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Abstract

Functional diversity in teams is one of the widely studied issues in strategic management. It is studied from different points and at different organizational levels. In this thesis, we attempt to consider the problem of functional diversity on the example of research articles. Research articles are one of the most popular ways in the modern world to obtain information and knowledge on a subject of interest. Moreover, it is one of the most effective way to convey the idea, the point of view, the results of the work which have been done by the author on the question of interest. Furthermore, the questions raised in research articles are also a part of the current information field of the modern business community. But it is not apparent how to make articles more readable, what is needed for them to become popular among people, who should be the author or authors to bring the material to success. Do any factors that can affect the citation of articles exist? This thesis proposes research based on manually collected data about the articles published in the Strategic Management Journal from 2014 to 2017. Articles can be written by an author or a group of authors. Groups of authors can be functionally diverse; they can be from the different field of study, can work in different universities and for sure cannot have the same experience and level. As an indicator of success or as teams' performance the numbers of citations were considered. All statistical tests were carried out in Stata. Based on the researcher's results this thesis explained how functional diversity affects the team performance in a case when we consider the authors of research article as a team and the number of citations as a team performance. In other words which factors can be taken into consideration during the planning of research article creation to make the article more frequently cited.

Keywords: functional diversity, team performance, articles citation.

Zusammenfassung

Eines der am meisten diskutierten Themen im strategischen Management ist „Functional Diversity“. Dieses wurde aus verschiedenen Perspektiven, sowie auch auf verschiedenen organisatorischen Ebenen erforscht. In dieser Arbeit betrachten wir den Aspekt der „Functional Diversity“ in wissenschaftlichen Arbeiten. Um Fachwissen und Kenntnisse über ein bestimmtes Thema zu erlangen, sind wissenschaftliche Arbeiten eines der beliebtesten Quellen. Außerdem ist es auch einer der effektivsten Wege für den Autor seine Idee, die verschiedene Betrachtungsweisen und um seine Forschungsergebnisse zu präsentieren. Darüber hinaus sind die dort diskutierten Fragestellungen ein Teil der Informationsquelle der modernen Business Community. Es ist nicht offensichtlich was erforderlich ist um eine wissenschaftliche Arbeit beliebt und lesenswert zu machen. Welcher Autor oder Autoren bringen die richtigen Mittel zum Erfolg. Haben bestimmte Faktoren Einfluss auf die Häufigkeit der Zitierungen einer Arbeit. Für diese Arbeit wurde Daten über wissenschaftliche Artikel gesammelt und ausgewertet, die in dem „Strategic Management Journal“ von 2014 bis 2017 erschienen sind. Diese Artikel sind entweder von einem Autor oder von einer Gruppe von Autoren veröffentlicht. Die Autoren einer Gruppe können sich fachlich unterscheiden: sie können aus unterschiedlichen Fachgebieten oder von verschiedenen Universitäten kommen und natürlich haben sie nicht dieselben Erfahrungswerte. Die Anzahl der Zitierungen einer Arbeit wird als Indikator für dessen Erfolg gewertet. Alle statistischen Tests wurden in STATA ausgeführt. Basierend auf den Ergebnissen, wird in der Arbeit der Einfluss von „Functional Diversity“ auf den Erfolg einer wissenschaftlichen Arbeit erklärt. Wobei folgenden Annahmen getroffen wurden: die Autoren einer Arbeit bilden das Team und der Erfolg der Teamleistung an der Anzahl der Zitierungen gemessen wird. Es wird untersucht, welche Faktoren in Betracht gezogen werden sollten bei der Planung einer wissenschaftlichen Arbeit, damit diese oft zitiert wird.

Schlagwörter: Funktionsvielfalt, Teamleistung, Artikel zitieren.

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1. Introduction

The question of functional diversity in teams is a broad field for studies and thoughts, and it could be covered from different perspectives.

In this work, we would study this question from the side of the interdependence between functional diversity and team performance. How does functional diversity contribute to team performance was also studied by many researchers. But what is the functional diversity itself? This concept can have several meanings, so we have to define that further in this work by functional diversity we consider the idea that individuals with a variety of educational/ working/ any other background can work together more effectively. A variety of different conceptualizations already exist. In this research, we will move from the general to the particular question.

In this work, the problem of functional diversity in teams would be considered regarding the success of the research articles. Creation of the research teams could be a key factor of the team performance which in our case is a research paper success measured by the number of citations. Nowadays it is possible to find a huge number of scientific publications, articles, and researches. Not only people who are part of the scientific world are interested in such publications, but also students, people who are interested in self-education, every year more and more people and especially young people are interested in it.

Research articles are one of the most useful resources to get consolidated information on a particular question. Despite that, on the one hand, it always contains some point of view which belongs to the author and proved or rejected by research. On the other hand it always also contains some theoretical background and overviews of other thoughts and studies so you can always build your own opinion and think about the problem from different points of view.

By team performance in our work, we will consider the number of citations obtained from Google Scholar. The group of authors would be considered as a team. Thus, in the context of this work, the definition "group of authors" and "team of authors" are identical. We will try to identify whether we could say that functional diversity in such a team really makes sense and we also will investigate how we

can recognize that such team is functionally diversified. By functional diversity in groups of authors, we will consider factors as the number of team members (authors) for each article, the University in which the authors were working at the moment of publication and the fields of authors' specialization studies and interests (areas of expertise). We will also check some other factors, which can influence the number citations such as the number of authors, h-index, i10 index, the number of articles which have already been published in the Strategic Management Journal.

Strategic Management Journal (SMJ) was chosen as a data source for data collection. It is a journal that is published 13 times per year since 1980. It is one of the most respected scientific journals in the field of Business Administration.

The main purpose of this work is to identify the influence of team diversity on team performance by analyzing the data taken from the Strategic Management Journal. In other words, we would like to answer the question "Is there any interdependence between the number of citations and functional diversity in groups of authors?". For the statistical part of the work, we would use Stata and R to check the hypothesis, since these programs are the most popular programs used for these purposes.

2. Literature review

2.1 Applicability of functional diversity for research teams

Almost all articles in Strategic Management Journal are written by universities' professors, Ph.D. students, professors' assistants or any other people who are related to the university and the educational process. In terms of this work, we would consider university as an organization like any other. And when the universities' professors, Ph.D. students or any other members form a research group or a group of authors for creating research articles the team composition become a strategic question since all the members are interested in the success of their research. The composition of the research teams will directly affect the working process and their performance. „ The creation of research teams has become an important mechanism for generation of knowledge, as they are considered to be the basic unit of the research system in many disciplines „ (Perianes-Rodríguez et al., 2010)

"Some task-related attributes of the research teams affect their number of publications in a linear way and other in non-linear one" (Hormiga, Saá-Pérez, Díaz-Díaz, Aguiar-Díaz, and Ballesteros-Rodríguez, 2017). In this research, the authors analyzed which influence has the functional diversity in academic research teams on their scientific performance. In the empirical study, a sample of existing research groups in a Spanish University from 2006 to 2009 was used. The source of information for that empirical study was the set of annual university's reports. They analyzed the numbers of research groups by each year, also the composition of the groups: number of group members, gender, position, place of work, to which knowledge areas these groups belong, and some others work related attributes. The results did not show any significant influence of functional diversity on academic research performance which was measured by three variables: the number of published articles per research team each year of the period 2006-2009, publications in local journals and international ones.

Based on study results functional diversity is important for international publications. However, the relationship between functional diversity and team performance may have both positive and negative sides. „Diversity can encourage an exchange of information, intellectual debate and knowledge creation; nevertheless, it can also produce communication and coordination problems among team members. Too much disparity can lead to the breaking up of the team when the members stop communicating and collaborating or even block the effort of the others" (Stvilia et al., 2011). The teams' members must understand the mixed effects of diversity and organize the work, the interaction between members, try to create, discuss, modify and apply new ideas in such way that it would be possible to increase their performance.

2.2 Typology of teams and goals

We will start the literature review with considering the typology of teams and goals since all the teams have goals or purpose of creation. Each team sets its own goals. Goals are created to fulfill the tasks facing the team and to support the organizational mission. Team efforts and team goals can be broken down into three parts:

1) The definition of a workflow or decision that corresponds to the organizational vision, or their improvement;

2) Development of recommendations for the implementation of these processes, decisions, and improvements;

3) How to implement these recommendations.

A team can be created for any purpose. In some cases, teams have interdependent goals: one team does its part only after the other has done its part.

Researchers have not yet come to a standard typology of teams. One of the classifications supposed that there are two main types of teams: cross-functional and intact teams (Donna McIntosh-Fletcher, 1996).

A cross-functional team is formed from representatives of various departments of the formal organization and reflects their interests. Teams of this type are characterized by the presence of a specific, one-time task, denoting the result, problem or opportunity. The duration of the team is determined by the completion of the task. For team members, work on a task is secondary to their main job. The team leader may be formally appointed or selected from the team members.

An intact team is a production unit or a long-term working group that produces a specific product or service. This type of team can have a manager who, while not being a member of a team, ensures the order and coordination of work, which allows team members to focus their efforts on assigned tasks. In other cases, the team may have a leader who is a member of the team, who also holds meetings and coordinates team interactions with other groups. In some cases, the role of a leader can also be performed alternately by members of a group as their leadership skills develop or depending on the situation.

“When we speak about functionally diversified teams, we can operate with such a concept as cross-functional teams. “Cross-functional teams are groups consisting of members of different functional areas,

(…) such as engineering, manufacturing or marketing. The cross-functional makeup provides the advantages of multiple sources of information and perspectives." (Keller, 2001).

Another approach distinguishes the following teams by the type of activity which the group performs in the organization (Katzenbach and Smith, 1997) :

- preparing recommendations;
- production teams;
- control commands.

Moreover, each of the team can be at one of the following levels of development of group activity, depending on team efforts - the effectiveness of the interaction of group members:

- working group;
- pseudo team;
- potential team;
- real team;
- high-performance team.

A working group is a group that does not need to increase the efficiency of joint work, or it is not possible to become a team. Group members interact with each other primarily to exchange information, work experience or to determine prospects and make decisions to help everyone work within their area of responsibility. In such groups, there is no common goal and mutual responsibility. Unlike teams, working groups rely on the amount of "individual benefits" needed to complete the work. They do not aim at the collective production of a product requiring joint efforts.

Choosing the path of the team, rather than the working group, people take the risk of conflict, join forces to produce products or services and use the collective actions necessary to determine the general direction, goals, activities, approaches to work and mutual responsibility.

A pseudo-team is a group that needs to increase the efficiency of joint work, it is possible to become a team, but it has not focused on the collective execution of work and is not trying to do it. Group members show no interest in defining and formulating the general direction and goals of the activity, although the group may call itself a team. Pseudo-teams have the lowest performance indicators because the methods of work they use to reduce the individual performance of each member and do not have the effect of combining. In pseudo-teams, negative synergy exists (the output of the whole team is less than the sum of the potential of the individual parts).

A potential team is a group that has a significant need to increase the efficiency of joint work, and it tries to do it. However, as a rule, such a team lacks clarity regarding the direction, goals, and process of the work. This group has not yet established collective responsibility, and it requires a higher level of discipline. Such teams are called potential teams, as their members take on the risks, trying to withstand the inevitable obstacles.

A real team is a group of few people with complementary skills, with a common direction of this skills, shared goals and working approach. In such a team, each member feels responsible for each other. Members identify the standard procedures and the processes of the set goals achievement. Each member knows that his contribution is necessary for the team effectiveness and to improve the expected result.

A high-performance team is a real team whose members are super-binding regarding the performance of teamwork. Working methods and teamwork contribute to personal growth and the success of team members. Such groups have an excess of synergy and achieve a result that exceeds the expectations of others.

According to the way of team creation, the following types of teams can be distinguished:

- Leadership team: This type of team is created by a leader who is also simultaneously an emotional leader within the team and the engine of workflows and even an organizer. The status of all team members is not the same. The personal sympathies of the leader have great importance in such teams. The distribution of roles and power is carried out not within a professional attribute but by proximity to the leader. Depending on the personality characteristics of the leader, his style may be different, from authoritarian to liberal, excluding conniving. The disadvantages of such teams are the impossibility to save the team if the leader leaves, the struggle for influence on the leader, the unwillingness to accept new people, especially if they can carry something new to the team.

- Democratic team: Leadership roles are distributed by the professional level and the desire of everyone to work together. The leader also exists in such type of team, and he is responsible for everything alone. There can be several leaders, and they are also responsible for their group or their direction. Allocation of leaders follows the path of implementing the functional roles of two types: target roles and support roles. One person is not able to fulfill all the functional roles so that they will be distributed among the team members.

- Self-organizing team: there is a separation not only of a leadership role, but also functions of the chief role. This type of team does not need a manager who will assign the work, goal, deadline and so on. Each member should communicate and trust other members.

We will assume that the groups of authors who write the research articles are self-organizing teams. It is not possible to say with 100% probability that the authors organize themselves into teams/groups for writing articles, but since we assume that this is non-binding, the authors can choose themselves what they want to write and with whom. Therefore, further in this work, we assume that we are dealing with the self-organizing groups. Self - organizing groups are becoming more attractive in the conditions of modern reality.

Also, self-organizing teams are a widely used concept in Agile software development which also indicates a growing interest in this type of groups. Under self-organizing groups, we further would assume such teams where the members manage their work, organize surrounds, organize details of the tasks and can influence team effectiveness (Moe and Dingsoyr, 2010). In this way, the definition suggests that self-organizing groups can increase the effectiveness by a successful composition of a team. In our case, we suppose that groups are self-organizing and the effectiveness depends on team diversity. However, we considered this concept of self-organizing groups here to emphasize that further in this work we suppose that the team's effectiveness depends on the composition of the group. We will try to understand which of the considered factors should be taken into consideration when it is necessary to form the team for writing a research article.

Another important aspect nowadays is flexibility. The survey which was conducted by multinational consulting corporation Deloitte in 2016 and based on data obtained from more than 7000 managers from more than 130 countries has shown that many firms are going to change their organization of work from traditional to the side of flexible teams. Flexible teams are considered as authorized teams since the members are allowed to decide on the composition of teams, can choose between the projects, can autonomously plan, work and realize the ideas. We can also apply the flexibility to our model and say that groups of authors have a high level of flexibility.

It is necessary to highlight that it is common to distinguish between the two definitions «group» and «team». «Group - not a team who share the goal of high quality written, but work independently of each other» (Donna Deeprose, 2001). According to business dictionary «A team - is a group of people with a full set of complementary skills required to complete a task, job, or project. Team members (1) operate with a high degree of interdependence, (2) share authority and responsibility for self-management, (3) are accountable for the collective performance, and (4) work toward a common goal and shared rewards. A team becomes more than just a collection of people when a strong sense of mutual commitment creates synergy thus generating performance greater than the sum of the performance of its individual members. Whereas group is a collection of individuals who have regular contact and frequent interaction, mutual

influence, the common feeling of camaraderie, and who work together to achieve a common set of goals». However as was mentioned in the beginning of this work, here and further we will use both of the words as synonyms, we will consider that we deal with groups of authors which are also teams since the authors depend on each other, they share responsibility for the research and are accountable for performance (in our case we measure it through citations) and they have a common goal which is to conduct a research.

2.3 Functional diversity concept

«An extensive body of research, in a variety of research fields (e.g., Organizational behavior, management science) has convincingly identified functional diversity as a double-edged sword. On the one hand, functional diversity promotes team effectiveness as it broadens the range of expertise available in a team: on the other hand, differences of opinion and perspectives between members from different functional backgrounds hamper internal team processes and cohesiveness (Milken and Martins, 1996; Van Knippenberg et. al, 2004).

The analysis of seventeen studies which examined functional diversity on a team showed three conceptualizations of functional diversity (Bunderson, Sutcliffe, 2002):

1) Team members are from different functional areas, and each team member has spent in this area the most significant part of the career (dominant functional diversity). Ten of seventeen studies used this concept of functional diversity. In this approach determining or team members determine themselves the functional area or areas in which they have spent the longest and most important part of their careers. This concept does not consider any weight of experience which is outside the career path.

2) Team members have complete diverse functional backgrounds (functional background diversity). Two of seventeen studied used this approach and considered the functional diversity regarding functional background diversity as team members have the degree of difference in the full functional backgrounds. As the previous conceptualization of dominant functional diversity, this conceptualization is also considered the different functional experience of team members. Diverse functional background

supposed that knowledge and expertise are not overlapped; thus it creates a greater resource base. „Functional background diversity is positively associated with a diversity of beliefs and perceptions (Huber, 1993) and with the tendency to communicate more frequently (Huber et al., 1993). Diversity in the functional background is considered by many authors as a vital source of expertise. «A common belief is that experiences associated with functional backgrounds affect what members of the group perceive (where «functional background» refers to past work experience in jobs within functional areas of organization).» (Waller, Huber, Glick, 1995). A functional background can be considered as one of the most crucial criteria for team members selection.

3) Team members have diverse functional assignments (practical assignments diversity) — this concept based on the idea that team members' functional assignments cover a relevant range of functional categories. That means each team member can relate to some functional area based on job-related responsibilities or job title or some other job-task related factor.

The fourth concept of functional diversity suggests the intrapersonal functional diversity. Such a concept implies background of each team members has a useful divorced background on an individual level. Each person can be either a narrow specialist in some functional area or has experience in a range of functional domains. Many researchers consider this approach of functional diversity as the one who can give a significant implication for team performance and teamwork. The results of the study showed that intrapersonal functional diversity is positively associated with information sharing. If each team member has broad functional diversity, they would be more motivated to exchange information and would be more resistant to stereotypes and biases influence which sometimes can limit the process of sharing information in an open form. By improving the process of information sharing the intrapersonal functional diversity have positive implications for team performance. But authors argue that it goes beyond just improved information sharing and as a result better-informed decisions, but now it is only a direction for future research (Bunderson, Sutcliffe, 2002).

Another view on functional diversity in a team on an example of cross-functional teams drives from functional background to social identity. Considering the functional background, identity, individual performance in cross-functional teams, some authors are focused on functional background not only because it is one of the key factors, but it is also job-related characteristic unlike other demographic characteristics and has a direct impact on team performance (Wiliams and O'Reilly, 1998). In one study the authors' aim was to push the frame of the traditional approach of considering functional diversity where functional diversity considered only in relation to demography and measured by demographic dissimilarity. (Randel, Jaussi, 2003). However past experience and functional background influence on personal identity. In some cases when researchers considered identity, they did it through a social identity theoretical framework and excluded personal identity. In that study, the authors investigated two types of identity: social and personal. Social identity in that study implied success and failure obtained from being in a group or a number of groups — personal identity suggested a person's own experience from the past and background. The authors focused on the difference in functional background and how this affects the relationship between identity and individual performance. It is noted that demographic characteristic is constructed from the reference, which goes from social and personal identity types. Functional background in that survey is considered as demographic characteristic and comprises the content of an individual's social and personal identities. This research checks the statement that functional background difference has an influence on the strength of a relationship between identity and individual performance. They attempted to examine how such factors as personal identity, social identity namely members identity as functional background subgroup member and demographic differences related to functional background. Authors believe that study has important implications for managers regarding the composition of cross-functional-teams and their composition and also regarding the individual performance in such teams.

Functional diversity is also one of the most important aspects which can predict the innovation. (Bantel, Jakson, 1989) Functionally diverse teams can quickly implement certain types of organizational changes than homogeneous teams (Williams, Hoffman and Lamont, 1995).

Different ranges and areas of experience and expertise in a team can influence the effectiveness. Team effectiveness is closely related with team diversity in functional background. (Bunderson, Sutcliffe, 2002).

2.4 Ways of measurement for a team performance

The successful teams should have the following characteristics (Donna Deeprose, 2001):

- Member interdependencies;
- Technical, problem-solving, interpersonal skills;
- Specific, measurable goals;
- Shared purpose.

Moreover speaking about a successful team, we imply the following:

- Members can express their opinions and ideas without fear;
- Everyone who will be impacted by the result tries to find a decision;
- Innovation and change are rewarded and encouraged;
- Creative solutions are in focus, but air disagreements and conflicts are allowed;
- Leadership is spread across the team.

The group's evaluation usually based on the results. «Teams, not just individuals, must have clear goals and objectives on which they are evaluated and measured» (Saratoga Institute, American Management Association, 1997). These goals should be measurable, challenging and should be discussed inside the team. Measuring in quantitative as well as qualitative terms requires to have a measurement system. Based on the classification described in the book «Managing team Performance: Evaluation, Measurement, Rewards» team effectiveness can be measured by industry type:

1. Electronics where all companies are electronic ones and measure their team performance by:

- Work orders completed;
- Rework numbers;
- Production schedules, levels, costs, and time;
- Quality yields;
- Delivery time vs. Customer requirements vs. Ship dates;
- Customer satisfaction;
- Quarterly productivity and quality goals;
- Inventory turns and cycles time;
- On-time project completion;
- Financial budget, ROA, and ROE.

2. Companies which deal with food and beverages. Most of metrics for measuring team performance here were unspecific and used in particular situations.

3. In the health care industry, only 37% of participating in the research companies had measurements. The companies which used some metric for measuring underlined the following:

- Clinical outcome measures;
- Satisfaction of the patients/customers;
- Self-directed team assessment instruments;
- The specific team set goals.

4. Companies from the insurance industry. In general, insurance enters into a financial community and use the following standard business metrics:

- Deadlines for deliverables;
- Milestones met or exceeded;
- Budget goals exceeded;
- Value-added earnings;
- Transaction counts;
- Divisional earnings;
- Service results;
- Customer satisfaction.

5. Manufacturing companies the most used metrics were:

- Customer satisfaction;
- Percent of jobs completed above average;
- Improved «go to market economics»;
- Objectives and goals set by teams;
- Comparison of production (money vs money per hour)

6. Utility. Companies from this sector usually used:

- Cost reductions;

- Customer satisfaction;
- Volume increases;
- Improved turnaround time on recommendations;
- Achievement of financial goals;
- Reduction of safety problems;
- Reduction of customer service problems;
- Reduction of outage minutes.

Qualitative metrics which are used for measuring team performance are a large part of the assessment process, and they are directly related to team performance. Sometimes the qualitative metrics are rather difficult to verify and also not easy to link them to performance outcomes because they can be subjective. For example, how we can estimate cooperation or participation, effectiveness and work involvement, all of them are subjective judgments. Below there is a measurement matrix where any team or business unit can find an appropriate measure. With the help of this measurement matrix, it is possible to develop the specific measures which will respond to the specific and needs of the team stricture or organization, business.

Measurement Matrix			
	Service	Quality	Productivity
Cost		Rework cost	Cost per hire
Time	Response time	Process time	Claims per adjustor
Volume			Trained
Errors		Data entry	
Human	Managerial satisfaction	Quality of hire	

Table 1. Measurement Matrix

It is a difficult process to build an appropriate team which can perform well but sometimes to build an effective team cannot be the key to success. In different circumstances team operates differently as well as every team participant, not all teams are equally created, and if the purpose or goal of the team creation was not a good idea itself, the good team cannot drive to success. For example, if your product line is out of date, you can hire the best of the best and build a brilliant team, but it is not likely that the team can save the situation. Expectations should be realistic based on the goals, power and common sense.

3. Methodology

3.1 Sample

To analyze the effect of functional diversity in teams writing the research papers, the data collected from strategic management journal during the years 2014-2017 was used. Strategic management journal was chosen for this study, not by chance. The journal was founded in 1980 and is currently considered as the leading mass impact journal for research in strategic management in the world. Each year the journal published one volume (as an example in 2018 it is Volume 39), each volume consists of 13 issues. Usually, each issue has approximately ten research papers, depending on the year the number of articles can vary from 6 to 18. Thereby on total, we have around 500 observations in the first data set and about 1000 in the second data set.

In the first data set, we collected the following data about articles: numbers of authors in each article, number of citations. The number of citations was obtained from the Google Scholar database since Google Scholar is one of the best free available trustful resources.

In the second data set, we collected more detailed information about each article for a more precise analysis of diversity in teams of authors. It contains the following information: interests and spheres of expertise of each author, the number of articles which has been published in strategic management journal by each author, the current university (place of work) and university's place in the university world ranking, h-index and i10-index for each author. The university world ranking was taken from the QS World University Rankings per 2018.

The h-index existed from 2005 and was offered by physicists Horche Hirsh. At first, the idea of using was to measure the physicists' productivity. It is a quantity characteristic of productivity for scientist based on the numbers of publications and numbers of citations. In other words, it is representing an authors number of publications and number of citations per publication in one value. The idea to include the h-index to the data set came because this is a rather new index and it is interesting to work with; it is easy to get it.

I10-index is the newest index which applicable for journal metrics. It was also introduced by Google Scholar. The idea of this index is the same as h-index with only one difference that i10-index is used for articles which have 10 or more citations.

Both h-index and i10 index are considered as more objective indicators for estimation of scientific productivity than the total number of scientific publications and their citations. For sure both of the indexes are considered as not the perfect indicators, and we have to add it to the assumptions. In some cases h-index could show a completely incorrect picture about the significance of the researcher, as an example, it would be the authors with a short career as scientists or young researchers who also have a small number of works. The h-index has become very popular in the scientific community although there was a lot of criticism. Nevertheless, h-index due to its simplicity remains one the most popular analysis parameter today.

3.3 Hypothesis first part

We start the analysis by studying the first data set. We would like to understand whether the number of citations depends on whether the article was written by an individual author or a team. In the first four hypotheses, we test if the number of people in groups of authors affects the number of citations taking into consideration that the greater number of authors could make the group more functionally diverse from one side but from the other side can be a negative factor since it may create some problems between group members communication. In other words, we question whether the number of authors can influence a team performance, that is, in our case, the number of citations.

To address this question, we separate all the articles in two groups: first group — written by one author, and second group — written by a group of authors (number of authors is two or more). We will compare the number of citations achieved by one author to the number of citations achieved by a group of authors. Afterward, we conduct a t-test to understand whether there is statistical evidence that a group of authors is achieving better results on average. Based on the first data set we will test 4 hypothesis:

H1) Null hypothesis: There is no difference in the number of citations between articles which were written by 1 author and articles which were written by a group of authors (more than 2)

H2) Null hypothesis: There is no difference in the number of citations between articles which were written by 2 authors and articles which were written by 3 authors.

H3) Null hypothesis: There is no difference in the number of citations between articles which were written by 3 authors and articles which were written by more than 3 authors.

H4) Null hypothesis: There is no difference in the number of citations between articles which were written by 2 authors and articles which were written by more than 3 authors.

For the third and fourth hypotheses we sum up the articles which were written by 4 and more than 4 authors since separate samples for 4, 5 and 6 authors had a small number of observations.

3.3 Statistical assumptions

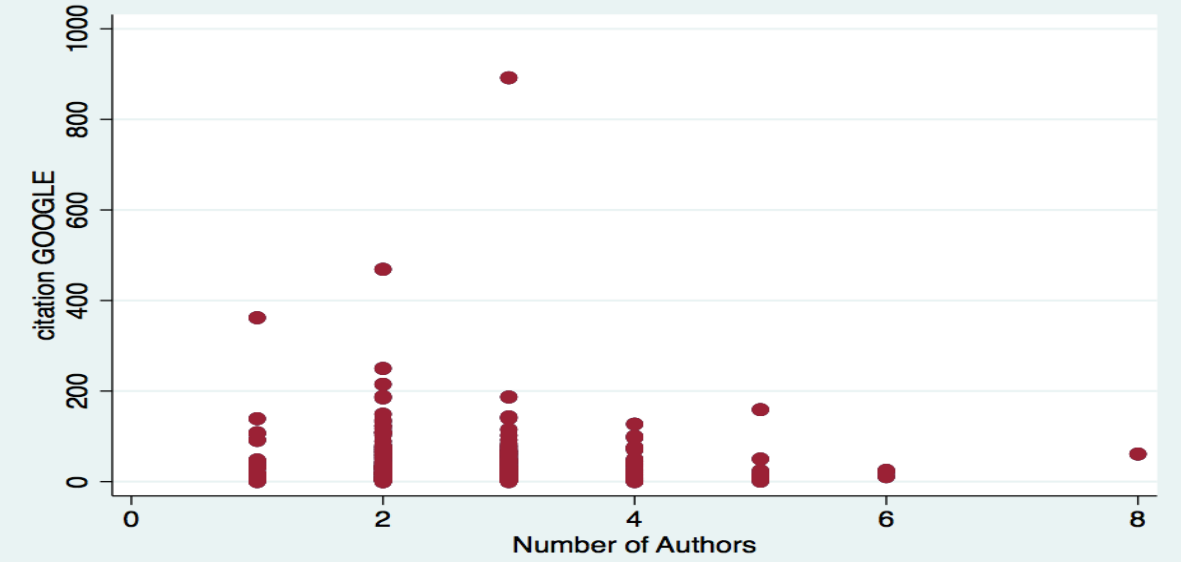
Before proceeding with data analysis using Stata we need to identify which test can be applicable to test our hypothesis. The first test which can be suitable for our data is the independent t-test. Before processing the data, it is necessary to check whether it could be applicable. To test our hypotheses with T-test, the data has to meet 6 assumptions. First three assumptions relate to research design and choice of variables.

1) The first assumption states that the dependent variable should be measured at the interval or ratio. This assumption is filled. Our dependent variable is a number, and it is measured at the ratio scale in the range from 0 to 250.

2) According to the second assumption, the independent variable which is in our case for first 4 hypothesis number of authors should consist of two unrelated and independent groups. Our data also meet the assumption since we always compare two independent groups. In the first hypothesis, we compare articles with 1 author versus articles with more than 1 authors, in the second hypothesis articles which were written by 2 authors and articles written by more than 2 authors. In the third one, we compare 3 authors and more than 3 authors.

3) The third criterion is that our observations should be independent. This assumption is also satisfied.

4) According to the fourth assumption our data should not contain significant outliers. This assumption was checked using Stata. Outliers can affect negatively in the results of independent t-test and reduce accuracy. Below there is the initial data with outliers.



Extract 1. Outliers

[ ) The fifth assumption implies that the dependent variable which is in our research the number of citations is approximately normally distributed. This distribution should be normal for each category of the independent variable. To check the normality we used the Shapiro-Wilk test. The results were the following:

For articles with 1 author (42 observations):

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
a1	**42**	**0.77461**	**9.251**	**4.696**	**0.00000**

Extract 2.

For articles with more than 1 author (to test the first hypothesis, 417 observations):

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
a_group	**417**	**0.80197**	**56.587**	**9.621**	**0.00000**

Extract 3.

For articles with 2 authors (173 observations):

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
a2	**173**	**0.80346**	**25.855**	**7.428**	**0.00000**

Extract 4.

For articles with 3 authors (182 observations):

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
a3	**182**	**0.82674**	**23.815**	**7.260**	**0.00000**

Extract 5.

For articles with 4 and more authors (62 observations):

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
a4	62	0.82685	9.663	4.899	0.00000

Extract 6.

All observations divided by groups do not have the normal distribution, that is why according to the rules we should apply a nonparametric test and check the hypothesis using the Wilcoxon test (here and later we mean the Wilcoxon rank-sum test also called the Mann-Whitney U test). However, nowadays researches often and actively discuss whether this condition is essential for t-test with a large number of observations (> than 30). The researchers claim that when you deal with large samples t-test is valid for any distribution.

The explanations are based on the Central Limit Theorem. One of the sources where the question about normally distributed data is the Minitab Statistical Software Blog. Since the question of the normal distribution importance is still controversial, and this work is not dedicated to identifying whether is it acceptable to ignore the normal distribution, using large sample we will apply both Wilcoxon and independent T-test to check our hypothesis.

6) Assumption six tells us that it is necessary to check whether the groups have the same variances or not using the Levene's test or Barlett's test for equality of variances. The Levene's test is considered as a more robust test to non-normality than other tests which can be applicable to test homogeneity. But since it can be still influenced by non-normality, we will use two tests: Levene's and Barlett's. Below you can find the results of Levene's test and Barlett test for the data which will be used to check the first hypothesis.

Levene's test:

Group of Authors	Summary of citation GOOGLE Mean	Std. Dev.	Freq.
0	20.285714	22.020263	42
1	35.486811	34.989496	417
Total	34.095861	34.273234	459

W0 = 5.6013386 df(1, 457) Pr > F = 0.01836274

W50 = 4.0488340 df(1, 457) Pr > F = 0.04478814

W10 = 4.7530883 df(1, 457) Pr > F = 0.02975529

Extract 7.

Barlett's test:

Variance ratio test

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	42	20.28571	3.3978	22.02026	13.42372	27.14771
1	417	35.48681	1.713443	34.9895	32.11872	38.8549
combined	459	34.09586	1.599738	34.27323	30.95212	37.2396

ratio = sd(0) / sd(1) f = 0.3961

Ho: ratio = 1 degrees of freedom = 41, 416

Ha: ratio < 1 Ha: ratio != 1 Ha: ratio > 1

Pr(F < f) = 0.0003 2*Pr(F < f) = 0.0005 Pr(F > f) = 0.9997

Extract 8.

Levene's test shows us that the data does not have the equal variances (null hypothesis is rejected at 5% level). The Barlett's test shows us the same - the null hypothesis can be rejected at 1% level (p=0.0005) and our variances are not equal. Doing our t-test for the first hypothesis, we will take it into consideration and run the independent t-test with unequal variances.

Similarly, we tested the data used to check the other 3 hypotheses and received the following results for the second hypothesis where we compare articles with 2 and 3 authors:

Levene's test:

gr23	Summary of cit23 Mean	Std. Dev.	Freq.
2	41.445087	41.541988	173
3	31.972527	28.784862	182
Total	36.588732	35.841615	355

W0 = 14.2693942 df(1, 353) Pr > F = 0.00018587

W50 = 7.5158594 df(1, 353) Pr > F = 0.00642717

W10 = 8.6596261 df(1, 353) Pr > F = 0.00346848

Extract 9.

Barlett's test:

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
2	173	41.44509	3.158379	41.54199	35.21091	47.67926
3	182	31.97253	2.133676	28.78486	27.76245	36.18261
combined	355	36.58873	1.902275	35.84161	32.84755	40.32991

ratio = sd(2) / sd(3) f = 2.0828

Ho: ratio = 1 degrees of freedom = 172, 181

Ha: ratio < 1 Pr(F < f) = 1.0000

Ha: ratio != 1 2*Pr(F > f) = 0.0000

Ha: ratio > 1 Pr(F > f) = 0.0000

Extract 10.

Accordingly, based on tests' results for checking the second hypothesis we also have to use the independent t-test with unequal variances (the null hypothesis is rejected for both test at 1% significance level).

For the third hypothesis the tests results are:

Levene's test:

gr34	Summary of cit34 Mean	Std. Dev.	Freq.
3	31.972527	28.784862	182
4	29.177419	29.095391	62
Total	31.262295	28.829798	244

W0 = 0.19103302 df(1, 242) Pr > F = 0.66244799

W50 = 0.04333943 df(1, 242) Pr > F = 0.83526255

W10 = 0.04073506 df(1, 242) Pr > F = 0.84021973

Extract 11.

Barlett's test:

Variance ratio test

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
3	182	31.97253	2.133676	28.78486	27.76245	36.18261
4	62	29.17742	3.695118	29.09539	21.78857	36.56627
combined	244	31.2623	1.845639	28.8298	27.6268	34.89779

ratio = sd(3) / sd(4) f = 0.9788

Ho: ratio = 1 degrees of freedom = 181, 61

Ha: ratio < 1 Ha: ratio != 1 Ha: ratio > 1

Pr(F < f) = 0.4455 2*Pr(F < f) = 0.8910 Pr(F > f) = 0.5545

Extract 12.

Both Levene's test and Barlett's test suggest that we cannot reject the variance equality hypothesis, thus, for checking the third hypothesis we can use the independent t-test with equal variances.

The used data for checking the fourth hypothesis has the following results:

Levene's test:

gr24	Summary of cit24 Mean	Std. Dev.	Freq.
2	41.445087	41.541988	173
4	29.177419	29.095391	62
Total	38.208511	38.968253	235

W0 = 4.8320191 df(1, 233) Pr > F = 0.02892011

W50 = 2.7290241 df(1, 233) Pr > F = 0.09988645

W10 = 3.1931610 df(1, 233) Pr > F = 0.07524682

Extract 13.

Barlett's test:

Variance ratio test

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
2	173	41.44509	3.158379	41.54199	35.21091	47.67926
4	62	29.17742	3.695118	29.09539	21.78857	36.56627
combined	235	38.20851	2.542009	38.96825	33.20036	43.21666

ratio = sd(2) / sd(4) f = 2.0386

Ho: ratio = 1 degrees of freedom = 172, 61

Ha: ratio < 1 Ha: ratio != 1 Ha: ratio > 1

Pr(F < f) = 0.9991 2*Pr(F > f) = 0.0017 Pr(F > f) = 0.0009

Extract 14.

Based on the Barlett's test results we can reject the variance equality hypothesis at 1% significance level (even though Levene's test rejects the null at a different significance level) and will apply an independent t-test with unequal variances to check the fourth hypotheses.

3.4 Results the first part

3.4.1 One author VS group of authors

Two-sample t test with unequal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	417	35.48681	1.713443	34.9895	32.11872	38.8549
1	42	20.28571	3.3978	22.02026	13.42372	27.14771
combined	459	34.09586	1.599738	34.27323	30.95212	37.2396
diff		15.2011	3.805382		7.601672	22.80052

diff = mean(0) - mean(1) t = 3.9946
Ho: diff = 0 Welch's degrees of freedom = 65.2033

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.9999 Pr(|T| > |t|) = 0.0002 Pr(T > t) = 0.0001

Extract 15.

The first independent t-test was conducted on a sample of 459 research articles to determine if there is a difference in a number of citations based on the number of authors, consisting of articles which were written by only 1 author and the articles which were written by groups of authors. There were 42 articles which were written by 1 author and 417 which were written by a group of authors (more than 1). In the table with results, group 0 represents a group of authors and group 1 represents one author. The null hypothesis of the mean equality is rejected at 1% significance level (p=0.0002) in favor of H_a: difference ≠ 0. The results also showed that groups of authors had a statistically higher number of citations (35.49±1.71) compared with the articles which were written by only 1 author, meaning we can reject the null hypothesis in favor of H_a: difference > 0 (20.29±3.39), t(65) = -3.995, p = 0.0001.

Then we have to check the same hypothesis with a Wilcoxon test. The results also show us that we can reject the null hypothesis at 1% significance level (p=0.0006). This means that the results of the Wilcoxon test confirm that there is a significant difference in means between two groups.

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

        gr_1 |       obs    rank sum    expected
-------------+---------------------------------
           0 |       417       98734       95910
           1 |        42        6836        9660
-------------+---------------------------------
    combined |       459      105570      105570

unadjusted variance   671370.00
adjustment for ties     -245.77
                     ----------
adjusted variance     671124.23

Ho: cit_gr_1(gr_1==0) = cit_gr_1(gr_1==1)
             z =   3.447
    Prob > |z| =   0.0006
```

Extract 16.

3.4.2 Two authors VS three authors

```
Two-sample t test with unequal variances

   Group |       Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       2 |       173    41.44509    3.158379    41.54199    35.21091    47.67926
       3 |       182    31.97253    2.133676    28.78486    27.76245    36.18261
---------+--------------------------------------------------------------------
combined |       355    36.58873    1.902275    35.84161    32.84755    40.32991
---------+--------------------------------------------------------------------
    diff |            9.472559    3.811552                1.972395    16.97272
------------------------------------------------------------------------------
    diff = mean(2) - mean(3)                                      t =   2.4852
Ho: diff = 0                     Welch's degrees of freedom =  306.055

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9933         Pr(|T| > |t|) = 0.0135          Pr(T > t) = 0.0067
```

Extract 17.

After checking the first hypothesis, it became clear that articles which were written by a group of authors are cited more often than the articles which were written by one author. In the next 3 hypotheses, we will try to identify whether it is possible to say the exact number of authors which write more cited

articles. In the second t-test, we compared the articles which were written by 2 authors and articles which are written by 3 authors. There were 355 observations where 173 were written by two authors (group 2 in the results table), and 3 authors wrote 182 articles (group 3 in the results table). The results suggest that the null hypothesis of the mean equality can be rejected at 2% significance level (p=0.0135). Moreover, the results of the t-test showed that articles which were written by 2 authors are cited more often (41.45 ± 3.16) than the articles which have more than two authors (31.97±2.13), t(306)= 2.485, p=0.0067. In other words, we can reject the null in favor of H_a: mean (2) – mean (3) > 0.

However, the Wilcoxon test results below show conflicting results with the t-test. P=0.132 means that we fail to reject the null hypothesis at 2% level. Since our data were not normally distributed we would rely on the results of the Wilcoxon test and based on it, we cannot say that there is a significant difference in a number of citations between articles which were written by 2 authors and articles which were written by 3 authors.

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

        a23 |      obs    rank sum    expected
------------+---------------------------------
          2 |      173     32250.5       30794
          3 |      182     30939.5       32396
------------+---------------------------------
   combined |      355       63190       63190

unadjusted variance   934084.67
adjustment for ties     -333.48
                     ----------
adjusted variance     933751.19

Ho: cit23(a23==2) = cit23(a23==3)
             z =   1.507
    Prob > |z| =   0.1317
```

Extract 18.

3.4.3 Three authors VS four and more authors

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
3	182	31.97253	2.133676	28.78486	27.76245	36.18261
4	62	29.17742	3.695118	29.09539	21.78857	36.56627
combined	244	31.2623	1.845639	28.8298	27.6268	34.89779
diff		2.795108	4.244354		-5.565485	11.1557

diff = mean(3) - mean(4) t = 0.6585
Ho: diff = 0 degrees of freedom = 242

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.7446 Pr(|T| > |t|) = 0.5108 Pr(T > t) = 0.2554

Extract 19.

To test our third hypothesis, we can use an independent t-test with equal variances. We compared articles with 3 authors and articles which were written by more than 3 authors. In total, we had 244 observations where 182 were the articles with 3 authors (group 3 in the table with results) and 62 articles with more than 3 authors (group 4 in the table with results). The results showed in Extract 19 that there is no statistical evidence of significant difference between these two compared groups. We fail to reject the null hypothesis of the equality of means (p=0.5108) at 2% significance level. We also cannot say that articles with 3 authors are cited more or less often than the articles with more than 3 authors – meaning we cannot support any of our alternative hypotheses (p=0.7446; p=0.2554).

The results of the Wilcoxon test below also show us that we cannot reject the null hypothesis at 2% significance level, since the p=0.2205.

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

        a34 |      obs    rank sum    expected
------------+---------------------------------
          3 |      182       22883       22295
          4 |       62        7007        7595
------------+---------------------------------
   combined |      244       29890       29890

unadjusted variance   230381.67
adjustment for ties      -98.20
                     ----------
adjusted variance     230283.47

Ho: cit34(a34==3) = cit34(a34==4)
             z =   1.225
    Prob > |z| =   0.2205
```

Extract 20.

3.4.4 Two authors VS four and more authors

```
Two-sample t test with unequal variances

   Group |      Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       2 |      173    41.44509    3.158379    41.54199    35.21091    47.67926
       4 |       62    29.17742    3.695118    29.09539    21.78857    36.56627
---------+--------------------------------------------------------------------
combined |      235    38.20851    2.542009    38.96825    33.20036    43.21666
---------+--------------------------------------------------------------------
    diff |            12.26767    4.860993                2.665867    21.86947
------------------------------------------------------------------------------
    diff = mean(2) - mean(4)                                      t =   2.5237
Ho: diff = 0                     Welch's degrees of freedom =  156.122

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.9937         Pr(|T| > |t|) = 0.0126          Pr(T > t) = 0.0063
```

Extract 21.

Above there are the results of a t-test for the fourth hypothesis. The results show that articles which were written by 2 authors are cited more often than the articles which were written by more than 3 authors. There were 235 observations where 173 were written by 2 authors (group 2 in the table with results), and more than 3 authors wrote 62 articles (group 4 in the table with results). We can reject the null hypothesis in favor of H_a: difference ≠ 0 at 3% significance level (p=0.0126). The results of t-test also show that we can reject the null hypothesis in favor of H_a: difference > 0 at 3% significance level -

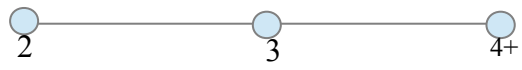
articles which were written by 2 authors are cited more often (41.45 ± 3.16) than the articles which have more than 3 authors (29.18±3.70), t(156)= 2.524, p=0.0063.

Below is the Extract 22, there are the results of the Wilcoxon's test which show us the following p-value: p=0.0293 which means that the null hypothesis could be rejected at the significance level of 3%. Based on the results of both tests we can say that there is a difference in a number of citations between articles which were written by 2 authors and articles which were written by more than 3 authors.

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

        a24 |      obs    rank sum    expected
------------+---------------------------------
          2 |      173       21415       20414
          4 |       62        6315        7316
------------+---------------------------------
   combined |      235       27730       27730

unadjusted variance   210944.67
adjustment for ties      -78.12
                     ----------
adjusted variance     210866.55

Ho: cit24(a24==2) = cit24(a24==4)
             z =   2.180
    Prob > |z| =   0.0293
```

Extract 22.

Based on the rejection of our first hypotheses we can conclude that articles written by the group of authors are more successful than articles written by one author. In the next 3 hypotheses, we tried to identify how many authors should be in a group to achieve the best results.



Picture 1.

When we compared articles with 2 authors with articles with 3 authors the difference in a number of citations was not statistically significant. The same situation occurred when we compared articles with 3 and 4+ authors. Probably the difference was not sufficient to be statistically significant on these small

intervals which connect 2 to 3 and 3 to 4+. However, when we compared articles directly with 2 authors and articles with 4 and more authors, we obtained statistically significant results. This might indicate that the number of citations decreases when the number of authors increases from 2 to 4.

The results of the study regarding how the number of authors affects the number of citations suggest that there is no clear direct or inverse relationship. Based on our sample, the number of citations tends to slightly decrease when the number of authors is increasing from 2 to 3 and 4+. This statement is confirmed by the fact that in the comparison of 2 authors versus 4+ authors, the null hypothesis is rejected by both Wilcoxon and the t-test, whereas t-test, in addition, is showing that 2 authors are cited more than 4+ authors. However, the difference between the neighboring groups (2 versus 3, 3 versus 4+) is not confirmed by statistical tests (in case 2 versus 3, we relied on the results of the Wilcoxon test). On the other hand, there is statistical evidence in our sample that the number of citations reached by groups of authors is consistently higher than the number of citations reached by single authors. Both Wilcoxon and the t-test confirm such result. One of the factors that might imply this result is the diversification that could be possible when a group of authors is working on the research.

3.5 Second part of hypotheses. Diversification impact on the team performance

After we have concluded that groups of authors are on average more successful than single authors, we continue with studying the other functional diversity benefits in teams. In further paragraphs, we will try to measure the diversity in teams and understand whether diversified groups are more successful than non-diversified groups. To address these questions, we are analyzing the specialization and background of authors comprising the group, comparing the diversified and non-diversified groups and trying to assess how diversification affects the team performance.

First of all, we analyzed the areas of expertise of each author in the study group that worked on the article. The areas of expertise of each author were taken from the ResearchGate (largest academic, a social network according to studies by „Nature" and „Times Higher Education"). When author's profile

was not available at ResearchGate, we took information from the Google Scholar or the department of the university where the author worked when the article was published.

As there are many specific areas of expertise, we first assigned them to a certain number of broader groups. The areas of expertise we have identified in our data are as follows:

1. Strategy
2. Accounting
3. Finance
4. Economics
5. Marketing
6. Management
7. Organizational Behaviour
8. Corporate Governance
9. Technology
10. Operations Management
11. Psychology
12. Markets
13. Politics
14. Sociology
15. Statistics
16. Entrepreneurship
17. Sustainability
18. Research Methods
19. Leadership
20. Other

It should be noted that the assignments of the research areas were subject to judgment from the author of this work. Some authors published more specific areas of expertise, some of the authors published only a few. We tried to avoid bias towards authors who provided a longer and more detailed list of their areas of expertise. In particular, our aim was to reveal the core areas of expertise of each author to further assess the intersection of these areas between the authors in the group.

After we have classified all the interests of the authors in standardized categories, we assessed the level of diversification in the areas of expertise for each article.

It was done by adding one point per each author that brings a unique area (or areas) of expertise to the group of authors working on the research paper. For example, when author 1 is expert in "Technology", whereas author 2 is expert in "Finance", the resulting figure is 2 (each author is adding a unique area of expertise). On the other hand, when author 1 and author 2 are both experts in "Technology" and "Finance", the resulting figure is 1 (authors are experts in the same area, and therefore there is no diversity in areas of expertise). When authors both are specializing in areas that are classified as "Other", we further analyze how close are the areas and assign the figure 1 or 2. Thus, the maximum number of diversification points could be equal to the number of authors in the group. Meaning if each author is an expert in a unique area, then the group reaches the maximum level of diversification.

Since our aim in this chapter is to understand the effect of the diversification on the result, we would like to eliminate the effect of the number of authors and compare the level of diversification among articles with a different number of authors; we calculate the "diversification ratio". It is defined as:

$$DR_{article} = \begin{cases} 1 \; when \; C_{areas} = N_{authors} \\ 0 \; when \; C_{areas} = 1 \\ C_{areas}/N_{authors} \end{cases},$$

where C_{areas} is a number of non-recurring areas of expertise described in the previous paragraph, $N_{authors}$ is the number of authors of the article.

The resulting ratio takes values from 0 to 1. When the ratio is 0, then all the authors are specializing in the same area (no diversification in the areas of expertise). When the ratio is 1, every author is specializing in a different area (maximum diversification). When the ratio is between 0 and 1, the number of areas is smaller than the number of authors (medium diversification).

We understand that the diversification ratio is not the most precise metric and is subject to judgment, however, we believe that it allows us to assess the degree of diversification in the group of authors and clearly distinguish between diversified and non-diversified groups.

In addition to the areas of expertise that we see as the major source of the functional diversity in teams, we believe that the university the author is working for might imply certain specific knowledge or expertise that could be a driver of the team performance. Therefore, we calculate an additional ratio to include in our analysis.

We count the number of non-recurring universities per article. In order to obtain the ratio that allows comparing the articles written by a different number of authors, we calculate the "university diversification ratio". It is defined as:

$$UDR_{article} = \begin{cases} 1 \; when \; C_{universities} = N_{authors} \\ 0 \; when \; C_{universities} = 1 \\ C_{universities} / N_{authors} \end{cases},$$

where $C_{universities}$ is a number of non-recurring universities.

In order to understand whether diversified groups of authors were on average more successful, we conduct a series of statistical tests.

First of all, we test whether groups of authors with diversified areas of expertise reach better results than groups of authors with no diversification. We compare the performance of groups of authors with $DR_{article}$ =0 (no diversification) versus $DR_{article}$ ≠0 (diversification).

The average number of citations tends to increase when DR increases from 0 to 1 as shown in the table below.

Diversification Ratio	Average citations
DR = 0	27,903
0 < DR < 0,5	31,513
0,5 < DR < 1	36,782
DR = 1	45,561

Table 2.

H5) Null hypothesis: There is no difference in a number of citations in articles which were written by diverse groups of authors and articles which were written by non-diversified groups of authors (groups with the same sphere of expertise).

To test the hypothesis H5 using a t-test we have to check the assumptions which were described in details in the chapter above. Here we state that all the assumptions are met, except the ones we are testing statistically further. Below there are results of the Shapiro-Wilk test, which test the normality of the data distribution.

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
citationgo~e	**416**	**0.79829**	**57.517**	**9.659**	**0.00000**

Extract 23.

The test result (Prob>z = 0.00000) suggests that the data does not follow a normal distribution. Recalling the approach in the previous chapter, we will conduct an unpaired t-test even with not normally distributed data due to a large number of observations and robustness of the test to non-normal data. However, to exclude errors, we will make in addition the Wilcoxon test which is common in such situations.

Before conducting the t-test test, we have to check the variance equality in order to choose which t-test to use. Below there are results of Barlett's test and Levene's test which were used to check the variance equality.

In the upcoming tests group 0 represents the absence of diversification in areas of expertise or $DR_{article}$ =0, group 1 represents existing diversification in areas of expertise or $DR_{article}$≠0.

Barlett's test:

Variance ratio test

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	144	27.90278	2.516039	30.19246	22.92934	32.87621
1	272	39.70588	2.274865	37.51804	35.22723	44.18454
combined	416	35.62019	1.74374	35.56545	32.19253	39.04786

ratio = sd(0) / sd(1) f = 0.6476
Ho: ratio = 1 degrees of freedom = 143, 271

Ha: ratio < 1 Ha: ratio != 1 Ha: ratio > 1
Pr(F < f) = 0.0020 2*Pr(F < f) = 0.0040 Pr(F > f) = 0.9980

Extract 24.

Levene's test:

DR	Summary of citationGOOGLE Mean	Std. Dev.	Freq.
0	27.902778	30.192464	144
1	39.705882	37.518038	272
Total	35.620192	35.565449	416

W0 = 9.9851053 df(1, 414) Pr > F = 0.00169398

W50 = 8.9103239 df(1, 414) Pr > F = 0.00300378

W10 = 9.4583752 df(1, 414) Pr > F = 0.00224122

Extract 25.

Both Barlett's and Levene's tests results show that we have to use unpaired t-test with unequal variances because the variance equality hypothesis is rejected. In particular, the result of both tests suggests rejecting the hypothesis of variance equality at 1% significance level.

The result of unpaired t-test with unequal variances is represented below. Based on the results we can conclude that the H5 null hypothesis should be rejected at 1% significance level in favour of H_a: diff ≠ 0 (p=0.0006). In addition, the result shows that articles which were written by a group of authors with different spheres of expertise are cited more often (39.71±2.27) than the articles which were written by authors from with the same expertise (27.9±2.52), t (351)=-3.48, p=0.0003 (reject null in the favour of H_a: diff <0).

```
Two-sample t test with unequal variances

   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |     144    27.90278    2.516039    30.19246    22.92934    32.87621
       1 |     272    39.70588    2.274865    37.51804    35.22723    44.18454
---------+--------------------------------------------------------------------
combined |     416    35.62019     1.74374    35.56545    32.19253    39.04786
---------+--------------------------------------------------------------------
    diff |            -11.8031     3.39197               -18.47421   -5.131995
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  -3.4797
Ho: diff = 0                     Welch's degrees of freedom =  351.497

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0003         Pr(|T| > |t|) = 0.0006          Pr(T > t) = 0.9997
```

Extract 26.

In other words, the result shows that we could accept the alternative hypothesis which states that the difference in means (group 0 – group 1) is less than 0. This means that there is statistical evidence that the number of citations in group 0 is consistently smaller than the number of citations in group 1.

Below the results of the Wilcoxon test of the hypothesis, H5 is presented since we do not have normally distributed data.

The test result (Prob>|z| = 0.0005) allows rejecting the H5 null hypothesis of the test at 1% significance level. We confirm that there is a difference in the number of citations between articles which were written by diverse groups and groups with the same sphere of expertise.

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

          dr |      obs    rank sum    expected
-------------+---------------------------------
           0 |      144     25966.5       30024
           1 |      272     60769.5       56712
-------------+---------------------------------
    combined |      416       86736       86736

unadjusted variance  1361088.00
adjustment for ties     -452.28
                     ----------
adjusted variance    1360635.72

Ho: citati~e(dr==0) = citati~e(dr==1)
             z =  -3.478
    Prob > |z| =   0.0005
```

Extract 27.

Thus, the results of the Wilcoxon test confirm the previous results of the t-test with regards to the difference in group means, while the t-test results allow us to conclude that the diversified groups of authors reach a higher number of citations in comparison to the groups of authors which are not diversified.

We proceed with studying the effects of university diversification on the number of citations.

H6) Null hypothesis: There is no difference in a number of citations between articles which were written by groups of authors from the same university and articles which were written by groups of authors from different universities.

As we did previously, first of all, we check our data before conducting an independent t-test.

The Shapiro-Wilk test result suggests the non-normality of the data. In the absence of the normal distribution, we conduct both independent t-test and the Wilcoxon test.

Shapiro-Wilk W test for normal data

Variable	Obs	W	V	z	Prob>z
citationgo~e	**416**	**0.79829**	**57.517**	**9.659**	**0.00000**

Extract 28.

To check the equality of variances prior to conducting a t-test, both Levene's test and Barlett's tests were done. The results are interpreted below.

Barlett's test:

Variance ratio test

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	41	39.5122	6.542835	41.89458	26.28863	52.73576
1	375	35.19467	1.799265	34.84261	31.65672	38.73261
combined	416	35.62019	1.74374	35.56545	32.19253	39.04786

ratio = sd(0) / sd(1) f = 1.4458
Ho: ratio = 1 degrees of freedom = 40, 374

Ha: ratio < 1 Ha: ratio != 1 Ha: ratio > 1
Pr(F < f) = 0.9560 2*Pr(F > f) = 0.0879 Pr(F > f) = 0.0440

Extract 29.

In particular, Barlett's test result suggests that we fail to reject the hypothesis of the variance equality at 1% significance level.

Levene's test:

Summary of citationGOOGLE

UDR	Mean	Std. Dev.	Freq.
0	39.512195	41.894583	41
1	35.194667	34.84261	375
Total	35.620192	35.565449	416

W0 = 1.08844098 df(1, 414) Pr > F = 0.29742571

W50 = 0.64040496 df(1, 414) Pr > F = 0.42402315

W10 = 0.82482144 df(1, 414) Pr > F = 0.36430261

Extract 30.

The result of Levene's test also suggests that we fail to reject the variance equality at 1% significance level.

Based on the tests results, we proceed using an independent t-test with equal variances.

The results of unpaired t-test with equal variances are provided below. The mean number of citation for non-diversified groups (39.51±6.54) is bigger than the number of citations for diversified groups (35.19±1.8). Based on the results we can conclude that our null hypothesis could not be rejected at 1% significance level (p=0.46). Moreover, when we test the null hypothesis versus H_a: diff <0 (p=0.77) or H_a: diff >0 (p=0.23), we also fail to reject the null hypothesis. The results show that there is no statistical evidence to conclude that articles written by groups of authors from different universities are cited differently than groups of authors from the same university.

Two-sample t test with equal variances

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	41	39.5122	6.542835	41.89458	26.28863	52.73576
1	375	35.19467	1.799265	34.84261	31.65672	38.73261
combined	416	35.62019	1.74374	35.56545	32.19253	39.04786
diff		4.317528	5.853372		-7.188506	15.82356

diff = mean(0) - mean(1) t = 0.7376
Ho: diff = 0 degrees of freedom = 414

Ha: diff < 0 Ha: diff != 0 Ha: diff > 0
Pr(T < t) = 0.7694 Pr(|T| > |t|) = 0.4612 Pr(T > t) = 0.2306

Extract 31.

The results of the Wilcoxon test show that the null hypothesis cannot be rejected at 1% significance level (p=0.63). In other words, there is no statistical evidence to conclude that groups from the same university and groups from different universities have a different number of citations.

```
Two-sample Wilcoxon rank-sum (Mann-Whitney) test

        udr |      obs    rank sum    expected
------------+---------------------------------
          0 |       41        8900      8548.5
          1 |      375       77836     78187.5
------------+---------------------------------
   combined |      416       86736       86736

unadjusted variance   534281.25
adjustment for ties     -177.54
                      ----------
adjusted variance     534103.71

Ho: citati~e(udr==0) = citati~e(udr==1)
             z =   0.481
    Prob > |z| =   0.6305
```

Extract 32.

The results of the t-test and the Wilcoxon test lead to the same conclusions.

With the help of statistical tests, we have shown that diversification of areas of expertise in teams leads to better team performance – diversified teams are cited more than non-diversified teams. However, we have not found statistical evidence to conclude that the diversification of universities affects the team performance.

The results of t-tests and the Wilcoxon tests were conforming when we tested both H5 and H6, i.e., both tests suggested that we can reject the H5 null hypothesis and both tests suggested that we can't reject the H6 null hypothesis.

3.6 Regression analysis

3.6.1 Analysis of parameters

After we have identified that diversified groups of authors reach a higher number of citations, we would like to construct the linear model using this parameter as a predictor for citations. Moreover, we will combine the team diversification parameter with other possible predictors that were included in our data set. The list of possible predictors includes H-index, i-10-index, the world university ranking, and a

number of authors. The university diversification appeared to be not a suitable predictor for the number of citations, and therefore we will not include it.

The regression analysis was conducted in RStudio.

First of all, we have decided on how to use the collected indexes information. As was described in the chapter above, the indexes were created as a metric that aimed to capture the author's success.

We have calculated 2 different index-derived parameters to use as citation predictors. For each author group, which worked on the article, we have calculated the maximum h-index value and the average h-index value and the maximum and the average of the i10-index value. Higher correlation of maximum index value per group of authors with the number of citations would indicate that the rank of the most known and successful author in the group implies the overall citation. Higher correlation of the average index value per group of authors with the number of citations would indicate that the rank of each author is an important driver of the number of citations.

We have performed the same calculations for the number of articles each author had in the Strategic Management Journal. We have calculated the average number of articles in SMJ per group of authors, and the maximum number of articles in SMJ for a single author in the group.

Secondly, we have followed a similar approach with the world university ranking. Assuming that the university that is ranked higher in the rating should be more known and therefore be more cited, we have calculated the minimum world university ranking and the average university ranking for the group of authors, which worked on the article.

In addition, we have counted the number of non-recurring research areas per group of authors for each article. This parameter is called "Non-rec areas" and indicates the total number of areas of expertise for the group of authors.

Previously, we have concluded that there is no direct relationship between a bigger number of authors and a higher number of citations and even a group of authors is on average more successful than a single

author, the increase in citations is remaining only up to a certain extent (a certain number of authors). Therefore, we decided not to include this metric in our model.

After we have arranged a set of possible parameters, we would like to compare them and decide on the ones to be included in the model. In order to address this question, we calculated the correlations between the number of citations and the corresponding parameter.

The correlations are presented in the table below.

Parameter	**Correlation with citations**
h-index MAX	-0,01819
h-index AVG	-0,01014
i10-index MAX	0,10739
i10-index AVG	***0,14104***
WUR MIN	0,00703
WUR AVG	-0,02138
DR	***0,17687***
SMJ MAX	-0,04095
SMJ AVG	-0,02725
Non-rec areas	***0,06495***

Table3.

Surprisingly, the h-index tends to be uncorrelated (even slightly negatively correlated) with the number of citations for our data in both the maximum and average per author group versions. On the other hand, i10-index shows a much greater correlation with citations, whereas the correlation is higher for the average per author group version. This suggests that all the members in the group of authors are driving the overall success of the research paper. This is an additional argument for the importance of the group composition in order to reach success.

The world university ranking has close correlation values (slight negative correlation) to the h-index, meaning it is almost uncorrelated with the number of citations.

The number of articles in SMJ has a higher absolute value of the correlation than h-index and the world university ranking; however the sign is negative, and the value itself is not high enough.

The number of non-recurring areas exhibits a positive correlation with the number of citations; the absolute value is lower than i10-index and DR.

The diversification ratio has the highest correlation with the number of citations.

Parameters with the highest correlation could be used as predictors in the model.

3.6.2 Model estimation

In order to assess how diversification ratio implies the number of citations, we build a simple linear model with one dependent and one independent variable. The simple model is stated as:

Number of Citations = β1 * DR

```
Residuals:
   Min     1Q Median     3Q    Max
-47.49 -16.33   7.00  25.00 188.00

Coefficients:
   Estimate Std. Error t value Pr(>|t|)
DR   48.492      2.929   16.55   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 38.62 on 404 degrees of freedom
Multiple R-squared:  0.4042,    Adjusted R-squared:  0.4027
F-statistic:   274 on 1 and 404 DF,  p-value: < 2.2e-16
```

We see that the DR is significant at 0.1% level and the t value is 16.55. The result also shows that the model explains the dependent variable only partially (R-squared of 0.4042 and adjusted R-squared of 0.4027). The F-statistic is 274.

Keeping this result in mind, we will compare it to the results of more complicated models with a bigger number of parameters.

Considering this information, we continue building models with the average i10-index, the diversification ratio (DR) and a number of non-recurring areas (NR) as predictive parameters as they had the highest correlation with the number of citations.

The first model is defined as:

Number of Citations = β1 * DR + β2 * i10-indexAVG + β3 * NR

```
Residuals:
    Min      1Q  Median      3Q     Max
-66.605 -20.985  -5.308  14.199 164.627

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
DR          19.68645    4.09256   4.810 2.13e-06 ***
i10indexAVG  0.26732    0.07137   3.745 0.000206 ***
NR           4.00634    0.64854   6.177 1.60e-09 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 34.98 on 402 degrees of freedom
Multiple R-squared:  0.5136,    Adjusted R-squared:   0.51
F-statistic: 141.5 on 3 and 402 DF,  p-value: < 2.2e-16
```

All the model parameters are statistically significant at 0.1% level. The NR has the highest t value among the model parameters (6.17), followed by DR (4.81). The R-squared of 0.5136 (Adjusted R-squared 0.51) is significantly higher than in the simple model, but the model still explains only a part of the number of citations (dependent variable).

We further re-calculate the model making it quadratic with respect to the parameter of our most interest – DR. The model is now formulated as:

Number of Citations = $\beta 1 * DR^2 + \beta 2 * i10\text{-}indexAVG + \beta 3 * NR$

```
Residuals:
    Min      1Q  Median      3Q     Max
-69.312 -20.343  -5.391  13.445 163.122

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
DR2         20.65674    4.15043   4.977 9.60e-07 ***
i10indexAVG  0.27071    0.07112   3.806 0.000163 ***
NR           4.29874    0.60586   7.095 5.87e-12 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 34.91 on 402 degrees of freedom
Multiple R-squared:  0.5155,    Adjusted R-squared:  0.5119
F-statistic: 142.6 on 3 and 402 DF,  p-value: < 2.2e-16
```

The new quadratic model also has all the parameters statistically significant at 0.1% level. NR still has the highest t value (7.095), followed by the DR-squared (4.977). The R-squared slightly increased to 0.5155, whereas the adjusted R-squared increased to 0.5119. The F-statistic also slightly increased from 141.5 to 142.6.

Overall, the model provided a slightly better result since there was a slight increase in R-squared metric, adjusted R-squared and the F-statistic.

We would like to decrease the number of parameters in the attempt to increase the adjusted R-squared as well as increase the predictive power of one single parameter.

We defined a new parameter “mult” = DR*NR. The parameter could also be explained from the theoretical point of view. It represents the number of research areas with adjustment for the diversification.

The model with the new parameter is then defined as follows:

Number of Citations = β1 * mult + β2 * i10-indexAVG

```
Residuals:
     Min       1Q   Median       3Q      Max
-116.616  -15.138    2.711   21.573  181.706

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
mult         7.24242    0.72538   9.984  < 2e-16 ***
i10indexAVG  0.50350    0.06612   7.615 1.89e-13 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 36.93 on 403 degrees of freedom
Multiple R-squared:  0.4566,    Adjusted R-squared:  0.4539
F-statistic: 169.3 on 2 and 403 DF,  p-value: < 2.2e-16
```

The resulting model also has all the coefficients statistically significant at 0.1% level. However, the R-squared decreased to 0.4566, whereas the adjusted R-squared decreased to 0.4539. The t value of the “mult” increased to 9.984. The F-statistic increased from 142.6 to 169.3.

The resulting model with less coefficients, in fact, had a lower R-squared and adjusted R-squared, the t-value of the “mult” coefficient is higher than NR and DR in the previous two models. The F-statistic also has increased.

The DR has shown to be more correlated with the number of citations than any other variable we have checked from our data. It is important to note that DR was more correlated with the number of citations than indices that were designed to capture the citations potential of an author (correlation of 0.18 versus correlation of 0.14 for the index best index).

The regression analysis suggests that the diversification ratio is an important driver of the number of citations that is statistically significant at the highest level in different versions of the model. As a

standalone independent parameter of the simple model, it explains approximately 0.4 of the variance of the dependent variable (R-squared~0.4).

Combination of DR with other independent variables in more complicated models results in an increase of the model explanatory power to approximately 0.5 of the variance of the dependent variable (R-squared~0.5).

Such results suggest that the diversification could be considered during the stage of the team formation as an important factor of the team success.

However, even after the inclusion of all the relevant factors in the model, the explanatory power is not high, i.e., the R-squared is not above the common threshold of 0.7. This suggests that many case specific and external factors that affect the citations of an article and it is not easy to predict the success of the research paper.

Certain things could be done in future works to enhance the research. Sets of articles from different journals could be analyzed and then compared between each other, the areas of expertise of authors could be directly obtained from the authors via polls. This topic is further raised in the next chapter.

4. Research assumptions and further development

In the framework of this master thesis we have to highlight the following remarks and assumptions (limitations):

1. Articles can have a low number of citations because the topic is not actual at the moment or has no wide practical application or very narrowly specialised area or question etc.

2. It is not possible to identify spheres of interests for all authors, and there are chances that we have derived the core areas of interests (expertise) incorrectly.

3. The use of internet resources, and the quantity of information is growing every year and therefore people may use only the fresh articles. On the other hand, the articles which have been published

a year ago may have been read more times and have more citations because they are longer available.

4. The sample is not large enough and is applicable to the Strategic Management area. Moreover, the sample is biased towards Strategic Management in the sense that the research areas are more detailed in the Strategic Management area.

Analyzing the results of the work that was done we decided to describe the ideas emerged to continue the study and make the improvement of the study, taking into consideration all the assumptions described earlier:

1) One of the solutions to improve this assumption is to create a new control variable by analyzing the main economic news that happened at the same time period as sampling was obtained and check whether the topics are related to any of this economic facts. This will help to isolate these effects from the study.

2) To address the question about spheres of interests directly to the authors. The idea is that the authors will receive an email where they are asked to participate in research and name a particular number of areas of expertise, e.g., 3 or 5. In this case, each author will have the same quantity of spheres and we will be able to compare the diversity of groups of authors in a more reliable way. However, in this case, we may face the following problems: obtaining such data is very time consuming and not all authors will want to participate in research. In any of the approaches, the data collection about authors' areas of expertise is very subjective and reflects the personal (authors') opinion.

3), 4) To expand the sample and increase the coverage it would be useful to collect the same data from the edition in strategic management sphere and also add the data obtained from a completely different sphere (it could be medicine, mathematics and so on). But both of the editions should be comparable in popularity to the Strategic Management Journal.

5. Conclusion

We have conducted research on the matter of functional diversity in teams. We have reviewed the available literature, stated our hypotheses and performed a real case study on the effects of functional diversity in groups of authors using statistical methods to check the stated hypotheses.

We have assessed different sources of functional diversification in teams that could potentially affect team performance and therefore could be considered at the stage of team creation. The number of citations was considered as a measure of team performance.

The data on articles published in Strategic Management Journal from 2014 to 2017 was manually collected and processed for the purposes of this work.

At the first part of the research, we considered the functional diversity in groups of authors in terms of quantity composition of such teams. We have shown that groups of authors working on research papers are on average more successful than single authors. However, we have not found any evidence that an increase in the number of authors tends to increase the number of citations. On the contrary, we have found statistical evidence that groups with a number of authors higher than 3 reach a lower number of citations in their research articles than groups with two authors.

In the second part, we considered the functional diversification more comprehensively. We have calculated two diversification parameters – diversification ratio of the group of authors with respect to their areas of expertise (areas of interest) and the university diversification ratio of the group of authors.

We have shown that there is no statistical evidence showing that groups of authors from different universities are more successful than groups of authors from the same university. However, the diversification ratio with respect to the author's areas of expertise showed to positively affect the team performance.

We have checked 10 parameters derived from the collected data on potential correlation with the number of citations. Based on the results, we have chosen only 3 parameters that could potentially affect

the number of citations. The calculated before diversification ratio showed the highest correlation with the number of citations.

Using the selected parameters, we have built several models with selected parameters as an independent variables and the number of citations as a dependent variable. The diversification ratio as a sole independent variable in the model resulted in R-squared of 0.4, which is an acceptable result. The R-squared later increased to 0.5 after the inclusion of other parameters, showing a marginal increase and suggesting that many external factors are affecting citations.

Considering all the results of the work, based on the collected data for the research, the functional diversity in groups of authors (different areas of expertise) positively affects teams performance and therefore should be considered at the stage of the team creation.

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