n* represents a number of an event or a thing and *m* represents its version. In Fig. 3 there is an example of a few managerial actions. Event *1.1* creates thing *1.1*, which starts event *2.1* that creates thing *2.1*. Then thing *2.1* starts event *3.1* which creates thing *3.1*. A can be seen, thing *3.1* creates a new version of event *1.2*. This way a new version of thing *1.1* is created.

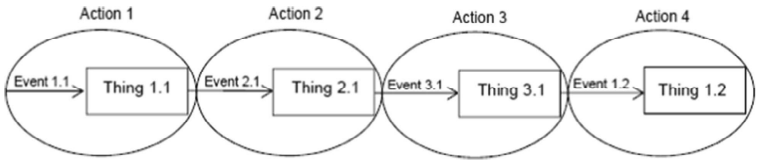


**Fig. 3.** Structure of a few managerial actions. Source: Own elaboration

A logical division allows us to distinguish two classes of organizational terms: primal and derivative ones. Things which are primal organizational terms in the organizational reality represent resources [47]. Events, derivative organizational terms, in the organizational reality represent processes [48]. This way one of the assumptions of the system of organizational terms was to combine the resource approach and the process approach in the management studies. As the result of that resources are always caused by processes. Together they are managerial actions.

As it was mentioned above, managerial actions can be described in time, content and human domains features. These features show how much two managerial actions differ from one another or one managerial action differs from itself – the present managerial action to the previous version in the past. Such an ontology of managerial actions allows for representing all activities of managers and their subordinates by a standardized features vector [49].

There is another advantage of the system of organizational terms which concerns a method of gathering information on team managerial actions. From the methodological point of view information should be recorded only on managerial actions, which take place in a team which a manager leads. In order to us the best way of recording information on team managerial actions online management tools or other electronic devices are the best research tools. The only limitation is that these managerial tools a manager and their team members should use during every day work [50]. For this reason a special research platform, called TransistorsHead.com, was designed and implemented. The online management tools in TransistorsHead.com record information in time, content and human domains which seems a method of time and motion study.

One of the epistemological assumption for the system of organizational terms is that an objective long-term observation should be the main research method [51]. The measurement of a managerial action in this methodology is defined "as an assignment of a certain set of values to a certain set of managerial action features" [52]. Every managerial action can be measured by a research tool which gathers data about the primal organizational term. This means the research tool, which is physically in the same time on online management tool, records information on the results of a certain process in team management [53]. From the theoretical point of view online management tools have such features:

- Every online management tool tracks and records one specific managerial action (according to the idea of a "unit of behaviour") [54].
- When a team manager uses any online management tool it is equal to a process which results in a resource [38].
- A certain managerial action is recorded by a certain management tool which is designed for it [40].

In Sect. 4, online management tools used in the research are described.

## 4 Results of Research

The long-term, non-participating observation of managers took part from 14th May 2019 to 4th June 2019. The managers were students of Human Relations Management at the Faculty of Psychology at the University of Silesia in Katowice. They had to conduct a given project from an idea to a final presentation, which concerned organizational solutions in one of Polish universities aimed at development in scientific achievements of academics. The problem to be solved by the students: one of the main Polish universities planned to be a research university from 2020, however, until then most of the academics had spent most of their time and effort teaching (lectures, seminars, etc.) instead of doing scientific work (scholarships, scientific projects, publications, etc.). The effect of their work was a public presentation of (1) a design of an organizational solution (motivating academics into this change of tasks) and (2) a plan of implementation and a budget. The students were assessed on the basis of, firstly, the content of the solution (its adequacy and innovation) and secondly, the intensity of their teamwork.

The students were working in six teams consisting 4–5 members, every one of which had a defined manager who led it. The method used to verify hypotheses introduced in Sect. 1 was a non-participant, long-term observation of students who played a role of managers in a project given to them during BA studies. All of the team members were using the online management tools in Transistorshead.com, a research platform available by an Internet browser (on laptops or mobiles). The research tools implemented in the TransistorsHead.com research platform were at the same time both managerial tools and research tools. The tools were recording managers' behaviour which made it possible to know what types of managerial action they took, in which order and what the features of the managerial actions were. The data gathered this way was compared with the instruction of managerial actions given to managers. As it was mentioned in Introduction,

**Table 1.** Names of online managerial tools, their numbers, names of primal and derivative organizational terms and names of managerial actions

| Name of managerial tools in TransistorsHead | Number of managerial actions | Name of managerial actions | Primal organizational term | Derivative organizational term |
|---|---|---|---|---|
| Set goals | 1 | Set goals | Goal | Set |
| Describe tasks | 2 | Describe tasks | Task | Describe |
| Generate ideas | 3 | Generate ideas | Idea | Generate |
| Specify ideas | 4 | Specify ideas | Specification | Specify |
| Create options | 5 | Create options | Option | Create |
| Choose options | 6 | Choose options | Choice | Choose |
| Check motivation | 7 | Check motivation | Check-up | Check |
| Solve conflicts | 8 | Solve conflicts | Solution | Solve |
| Prepare meetings | 9 | Prepare meetings | Agenda | Prepare |
| Explain problems | 10 | Explain problems | Explanation | Explain |

Source: Own elaboration

**Table 2.** Online management tools functions

| Tool | Application of the tool during the process of working |
|---|---|
| Set goals | Setting the goals of the project, results which have to achieved |
| Describe tasks | Describing tasks which have to be taken in order to achieve goals |
| Generate ideas | Generating ideas with the 635 technique (a silent brainstorm) in order to solve a managerial problem |
| Specify ideas | Describing features of the ideas which could be used to solve a managerial problem |
| Create options | Creating options in the process of decision making |
| Choose options | Choosing an option the most adequate to the criteria and a level of importance of them |
| Check motivation | Checking a level of team members' motivation |
| Solve conflicts | Analysing reasons for a conflict and designing a solution |
| Prepare meetings | Preparing agenda for a meeting based on market laws |
| Explain problems | Explaining managerial problems in details among team members |

Source: Own elaboration

the study describes the research on six groups using 10 managerial tools. Therefore, all the hypothesis were verified for such a research environment.

Table 1 contains the names of online managerial tools, their numbers (which are necessary to read the Fig. 4, 5, 6, 7, 8 and 9), names of primal and derivative organizational terms and names of managerial actions. In Table 2, there are functions of the online management tools.

Table 3 contains the amount of managerial actions taken by managers, the period and length of the teamwork. As can be seen in Table 3, the number of managerial actions taken by managers is totally different to one another, as well as the duration of the teamwork.

**Table 3.** Amount of managerial actions taken by managers, the period and length of the teamwork

| Manager | Number of managerial actions | Date of start | Date of finish | Period of teamwork (in seconds) |
|---|---|---|---|---|
| Manager 1 | 232 | 14.05.2019 10:58 | 28.05.2019 11:56 | 1213107 |
| Manager 2 | 663 | 14.05.2019 10:58 | 03.06.2019 16:20 | 1747358 |
| Manager 3 | 244 | 14.05.2019 11:01 | 05.06.2019 00:02 | 1861307 |
| Manager 4 | 1017 | 14.05.2019 10:59 | 03.06.2019 19:16 | 1757849 |
| Manager 5 | 427 | 14.05.2019 11:00 | 04.06.2019 19:06 | 1843529 |
| Manager 6 | 196 | 14.05.2019 11:06 | 04.06.2019 22:52 | 1856737 |

Source: Own elaboration

**Table 4.** Quantities of primal organizational terms (things) created in managerial actions

| Name of a managerial action (and the online management tool) | Name of a thing created in a managerial action (recorded by the online management tool) | Manager | | | | | |
|---|---|---|---|---|---|---|---|
| | | Manager 1 | Manager 2 | Manager 3 | Manager 4 | Manager 5 | Manager 6 |
| Set goals | Goal | 4 | 1 | 3 | 4 | 2 | 1 |
| Describe tasks | Task | 1 | 0 | 5 | 1 | 1 | 1 |
| Generate ideas | Idea | 2 | 1 | 3 | 2 | 2 | 1 |
| Specify ideas | Specification | 2 | 1 | 2 | 1 | 1 | 1 |
| Create options | Option | 1 | 1 | 2 | 2 | 1 | 1 |
| Choose options | Choice | 1 | 3 | 1 | 1 | 1 | 1 |
| Check motivation | Check-up | 2 | 2 | 2 | 2 | 2 | 1 |
| Solve conflicts | Solution | 0 | 1 | 2 | 1 | 0 | 1 |
| Prepare meetings | Agenda | 3 | 2 | 1 | 2 | 1 | 0 |
| Explain problems | Explanation | 1 | 1 | 4 | 1 | 0 | 1 |
| Total number of things | | 17 | 13 | 25 | 17 | 11 | 9 |

Source: Own elaboration

Table 4 contains quantities of primal organizational terms (things) created in managerial actions, whereas in Table 5 there are numbers of versions of these primal organizational terms (things) created by managers taking managerial actions. It specifies how many times they corrected the primal organizational terms until they finished their work. As can be seen, the number of things as well as the number of their versions are completely different for each manager. In addition to data in Table 3, it can be seen that managers created much fewer primal organizational terms (things) than managerial actions they took. This comparison verified the hypothesis H1 as true. It means that in the time of using online managerial tools the human-computer interaction was so intense that much of the work on the screen did not result in any primal organizational term

**Table 5.** Numbers of versions of these primal organizational terms (things) created by managers taking managerial actions

| Name of a managerial action (and the online management tool) | Name of a thing created in a managerial action (recorded by the online management tool) | Manager | | | | | |
|---|---|---|---|---|---|---|---|
| | | Manager 1 | Manager 2 | Manager 3 | Manager 4 | Manager 5 | Manager 6 |
| Set goals | Goal | 6 | 11 | 23 | 10 | 5 | 3 |
| Describe tasks | Task | 2 | 0 | 12 | 4 | 3 | 1 |
| Generate ideas | Idea | 3 | 8 | 75 | 6 | 23 | 8 |
| Specify ideas | Specification | 4 | 9 | 27 | 2 | 2 | 1 |
| Create options | Option | 5 | 13 | 43 | 8 | 3 | 2 |
| Choose options | Choice | 1 | 7 | 13 | 2 | 1 | 1 |
| Check motivation | Check-up | 2 | 15 | 39 | 2 | 8 | 7 |
| Solve conflicts | Solution | 0 | 6 | 7 | 2 | 0 | 1 |
| Prepare meetings | Agenda | 6 | 5 | 7 | 3 | 1 | 0 |
| Explain problems | Explanation | 2 | 6 | 13 | 2 | 0 | 9 |
| Total number of things' versions | | 31 | 80 | 259 | 41 | 46 | 33 |

Source: Own elaboration

**Table 6.** Commands in the instruction and the online management tools which respond to the commands

| Number of commands (A) | Commands in the instruction | Number of managerial tools in TransistorsHead (B) | Name of managerial actions |
|---|---|---|---|
| *Main part of the instruction – main actions* | | | |
| 1 | Define the problem of becoming a research university instead of a college. | 10 | Explain problems |
| 2 | Set a goal (or goals) of the problem solution. | 1 | Set goals |
| 3 | Create ideas concerning the problem solution – its features and actions taken in the solution. | 3 | Generate ideas |
| 4 | Make the ideas detailed – write the optimal values, features, ranges of characteristics etc. | 4 | Specify ideas |
| 5 | Create a few potential solutions of to the problem. | 5 | Create options |
| 6 | Make a decision which option is optimal | 6 | Choose option |
| 7 | Make a list of tasks which have to achieve a goal. | 2 | Describe tasks |
| *Additional part of the instruction – supportive actions* | | | |
| A | Check motivation of your team members. | 7 | Check motivation |
| B | Arrange an agenda of the team meeting | 9 | Prepare meeting |
| C | Analyse and solve a conflict which can appear during teamwork | 8 | Solve conflicts |

Source: Own elaboration

(thing). There comes a question whether it is possible to design such an interface which could effectively decrease inefficient movements in online managerial tools.

The instruction for students showed them the order of work according to good practices in team management, however, the order was only a default pattern for managers, which the real order of managerial actions was compared to. In Table 6, there are commands in the instruction and the online management tools which respond to the commands.

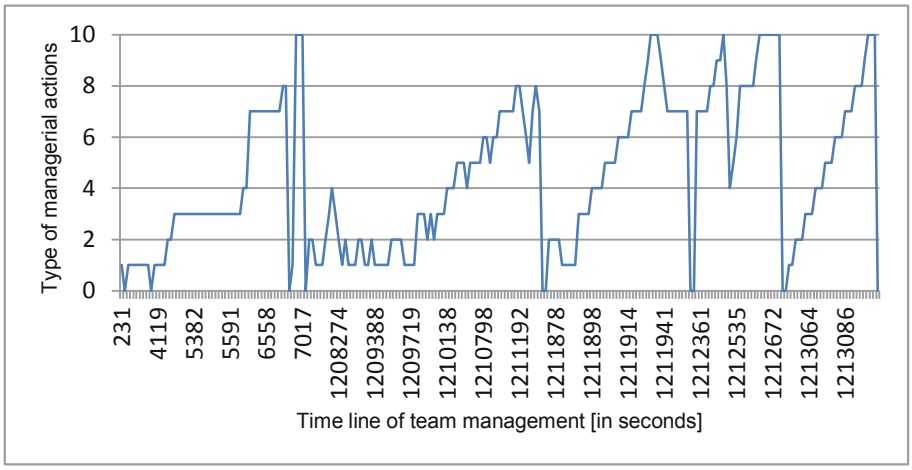


**Fig. 4.** Trajectory of team management by Manager 1. Source: Own elaboration

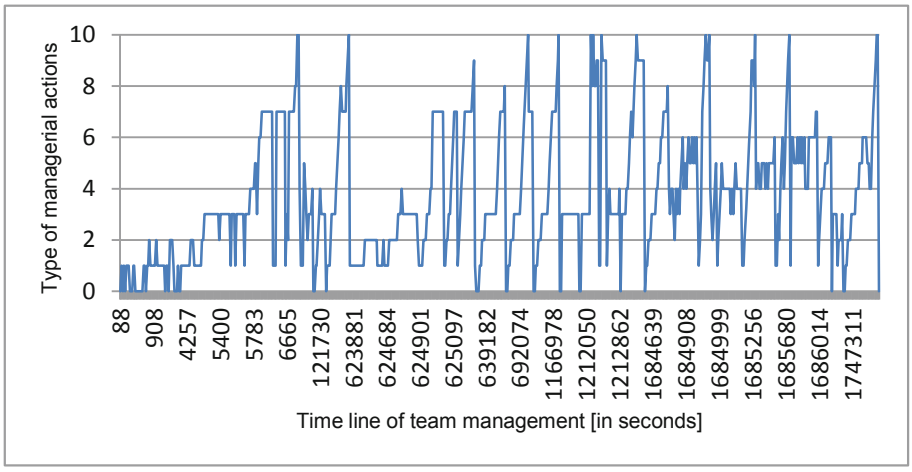


**Fig. 5.** Trajectory of team management by Manager 2. Source: Own elaboration

Figure 4, 5, 6, 7, 8 and 9 show a sequence of the used types of managerial tools in a time line. As it was mentioned in Table 1, names of the managerial tools are the same as managerial actions. When we compare the recommended order of managerial

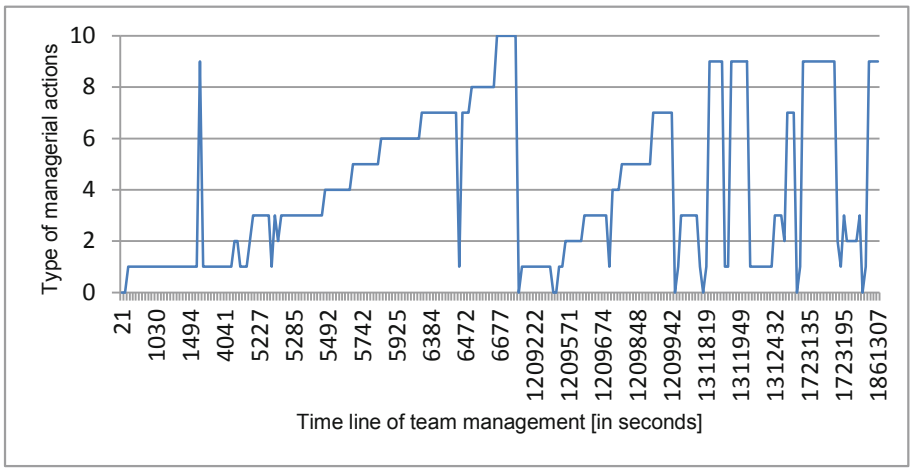


**Fig. 6.** Trajectory of team management by Manager 3. Source: Own elaboration

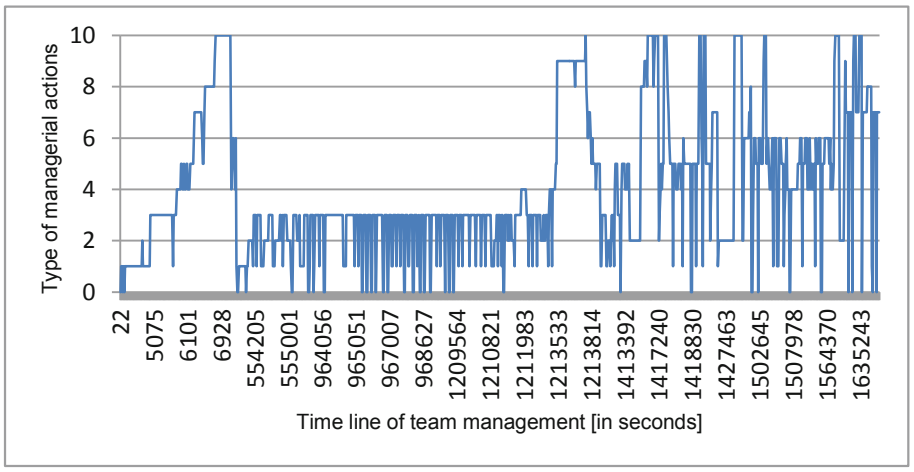


**Fig. 7.** Trajectory of team management by Manager 4. Source: Own elaboration

actions in Table 6 (parameter A) and the numbers of managerial tools in TransistorsHead corresponding to it (parameter B), we can see the suggested order of the use of the managerial actions. However, when we compare parameter B to any of the trajectories of team management done by managers, we can see that none of the managers obeyed the instructions jumping from one tool to another and taking one managerial action after another.

In the trajectories in Fig. 4, 5, 6, 7, 8 and 9 there are visible some packages of managerial actions similar to the order suggested in the instructions, however, when it comes to details, they are never the same or even similar to the sequence of managerial actions recommended in the instruction. The trajectories show how chaotic and random

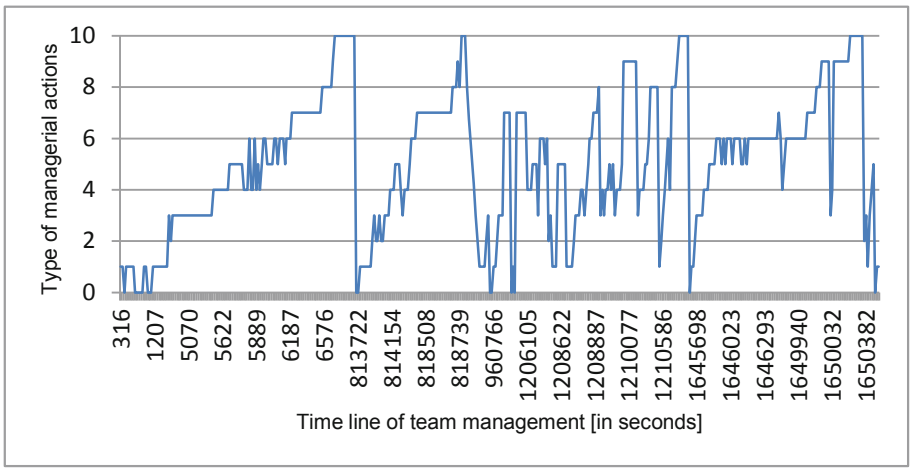


**Fig. 8.** Trajectory of team management by Manager 5. Source: Own elaboration

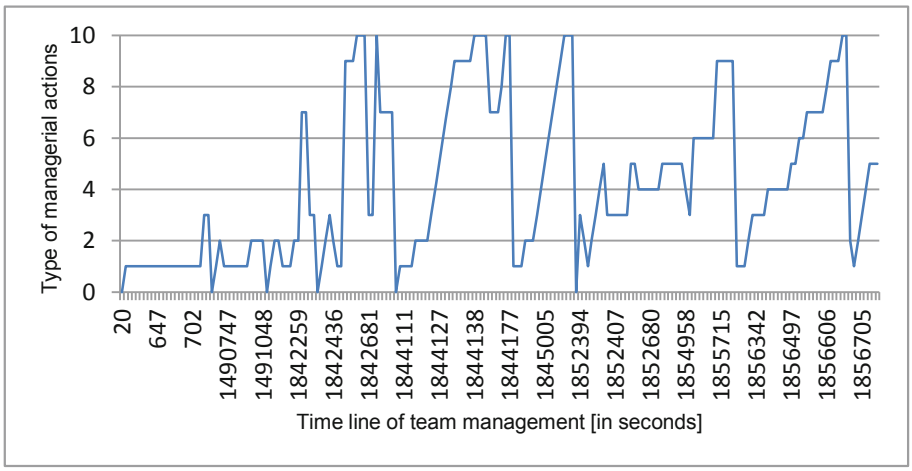


**Fig. 9.** Trajectory of team management by Manager 6. Source: Own elaboration

process occurred when the managers could use the online management tools. They had all ten tools available all the time on the dashboard and they tried to use them one by one, sometimes following an instruction about a step and again using some other tools as they were distracted by the number of possibilities on the screen. The comparison of the suggested order of managerial actions in Table 6 and their real trajectory in Fig. 4, 5, 6, 7, 8 and 9 clearly implies that the hypothesis H2 is true. It means that the use of the online management tools changes an order of managerial actions in team management compared to the given as the best to follow.

## 5 Conclusions

The idea of replacing human team managers with robots, presented in Sect. 1, was based on the assumption that managers could teach a machine by using managerial tools which would record managerial actions taken by team managers. At first sight, it seemed quite simple and the main challenge was to design an appropriate theoretical foundation (the system of organizational terms) and easy-to-use online managerial tools recording managers' behaviour. Nevertheless, these online managerial tools, used as typical measure tools, are likely to create some kind of a research noise, which can distort the recording managers' behaviour. As it was proved by the research, firstly, the activity of the managers in managerial tools was excessive compared to created effects, and secondly, the order of the taken managerial tools was completely different from the recommended as the best one in the instruction.

The naive research intuition can say that it is enough to record that the manager does in his work with his team in order to replace him by a machine or an algorithm and it lets build an artificial manager for this team. However, the research showed that the online managerial tools influenced the recorded managerial actions making them not as real as they could be without the tools. This influence of online management tools on team management was possible to be predicted and, on the ground of the recorded data presented in tables and figures in Sect. 4, it was particularly significant.

This as an important conclusion, because it appears that such measure tools as online managerial tools are not a perfect solution to the methodological problem, regarding how to acquire detailed knowledge what a team manager really does [54], which makes the research problem still valid.

Going back to a place of this research in team management automation, it is necessary to claim that the estimation of the research bias caused by the online management tools used as research tools is crucial in a process of design such online management tools. In the future more detailed research is needed and it is planned to compare team management with online tools and without online tools, which would give further conclusions on "human-computer interaction" in the perspective of team management automation.

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