Managing the Process of Evaluation of the Academic Teachers with the Use of Data Mart and Business Intelligence

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Abstract:

Purpose: The purpose of this research is to present the original model of management of academic teachers' remote work evaluation that implements an analytical approach.
Design/Methodology/Approach: Desk research and interview method have been applied in this paper. The literature review concerned two areas, i.e., the analytical approach to management and the management of university educational processes. Unstructured interviews conducted with university authorities located in Poland were the second research method applied.
Findings: Based on literature studies, conducted interviews and authors' personal experience, the original model of academic teachers' remote work evaluation that implements an analytical approach and utilises data mart concept and business intelligence tools has been created. This model contains the following elements, the conceptual model of data mart allowing the evaluation of courses realisation and teachers job, KPIs utilised in this evaluation, and the dashboard presenting KPI's values. Two main areas representing courses evaluation and teachers' evaluation have been considered.
Practical Implications: The authors propose the solution that utilises an analytical approach to improve the management of the evaluation process of educational processes at the university. Created model may be a valuable source of inspiration for university authorities responsible for ensuring the high efficiency of these processes, and for people responsible for developing teachers' competencies. According to the authors, the implementation of this model can contribute to the improvement of the academic education.
Originality/Value: An analytical approach in evaluation of educational processes proposed by authors is innovative in nature and is particularly important in the context of increasingly widespread remote education. Its adoption to management states a big challenge for university authorities.

Keywords: Management, job evaluation, KPI, data mart, business intelligence, academic teacher.
JEL codes: M15, C88, M54, O32.

Paper Type: Research Paper.

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1. Introduction

The contemporary organizations, operating in a dynamically changing environment, have not only to react quickly to the constantly emerging opportunities and threats but first, take up the challenge of properly anticipating new trends and building long-term strategies that guarantee success in a long-term perspective. However, analysing the current situation and forecasting the future is becoming increasingly difficult and complex. This is related to the huge increase in the amount of data generated both within the organization and in its environment.

Nowadays, the data analysis in management process has become more important than ever. The nature of data used in this process, i.e., their amount, complexity, and diversity, causes that they must be converted into a form useful in the evaluation of the chosen area of reality. This transformation requires the utilisation of different types of analytical techniques and advanced information technology (IT) which enable one to find the relationships between employees' performance and the organisation's outcomes more effectively.

A contemporary university is an organization that is increasingly being compared to an enterprise. Students are perceived as clients, marketing and image-building activities of the university are modelled on business solutions, and formalised human resources management processes concern not only administration employees but increasingly often also academic teachers. At the same time domination of information technology and related digitalisation and computerisation of work are visible in almost all processes realised in higher education institutions. These phenomena lead to a significant increase in the amount of generated and processed data, which, however, are not utilised properly, especially to evaluate the realisation of teaching processes. Modern universities must work in many areas in the same way as enterprises, which are using key performance indicators (KPIs) to evaluate their way of running. The analytical approach to management must be applied not only to manage financial, physical, or human resources but also to manage key processes like education. The university authorities at all levels, i.e., rectors, deans, heads of departments, should evaluate the efficiency of using these resources in educational processes realisation among which the academic teachers are the most important.

The paper presents the original model of management of academic teachers' remote work evaluation that implements an analytical approach and utilises data mart concept and business intelligence tools. It considers different aspects of academic education resulting from the limitations related to the COVID-19 pandemic.

## 2. The Analytical Approach to Management

The globalisation and competitiveness are the phenomena mostly associated with business organisations. However, B. Daniel notes that "more and more universities

are operating under increasing pressure to face the challenges of national and global economic, political and social change such as the growing need to increase the proportion of students in certain disciplines and ensuring that the quality of curricula are both nationally and globally relevant" (Daniel, 2015).

Achieving high effectiveness of the implementation of the university's mission as well as a significant and constant strategic advantage require the implementation at the university a new approach referred to as data-driven management or, in other words, relating to decision making based on data analysis. It is becoming a requirement of modern times and ensures high efficiency of the organisation's functioning (Morrison, 2015). The potential hidden in the common use of data analysis enables organizations to discover a lot of new information and creates conditions for increasing their own value on the market (Anderson, 2015). Therefore, data analytics, i.e., the process of transforming raw data into a form enabling decision making is crucial (Liberatore and Luo, 2010). Watson (2009) sees analytics as a broad category of applications, technologies, and processes that enable the acquisition, collection, sharing, and analysis of data and support decision-makers in managing the units. Currently, the data-driven management approach is applied to a limited extent in universities. The main reason for this situation is the low common culture of using this type of solutions, which is caused by a lack of competent employees who can properly acquire and interpret data and transform it into appropriate actions leading to success (Moon, 2015). The use of an analytical approach requires managers to have extensive knowledge in the field of data analysis, knowledge of software for performing statistical analyses, and the ability to properly interpret their results.

According to Attaran *et al.* (2018) higher education institutions can utilise analytical solutions to transform many activities, including enrolment, student support, alumni engagement, and other learning functions. They proposed a conceptual approach for implementing analytics in higher education shown in Figure 1.

Figure 1. *The conceptual approach of analytics use in higher education institutions*
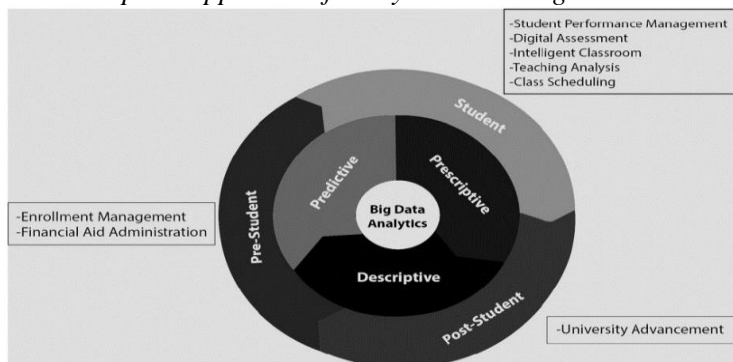
Source: Attaran et al., 2018.

The high value of this concept is created by two aspects. The first one considers the full student lifecycle. This makes it possible to find relationships between successive stages of student academic education. The second aspect is the approach leverages all types of analytics that assure finding the responses to the questions regarding the past, the present, and the future.

The business cases show that analytics play a crucial role in the management processes in modern organisations, and the deployment of analytics helped them to be more competitive on the market. Therefore, the analytical approach should be universally applied in all areas that affect the university's outcome (Marin-Diaz *et al.,* 2016). The COVID-19 pandemic has changed the existing way of education, forcing remote work (Khan *et al.,* 2020). In these conditions, the need to manage academic personnel and their work, as well as the evaluation of teaching outcomes, becomes stronger than ever. According to Mohr and Hürtgen (2018), there has never been a better time to understand the importance of analytics in contemporary institutions of higher education.

3. IT Solutions Supporting the Management of Educational Processes

Many universities are using different IT systems that support the processes realised in the area of academic education (Hauser and Ryan, 2020). Most of these solutions have been implemented to make an evidence of students' and teachers' activities. Their main functionalities are related to creating a detailed description of operational processes like enrolment the courses, conducting the tests and exams, giving the grades, leaving the opinions about teachers and courses, etc. Villegas-Ch *et al.* (2020) notice that the information systems administered by universities store a large volume of data on the academic variables of the students.

However, these data are generally not used to create knowledge about the students, unlike in the business field, where the data are intensively analysed to gain a competitive advantage (Villegas-Ch *et al.,* 2020). The reason for that is these systems do not offer the functionalities that allow one to perform the analysis concerning different aspects of the educational process.

The COVID-19 pandemic changed crucially the way of getting and verifying the competencies of students. Many universities have been forced to introduce remote education as the only available teaching method. The consequence of that is the widespread utilisation of computers and different software that allow teachers to conduct the classes, and students to attend them. Such digitalisation of all activities undertaken in the frame of academic education caused that many new data sources have occurred which can be utilised to evaluate the job of academic teachers (Ardito *et al.,* 2021). Different platforms like Microsoft Teams, Moodle, Google Classroom, Zoom, or Webex create the perfect conditions to teach the students and verify their competencies. All these IT solutions generate many useful data that can be used by the teachers as well as by the university authorities to assess the

students, teachers, and the course realisation. There is, however, a certain problem that makes the analysis of the didactic process difficult. All platforms are running separately and are not integrated with each other. It means that the same didactic activities are described in a different way using different terms, heterogeneous data formats, and isolated databases. The data collected in these systems are not useful for the purpose of evaluation of teachers' and students' activities. They only describe the processes these people are involved in, not the value of these activities. The monitoring and the evaluation of their behaviour must be made on the basis of data with a higher level of aggregation, which better reflects the nature of the educational phenomena.

The efficient analysis, generating valuable and useful results, requires building the environment that creates one common view at the area that is the subject of the interest of academic teachers and their superiors. The requirement to possess one central store of analytical data can be satisfied by building the IT solution that utilises the data warehouse or the data mart. W. Inmon, the father of the data warehouse concept, defines it as "a subject-oriented, integrated, non-volatile, and time-variant collection of data in support of management's decisions" (Inmon, 2005). According to Kimball and Ross (2013), the data warehouse is constituted of many smaller and consistent data marts that are subject oriented on the departmental level of the organisation, satisfies their departmental information needs, and address the department's analytic requirements. Both approaches have a common feature. They require data gathered from inner transactional systems or other external sources, and then its transformation into the form that allows one to perform multidimensional analyses.

The possession of analytical data does not generate value for their owners yet. To get the information needed in the evaluation of teachers' job and courses, it is necessary to visualise data in an appropriate, readable and humanly understandable way. It can be done using business intelligence tools. One of the easiest and very popular tools is MS Excel or Apache OpenOffice Calc. But the main disadvantage of these tools is a lack of connectors to the databases used in the data mart. Therefore, there are being utilised in practice other tools like Microsoft Power BI or Tableau Desktop that offer more sophisticated functionalities allowing not only data visualization, but also data transformation to create new measures describing quantitatively the analysed area. The awareness that data have a business value, and the analytical attitude is a necessity in modern universities, as well as the widespread use of different IT tools, are the excellent starting point to create the management model to increase academic teachers' efficiency and involvement.

The implementation of the approach that utilises data marts and business intelligence require one to know the terms that are specific for this domain. There are the following ones:
- Fact – the subject (the area of reality) that will be analysed, e.g., students' satisfaction, students' engagement.

- Dimension – the feature that allows one to describe the fact from the certain point of view, e.g., time, students, course.
- Measure – the feature that allows one to describe the fact in the measurable (quantitative) way, e.g., number of students who expressed the opinion, satisfaction level.

There are different dimensions and measures that can satisfy the information needs of individuals who will use the results of these analyses in the management of academic education processes.

4. The Essence and the Utilisation of Measures in Analytics

The usability of the data mart and business intelligence depends on the proper choice of facts, dimensions, and measures that must be consistent with the purpose of the analysis. Considering greater number of dimensions, it is possible to perform the analysis with the higher level of details. The set of measures stored in the data mart can be extended in BI tool by defining new calculated measures, so-called indicators. This approach allows one to create a better view of academic education in the university. However, the excessive number of measures and indicators makes this task more difficult. Therefore, Parmenter (2020) proposes to group them into the following way:

- Key result indicators (KRIs) give the board an overall summary of how the organisation is performing.
- Result indicators (RIs) tell managers and how teams are combining to produce results.
- Performance indicators (PIs) tell managers what teams are delivering.
- Key performance indicators (KPIs) tell managers how the organisation is performing 24/7, daily, or weekly in their critical success factors.

Additionally, Parmenter recommends keeping a proper proportion between the numbers of particular measures. There should be used about 10 KRIs, up to 80 RIs and PIs, and 10 KPIs (Parmenter, 2020). In turn, Kaplan and Norton (1996) recommend no more than 20 KPIs, and Hope and Fraser suggest fewer than 10 KPIs (Kaplan and Norton, 1996). Looking at the subject of analysis from the time point of view, there can be noticed that the measures can be applied to describe the past, the present, and the future. According to Parmenter, the proper set should contain a mix of 60 percent past, 20 percent current, and 20 percent future-oriented measures (Parmenter, 2020).

Independently of the type of measures (or indicators), they provide the following three basic functions (Franceschini *et al.,* 2019):
- Control – indicators enable managers and workers to evaluate and control the performance of the resources that they are supposed to manage.

- Communication – indicators communicate performance to internal workers and managers, and to external stakeholders too.
- Improvement – indicators identify gaps (between performance and targets) that ideally point the way for possible improving actions. The size of these gaps and their direction (e.g., positive, or negative) can be used to adjust/plan corrective actions.

The set of measures, i.e., their number and types, used in the evaluation of processes and individuals as well as in decision making is strongly related to the area of the activity of the organisation and its size. Business organisations are using many more measures than universities. But in any case, when designing the measures, it is worth to avoid mistakes that make the analysis useless and lead to wrong conclusions. The biggest mistakes are measuring too much, treating all measures as KPIs, confusion over outcome and operational measurement, a lack of connectivity with the organization's critical success factors, and relying too much on past measures (Parmenter, 2020). The proper choice of measures is the key factor that affects the success and usability of the analytics implementation in the contemporary organisation.

5. Methodology

The research purpose is to find an answer to the following question: How can an analytical approach be implemented in the management of educational processes in the university? The subject of the research is the evaluation process of remote teaching.

Two methods were utilised in the research, i.e., desk research and interviews. The desk research included a review of scientific publications on the analytical approach to management and the management of educational processes in universities. However, the unstructured interviews, carried out in the period May-June 2020, i.e., during the conduct of remote education in universities due to the COVID-19 pandemic, were conducted with 33 university unit managers employed in various positions, i.e., rectors, deans, and heads of departments. The respondents represented authorities of technical, humanities, economic, and medical universities located in Poland.

Based on literature studies, conducted interviews, and the authors' personal experience, the management model of academic teachers' remote work evaluation that implements an analytical approach has been created.

6. The Concept of Data Mart and Business Intelligence Use

The benefits of the data mart and business intelligence implementation reported by many business organisations and widely presented in the literature of subject (Anderson, 2015; Coronel *et al.,* 2020; Deloitte, 2020; Findikli *et al.,* 2020; Olszak,

2020; PwC, 2019; Smith *et al.,* 2019) have led the authors of this paper to create the concept of the implementation of this approach in the higher education area to evaluate the job of academic teachers. The existence of the rich set of digital data sources generated in the frame of remote education strongly supports the realisation of the idea to build analytical solutions that will assure better performance and quality of educational processes.

Figure 2. *The architecture of the analytical system*
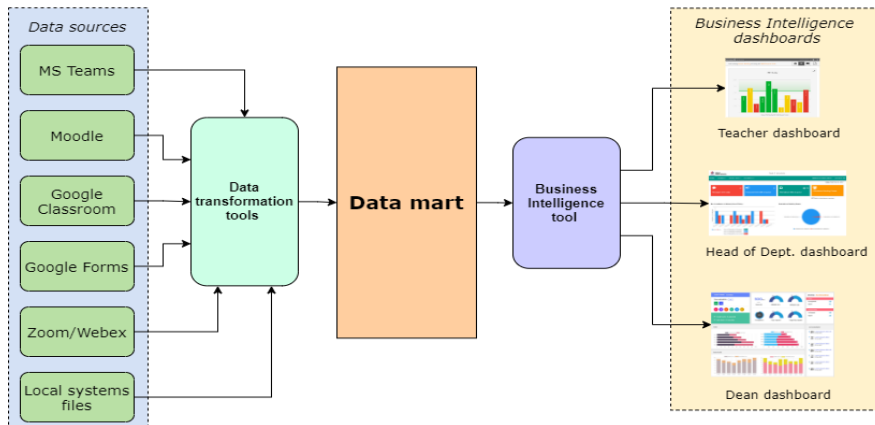
Source: *Own elaboration.*

Figure 2 presents the architecture of the analytical system that contains five layers. The first one represents data sources, i.e., different IT platforms used while teaching the students. They generate data in different formats and may describe the same objects and processes in a different way. Therefore, there is a need to transform these data into one common form that will ensure the consistent and uniform description of the subject of analysis. Data transformation performed in the second layer will also improve the efficiency of future analyses. There are many data integration and transformation tools among which the following ones can be worth to be mentioned, Talend Open Studio for Data Integration, Pentaho Data Integration (Kettle), or Informatica PowerCenter.

After proper transformation, data will be loaded into the third layer, i.e., into the data mart. It is a place of data storage designed according to the rules applied for analytical databases. The data organisation is based on data models used in these types of solutions, e.g., star, snowflake, or constellation schema. The data mart contains tables that represent the facts and dimensions identified while the definition of the information needs of managers.

The fourth layer is constituted by business intelligence tools like Microsoft Power BI, Tableau Desktop, QlickView, or Google Data Studio. The main purpose of these software use is the preparation of analytical reports and dashboards. Additionally, the functionalities of these platforms allow one to create so-called

hierarchies for dimensions that are useful while generating results of more detailed analysis. Currently, most of BI tools are very intuitive and they can be utilised also by the users not equipped with advanced IT skills.

The fifth layer is represented by reports and dashboards that deliver the information adequate to the type of the user. The most useful are the interactive dashboards because they allow users to discover new information by drilling down and switch between different visualisations to explain the selected activity area. The type of visualisation should be consistent with the nature of the presented data, and the content – readable and understandable for the user. In fact, the usability of the entire analytical system is perceived and assessed based on the value delivered in the fifth layer.

To present the usefulness of the presented concept in the evaluation of the academic personnel concerning remote education, there has been created the model that contains the following elements: the conceptual model of data mart allowing the evaluation of courses realisation and teachers job, KPIs utilised in this evaluation, and the dashboard presenting KPI's values. There will be considered two main facts representing courses evaluation and teachers' evaluation. Figure 3 presents the conceptual model including both facts. The fact *Course Evaluation* has been described by the following dimensions: *Time*, *Class type*, *Platform*, *Teacher*, *Course*, and *Student*. This set of dimensions ensures the possibility to perform detailed analyses of remote teaching the students considering many different points of view that are crucial for both university authorities and teachers.

Figure 3. *The conceptual model of a data mart for evaluation of course realisation and teachers' job*
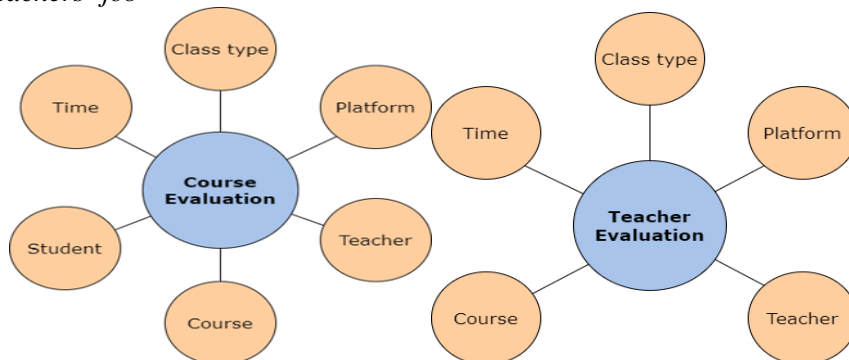
Source: *Own elaboration.*

The fact *Teacher Evaluation* has been identified to allow heads of department or deans to evaluate the job of academic teachers. The dimensions used to describe this fact are as follows, *Time*, *Class type*, *Platform*, *Teacher*, and *Course*. Although the *Time* dimension occurs in both cases, it will be, however, described with a different level of detail for particular facts. In the case of the first fact, the time is

defined with the precision of days. It means that the analysis of course performance can be conducted considering every single day when there are the classes. The *Time* dimension used for the second fact should not be defined in the same way. The reason for this is that storing data about a teacher's job in such short units of time does not allow the superior to get the true picture of subordinate's engagement in teaching the students. Therefore, this dimension for the fact *Teacher Evaluation* shall be described at least on the level of the week.

The existence of the conceptual model of data mart allows one to move to the next step that is the definition of the set of KPIs that will play the key role in management. They allow one to assess the degree of achievement of the operational and strategic organization's goals. KPIs are of great importance for building an outcome-oriented organizational culture, as they are for the managers a source of objective evaluation on subordinates' work, its costs, and quality. These indicators are also a tool of managerial control, as they allow one to quickly make decisions, plan and prioritize activities, and react to emerging problems. They also support the process of continuous improvement of employees' competencies and the efficient utilisation of resources owned by the organization (Badulescu *et al.*, 2018). The sets of KPIs for particular facts proposed by the authors of this paper have been presented in Table 1 and Table 2.

Table 1. *KPIs used in the evaluation of remote course realisation*

KPI	Description
Number of enrolled students	The number of students who enrolled in the course on the platform
% General student activity rate	The ratio of the number of students who did at least one activity on the platform to the number of all students enrolled in the course
% Student interaction activity rate	The ratio of the number of students who interact at least once with online course materials to the number of all students enrolled in the course
Interaction with course materials	The number that describes how often students interact with online course materials
Course site visits	The number of visits to the course site
Course site visits rate	The ratio of the number of visits to the course site to the number of all students enrolled in the course
% Returning students rate	The ratio of the number of students who return to the course site within a unit of time to the number of all enrolled students
Students engagement rate	The ratio of the number of all online activities performed by the students to the number of students enrolled in the course
Activity to visit rate	The ratio of the number of activities undertaken during the visit to the number of visits
% Attendance rate	The ratio of the number of students who attended the class to the number of all enrolled students
% Tests completion	The ratio of the number of students who passed the

rate	test on their first attempt to the number of students who took the test
Number of test executions	The average number of attempts the student needed to pass the test
Students satisfaction rate	The value from the range 1 to 10 that informs about the student satisfaction with the course (according to the students' opinions)
Time on course site	The average time spent on the course site
Bounce rate	The ratio of the number of visits to the course site without any activity to the total number of visits
Pages per visit	The number of pages (places within the course site) visited during the single visit to the course site

Source: Own elaboration.

**Table 2.** *KPIs used in the evaluation of teacher's job in remote teaching*

KPI	Description
Time on platform	The average time spent on the platform (hours)
General teacher performance rate	The ratio of the number of actual hours spent on the platform to the number of planned hours according to the scheduler
% Teaching activity rate	The ratio of the number of hours teaching the students to the total number of all online hours
% Extra teacher activity rate	The ratio of the number of other hours than teaching spent with students to the total number of all online hours
% Organisation activity rate	The ratio of the number of hours without contact with students to the total number of all online hours
Students satisfaction rate	The value from the range 1 to 10 that informs about the student satisfaction with the course (according to the students' opinions)
Teacher engagement rate	The value from the range 1 to 10 that informs about the level of engagement of the teacher (according to the students' opinions)
Uploaded course materials	The number of course materials uploaded by the teacher to the platform
Response time	The response time of the teacher to the message sent by the student (email, chat, forum) expressed in hours
Initiated activities	The number of online activities, e.g. email, chat, forum post initiated by the teacher

Source: Own elaboration.

The sets of KPIs presented above are the authors' proposal created based on the interviews with university authorities (rectors, deans, heads of departments) and their own experience in remote teaching. However, they do not exhaust all possible ways of the academic teacher's job evaluation. They can be modified depending on the purpose of the analysis and, consequently, the information needs defining by

managers of the conceptual model of a data mart, described in this article, there has been designed a dashboard, presenting examples of values of KPIs listed in Table 2, which delivers information to the superior about academic teacher's job and performance while remote teaching (Figure 4).

Figure 4. *Example of a dashboard for the superior of an academic teacher*
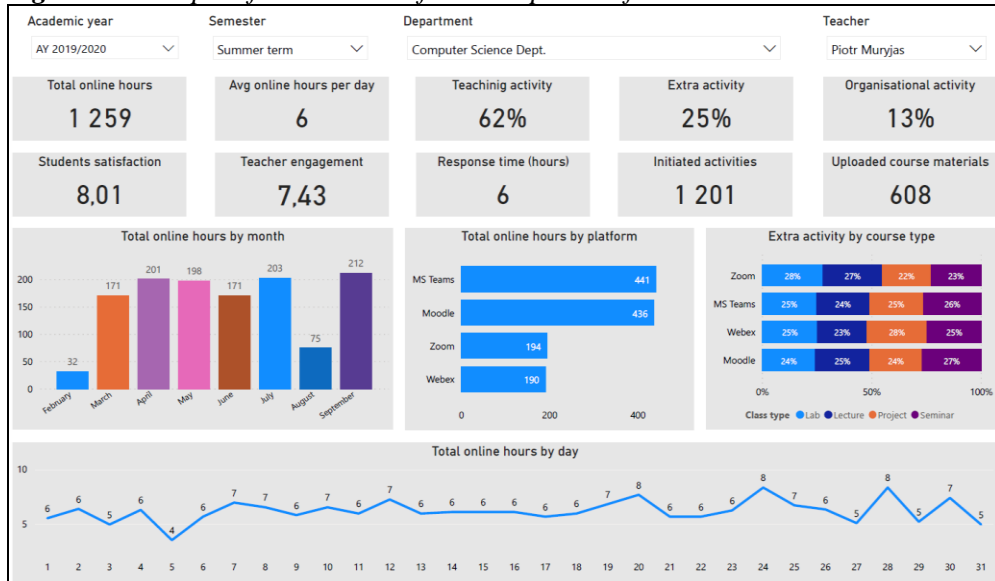
Source: Own elaboration.

The visualisation techniques applied here have been chosen accordingly to the type of information provided by components and its importance for managers. The dashboard is interactive what means that the user can filter data using the following criteria: the academic year, the semester, the department, and the teacher. Moreover, by clicking on any bar or column chart all other data, except previously used filters, will be updated according to the selection made. This way, the managers will obtain more detailed data that allow them to better understand the analysed fact.

7. Conclusions

Nowadays, many universities are faced with new challenges related to the restrictions created by COVID-19 pandemic. In these conditions, the way of university management must be modified due to the new paradigm of academic education, where the teaching is no longer based on the direct face-to-face contact of the teacher with the student. In many cases, remote teaching became the only way of academic education. However, in these conditions, one requirement remains the same – the learning outcomes have to be coherent with these that have been defined in existing curricula. Therefore, the innovative methods of management of the educational processes and the evaluation of an academic teachers' remote work in this context assume currently growing importance.

The information systems utilised by universities in the field of education store a huge amount of data that are not used properly to get the knowledge about the teaching processes and academic teachers' performance. The business cases when data are being intensively used to support management and improve the outcomes, confirm the high value and usability of data in achieving the aims of organisation. Therefore, modern universities should replicate solutions already verified in business that will ensure high efficiency of educational activities.

This paper presents the original model of utilisation of data mart and business intelligence that allows one to perform the objective evaluation of academic teachers' job. This model makes possible to transform data into information useful for management. In the authors' opinion, the application of the proposed approach can have a significant impact on improving the quality of academic education.

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