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Building interdisciplinary research teams according to the requirements of the national research evaluation system

Accepted by Editor Ewa Ziemia | Received: November 3, 2020 | Revised: December 10, 2020 | Accepted: December 22, 2020.

Abstract

Aim/purpose – The paper explores the issue of building interdisciplinary research teams from the point of view of the evaluation requirements for Polish researchers and research units. The main aim of the paper is to determine the possibility of creating interdisciplinary research teams involving management and economics researchers.

Design/methodology/approach – The author searched 30,404 journals. An assumption was made that team creation should reflect the evaluation requirements of several measurement factors of similarity between disciplines, these were duly developed. An analysis of the possibility of developing effective interdisciplinary teams to maximise the possible number of places for publications and points scored was performed and discussed. The analysis was performed by considering all of the scored journals useful for the development of young researchers and well-regarded journals publishing original research prepared by experienced scientists.

Findings – The analysis indicates that the relevant journals are not evenly spread among the various scientific disciplines examined. Considering the possibility of finding many shared journals for publication while achieving favourable interdisciplinary research outcomes and scoring a high number of evaluation points, researchers in the fields of economics as well as finance and management and quality sciences should mainly cooperate with researchers in the field of socio-economic geography and sociological sciences.

Research implications/limitations – The analysis was based on the Polish national research evaluation system, which may limit the generalisation of the results.

Originality/value/contribution – The results presented in the paper may be useful for researchers, research team managers and authorities who run research units and create effective research teams.

Keywords: interdisciplinary research, research teams, evaluation, research evaluation, university evaluation, evaluation system.

JEL Classification: I23.

1. Introduction

Academic research has become an international endeavour and productive research is both a complicated and long-lasting process. Not only do researchers have to find valuable areas of investigation, plan their research procedure in sufficient detail, perform an analysis in accordance with advanced methodologies, but also disseminate their research results, e.g. by publishing them in well-regarded, widely recognised research journals. Complicated research with additional organisational and administrative procedures requires the creation of more and more extensive and interdisciplinary research teams to generate synergy effects and increase the effectiveness of their research activities. In many areas of science, activity requires collaborative work among a group of experts and necessitates the implementation of an appropriate team building procedure. The team building process, including its benefits and problems, has been widely reported in the fields of sport, healthcare, business, administration and research (Bruner, Eys, Carreau, McLaren, & Van Woezik, 2020; Miller, Kim, Silverman, & Bauer, 2018; Misra & Srivastava, 2018; Moore, Everly, & Bauer, 2016; Newin, Bloom, & Loughhead, 2008; Carron, Spink, & Prapavessis, 1996; Riener, & Wiederhold, 2016). Joint teams have a high potential to develop better research, explore more issues, and may also be more successful in achieving funding and better at disseminating research results. Successful research teams require empowered members who actively participate in decision-making and this should allow for strong relationships between partners to be built up and maintained (Polanco et al., 2011). In teamwork another important activity is appropriate, namely knowledge brokering, which helps researchers and decision makers to effectively communicate their needs and abilities (Urquhart, Porter, & Grunfeld, 2011). Team building processes also generate certain problems and costs, sometimes it is not clear how to assess the participation of each member of the team (Conde, Rodríguez-Sedano, Sánchez-González, Fernández-Llamas, Rodríguez-Lera, & Matellán-Olivera, 2016), but such evaluations result in a higher performance efficiency and bring about better quality research results.

Therefore, team-building activities are recommended for project group members (Albanese, 1994). Managing interdisciplinary research teams also requires much effort and a diverse set of skills, which includes setting common goals, maintaining communication, and developing policies for disseminating research results. An appropriate team-building procedure also mediates the effect of transformational leadership on project success (Aga, Noorderhaven, & Vallejo, 2016). In this procedure, hard knowledge, expertise and professional skills must be considered, but there are also less easily defined aspects, like emotion that should be taken into account (Turunen & Hiltunen, 2019). Finally, appropriate team competencies play a significant role in determining the effectiveness of individual researchers and team member satisfaction (Misra & Srivastava, 2018).

The work of interdisciplinary teams must be evaluated frequently. Therefore, we may observe the huge interest among both academics and practitioners in team performance evaluation (Aybas & Uyargil, 2017). Research has been conducted to identify and promote the best methods, tools and mechanisms for influencing the sustainability and effectiveness of interdisciplinary teams (Frykman, von Thiele Schwarz, Athlin, Hasson, & Mazzocato, 2017; Innocenti, Angeli, Alesi, Scorpiniti, & Pini, 2016; Mattioli & Ingaramo, 2019; Reeves, Lewin, Espin, & Zwarenstein, 2011; Weaver et al., 2010). The papers also address the question of evaluation. This is the process of interpreting measurements in order to determine the degree to which the desired requirements are met. This process also involves systematic observation to determine whether or not the researcher's or the research unit's performance is consistent with the needs of the assessed institution (Azzini, Galimberti, Marrara, & Ratti, 2018; Ebadi & Schiffauerova, 2016; Rossi, Lipsey, & Henry, 2018).

The aims, desired attitudes and outcomes may be different in various systems. Therefore, in order to correctly assess research performance and reflect global demands for greater accountability, many countries have introduced their own national research evaluation systems. For example, the Research Excellence Framework (REF) is used to assess the quality of research in UK higher education institutions (REF2021, 2020); the Research Assessment Exercise (RAE) was developed to assess the performance of universities in Hong Kong and was designed to encourage world-class research and inspire excellence (UGC, 2020). The main aims of evaluation systems are to inform funding decisions, to encourage greater coordination within the field of research, but also to promote cooperation between science and business, thereby accelerating the development of competition between the universities. Well established systems also have an

influence over the discovery of knowledge (Barker, 2007; Bianco, Gras, & Sutz, 2016; Korhonen, Tainio, & Wallenius, 2001). The evaluation mechanisms should be appropriate to the discipline, and should integrate technical requirements with the requirements of the relevant authorities in order to perform self-improvement or make the right personnel decisions (Arreola, 2004). However, these mechanisms can also create new problems, e.g. a lot of energy is consumed with the aim of securing a better evaluation that could be used more productively for research. Research evaluation may have an obscure and complicated methodology (Geuna & Martin, 2003; Hicks, 2009; Hong, 2007; Klein, 2008), and therefore remain one of the least-understood aspects of the research process.

The most important consideration for scientists is the research aim and its area, however, researchers and research units are evaluated according to national evaluation systems. Therefore, the issue of creating joint research teams in accordance with the guidelines of national research evaluation systems is also crucial in order to enable high evaluation scores to be achieved not only for the leading discipline, but also for individual team members who may belong to different scientific fields. Therefore, the main aim of the paper is to explore the possibility of creating interdisciplinary research teams involving management and economics researchers according to a Polish evaluation system for individual researchers and research units, and to indicate to members which disciplines should work together in order to enhance their chances of publishing research outcomes in highly respected journals.

Meeting evaluation requirements is important because it not only allows future researchers to raise funds but the process also enhances the prestige of the researcher, research team, and scientific units. Finally, it enables students and researchers to be better educated so that in the future they may have a better chance of becoming the leaders of high-quality research teams. The motivation of the study is therefore to find new ways of building more effective research teams according to evaluation system requirements. Research motivation is linked with the quality of research team management and research work effectiveness.

The next parts of the paper are organised as follows: In Section 2, the author presents the framework of a novel Polish research evaluation system: scientific disciplines, list of scored scientific journals, characteristics of the researcher and research unit evaluation. In Section 3 the study methodology is outlined: research questions, research procedure and a sample of research which addresses the issue of building interdisciplinary research teams. Section 4 explains the

results in detail with the appropriate diagrams, followed by a discussion concerning their implications and the fields for potential cooperation are also identified. Finally, in Section 5, conclusions are outlined and in Section 6 suggestions for future research are presented.

2. Polish research evaluation system

A new Polish research evaluation system was introduced in order to motivate research units and researchers to perform high-quality research and disseminate their research outcomes in journals which are recognised worldwide.

According to information published by the Ministry of Science and Higher Education, the experts who prepared the evaluation system are for the most part well-known Polish professors, who have a profound degree of knowledge, skills, and experience in a total of forty-four evaluated scientific disciplines, as well as knowledge concerning the functioning of similar systems in other countries. In the author's opinion, the development of a national evaluation system should include both internal (country level) and external (international) data and best practices analysis.

The system introduces transparent criteria for evaluating both researchers and research units in order to effectively distribute the funds necessary to conduct research. The evaluation is obligatory for research units. Within the system, different criteria are used for the evaluation of researchers and research units. The evaluation of research units is based on three main criteria: scientific and artistic level of activities, the financial effects of the scientific research, and the impact of their scientific activity on the economy and on society as a whole. The position of the entity in the higher education system in Poland and its rightful place depends on the scientific category granted as the results of the evaluation, among other considerations. Furthermore, the potential of the research unit to educate students and doctoral students, or obtain funds for future scientific and teaching activities depends on the evaluation results. The subject of the evaluation are the scientific activities carried out by the entities of higher education, which includes scientific research, R&D studies, and artistic activity. The evaluation is carried out with regards to both scientific and artistic disciplines (Konstytucja dla nauki [Constitution for Science], 2020). The catalogue of scientific disciplines according to the Polish Ministry of Science and Higher Education is shown in Table 1.

Table 1. Disciplines in the Polish research evaluation system

Code	Name	Code	Name
D1	Archaeology	D23	Food and nutrition technology
D2	Philosophy	D24	Veterinary medicine
D3	History	D25	Zootechnics and fishing
D4	Linguistics	D26	Economics and finance
D5	Literature	D27	Socio-economic geography and spatial management
D6	Culture and religion sciences	D28	Security science
D7	Art sciences	D29	Social communication and media sciences
D8	Architecture and urban planning	D30	Political and administrative sciences
D9	Automation, electronics and electrical engineering	D31	Management and quality sciences
D10	Technical computer science and telecommunications	D32	Legal sciences
D11	Biomedical engineering	D33	Sociological sciences
D12	Chemical engineering	D34	Education
D13	Civil engineering and transport	D35	The canon law
D14	Material engineering	D36	Psychology
D15	Mechanical engineering	D37	Astronomy
D16	Environmental engineering, mining and energy	D38	Informatics
D17	Pharmaceutical sciences	D39	Mathematics
D18	Medical sciences	D40	Biological sciences
D19	Physical education sciences	D41	Chemical sciences
D20	Health sciences	D42	Physical sciences
D21	Forestry sciences	D43	Earth and environmental sciences
D22	Agriculture and gardening	D44	Theological sciences

Source: Author's own study.

The research unit may be evaluated in a given discipline only if the number of employees of the entity assigned to the discipline is a minimum of 12. Each researcher may be assigned to one or two disciplines and participation in a specific discipline can be 25%, 50%, 75% or 100%. The achievements of all of the employees who conduct scientific activity in the evaluated discipline are considered. The basis of evaluation of the research unit are the achievements of all employees who conducting scientific activity and therefore, a high score in the researcher activity category leads to a high assessment score for the scientific unit as a whole. Research level evaluation includes scientific articles, scientific monographs, chapters in scientific monographs, editing of monographs and patents for inventions or protection rights. The subject of evaluation are the achievements for the last four years, and therefore the researchers must maintain constant, highly effective scientific activity, as historical achievements are not taken into account. The assessment includes up to only four of the best achievements of the researcher, therefore the scientist should not prepare too many low quality papers, instead of that, they should concentrate on high quality research

and publish their outcomes in well regarded journals. The researcher scores 20, 40, 70, 100, 140 or 200 points for publication in a journal from the ministerial list of journals. If the journal is not on the list, only 5 points may be awarded (Dz.U. 2019 poz. 392 [Journal of Laws 2019 No. item 392], 2019). For the best publication (100 points or more), the number of evaluation points is not divided between co-authors.

The detailed scores for other scientific activities are presented in (Konstytucja dla nauki [Constitution for Science], 2020). Based on the requirements of the Polish national research evaluation system, the publishing activity of the researchers should include the following:

- a specified number of outcomes published per year,
- articles published in journals exclusively from the ministerial list of journals and monographs,
- an article published in highly scored journals with 100 points and more,
- the topics of scientific publications must be related to the research conducted in the discipline to which the employee has been assigned.

An extensive description of the Polish national research evaluation system for research units and researchers is actually far more complicated than the list above suggests and is presented in the guidance (Konstytucja dla nauki [Constitution for Science], 2020; PMSHE, 2019). However, in this paper, the author focuses only on core research work, such as the preparation of research articles and their publication in scientific journals, this activity is evaluated based on a list of journals approved by the Polish Ministry of Science and Higher Education (PMSHE, 2020).

3. Research

3.1. The research questions

The list of evaluated scientific journals recognised by the Polish Ministry of Science and Higher Education was explored and analysed in order to answer the following research questions:

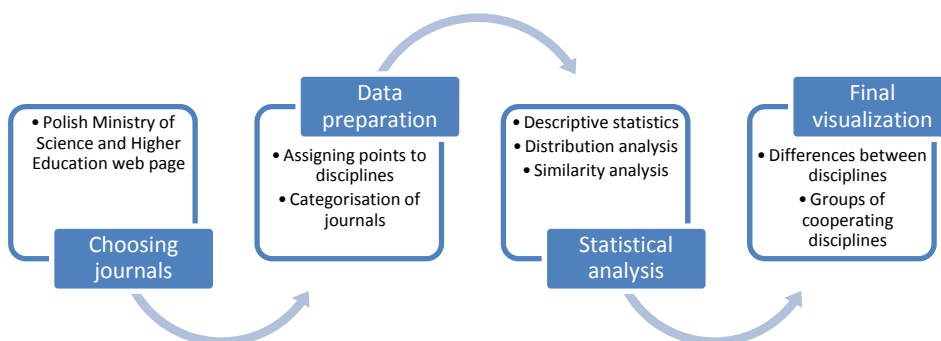
- Are the journals evenly distributed among the disciplines?
- What is the distribution of both the well-regarded journals and the less prestigious journals within the disciplines?
- What are the average values of the evaluation points of the journals assigned to the discipline?
- What disciplines should cooperate in order to achieve extensive publishing opportunities and receive high evaluation points?

The collected data were analysed with the use of the Microsoft Excel 2013 tool, and finally the analysed data were explored and visualised in SPSS Statistics 25 and Gnuplot 5.2.

3.2. The research procedure

The research was divided into four main steps: acquiring the list of evaluated journals from the Polish Ministry of Science and Higher Education, data preparation in Microsoft Excel, statistical analysis of evaluation points in SPSS, visualisation, discussion and final conclusions. The research procedure is shown in Figure 1.

Figure 1. The research procedure



Source: Author's own study.

The list of evaluated journals was acquired from the web page of the Polish Ministry of Science and Higher Education (PMSHE, 2020). The data were available in XLSX format, therefore for data preparation, Microsoft Excel 2013 was used. The points were assigned to the disciplines, also, the number of shared journals between the disciplines was calculated, mainly with the use of VLOOKUP, OFFSET, COUNTIFS and SUMIFS functions. A prepared data file was imported to SPSS Statistics in order to explore the descriptive statistics and distribution of the journals within the disciplines. Based on a similarity analysis performed in Microsoft Excel, and taking into account the number of shared journals, their total and average evaluation points, the final visualisation matrix charts were prepared in Gnuplot. The analysis and visualisations performed were discussed and used to prepare suitable recommendations for researchers seeking research partners and managers of research teams. Finally, based on the prepared analysis, plans for future research were developed and presented at the end of the paper.

3.3. Collected data

The author collected and analysed data from 30,404 scientific journals assigned to forty-four disciplines by the Polish PMSHE. The characteristics of the analysed journals are presented in Table 2.

Table 2. The characteristics of the analysed journals

Characteristic (n = 30,404)		n	%
Points	20	11982	39.41
	40	5985	19.68
	70	5821	19.15
	100	3864	12.71
	140	1911	6.29
	200	841	2.77
Number of disciplines	1-5	24323	80.00
	6-10	5575	18.34
	11-15	427	1.40
	16-20	56	0.18
	21-25	6	0.02
	41-44	17	0.06
Number of disciplines (highly scored journals)	1-5	4614	69.74
	6-10	1903	28.76
	11-15	84	1.27
	16-20	11	0.17
	21-25	4	0.06

Source: Author's own study.

It was possible for each journal to achieve between 20 and 200 points. The majority of the journals evaluated (about 40%) were assigned the lowest score while only slightly under 3% of them achieved maximum points. The number of points assigned to each journal would seem to be correct, as the number of points increases, the number of journals assigned to the category decreases. Such a division helps younger and less experienced researchers to find many places for the publication of articles, which are sometimes of not very high quality. If they wish to score more points, they must prepare better publications, as competition in the area of the highly scored journals (100 and more points) is far more intense. The number of the lowest scored journals is twice as large as the total number of journals for 100, 140 and 200 points together.

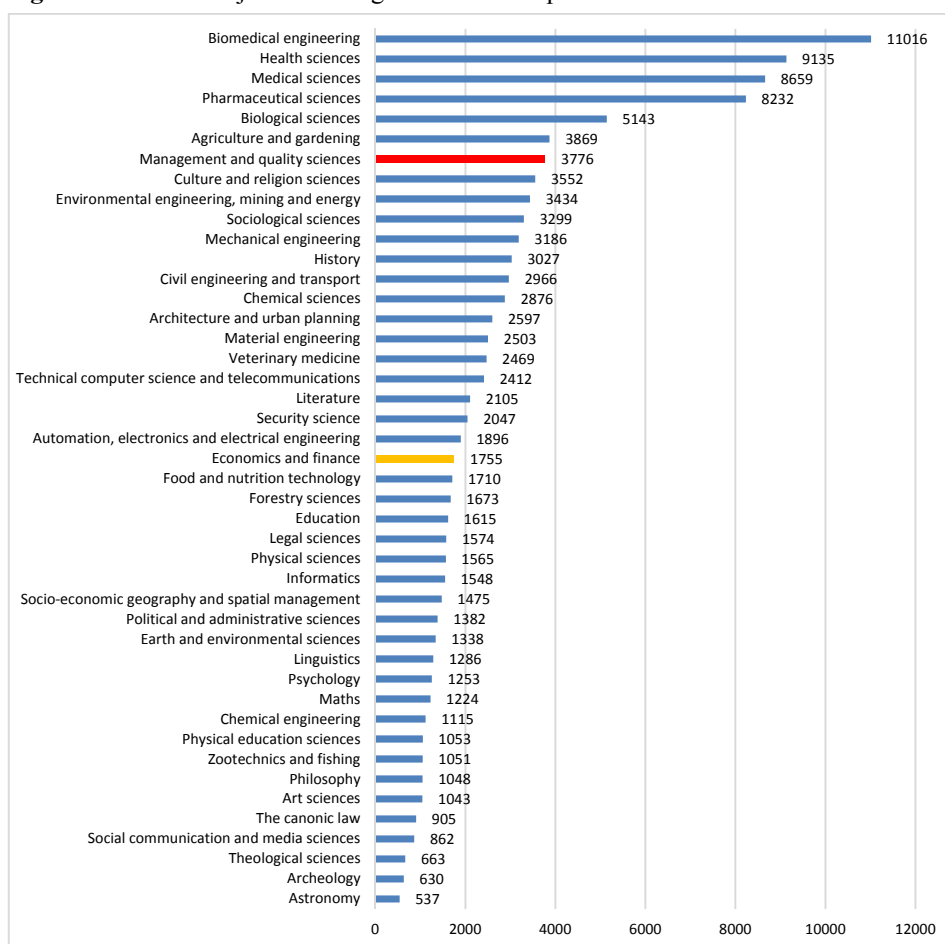
The evaluation system also presents the opportunity for interdisciplinary cooperation. Only 16.7% of the journals mentioned in the PMSHE list were assigned to only one discipline, while 80% belonged to any number from one to five disciplines. We can also find 17 journals that were assigned to all 44 disciplines. All of them are among the lowest scored journals (20 points). When we take into account only the highly scored journals (with 100 and more points)

most of them may be assigned to fewer than five disciplines and 91% to more than two fields of science, which presents advanced researchers with a great opportunity to establish high quality interdisciplinary research teams in which each researcher will be able to obtain high evaluation points.

4. Data analysis and discussion

The Polish Ministry of Science and Higher Education identified forty-four research disciplines (shown in Table 1). The 30,404 scientific journals were then assigned to the disciplines. One journal could be assigned to more than one field of science. The number of journals assigned to the discipline is shown in Figure 2.

Figure 2. Number of journals assigned to the discipline



Source: Author's own study.

The largest number of journals was assigned to disciplines related to medicine, health and pharmacy, and included more than 8200 examples. The lowest number of periodicals for publication was in the areas of canon law, social communication, theology, archaeology, and astronomy. We may assume that the number of journals is linked to the number of researchers assigned to a given discipline (at present the author has no such data). However, Figure 2 may indicate that biomedical, engineering, health sciences, medical sciences and pharmaceutical science are overrepresented, while the disciplines with a large number of researchers, such as sociological sciences, civil engineering, chemical sciences and finally economics and finance, literature, and computer science (informatics) have far fewer places available for publication in order to obtain the required evaluation points. A confirmation as to whether the number of journals was correctly assigned to the disciplines requires a more in-depth analysis and comparison with the database of researchers assigned to the disciplines. However, it seems likely that after the publication of such records, the assignment of articles to disciplines should be corrected.

The distribution of the journals among the disciplines is quite similar. For the vast majority of the disciplines, the number of items decreases as the number of points assigned to them increases (Figure 3).

In the fields of biomedical engineering, health sciences and medical sciences we may observe a relatively high number of the lowest scored journals, this may explain the large number of journals assigned to the discipline presented in Figure 2. Therefore, from the beginning of their careers, researchers from those areas have a great opportunity to start their scientific careers. Academics from other disciplines should be aware that creating joint teams with researchers from the aforementioned areas will result in a wide range of journals being available for publication, however, these journals will frequently be assigned low scores. The disciplines which have a relatively large number of highly scored journals are biological sciences, veterinary studies and medicine. In these disciplines, the number of medium scored journals exceeds the number of the periodicals with 20 points. The top scoring journals (140 points and above) are assigned to biomedical engineering, healthcare sciences and pharmaceutical sciences. Therefore, experienced researchers who are looking for research partners and who wish to publish their results in highly respected journals should address the research areas related to those fields of science.

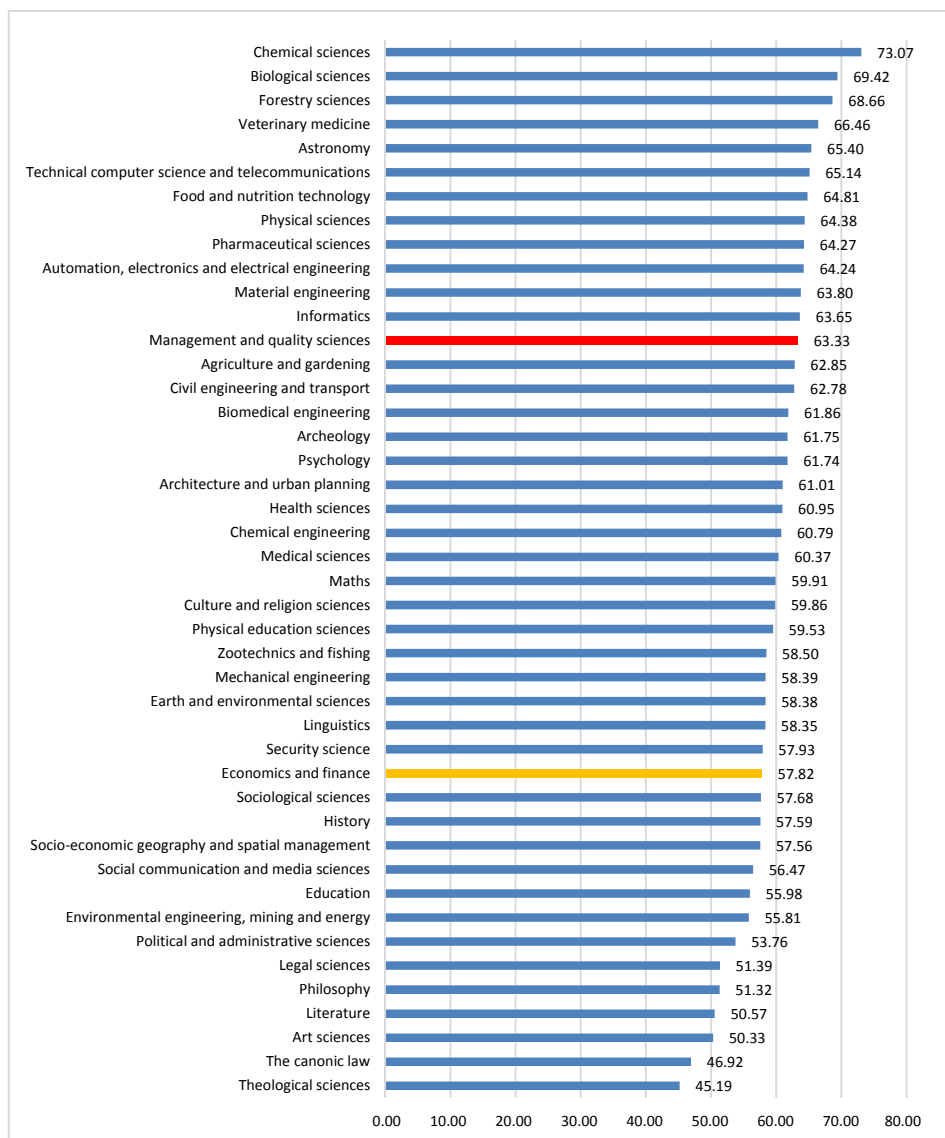
Figure 3. Distribution of journals assigned to the discipline



Source: Author's own study.

According to the evaluation points that can be scored by the researchers from different disciplines, the best positions are held by scientists who specialise in the areas of chemistry, biology, forestry, veterinary sciences and astronomy. The average number of points for journals assigned to those disciplines is higher than 65. The lowest average points were achieved by the journals assigned to literature, art sciences, canon law and theological sciences, the result was less than 51 (Figure 4).

Figure 4. Average number of points of journals assigned to the discipline

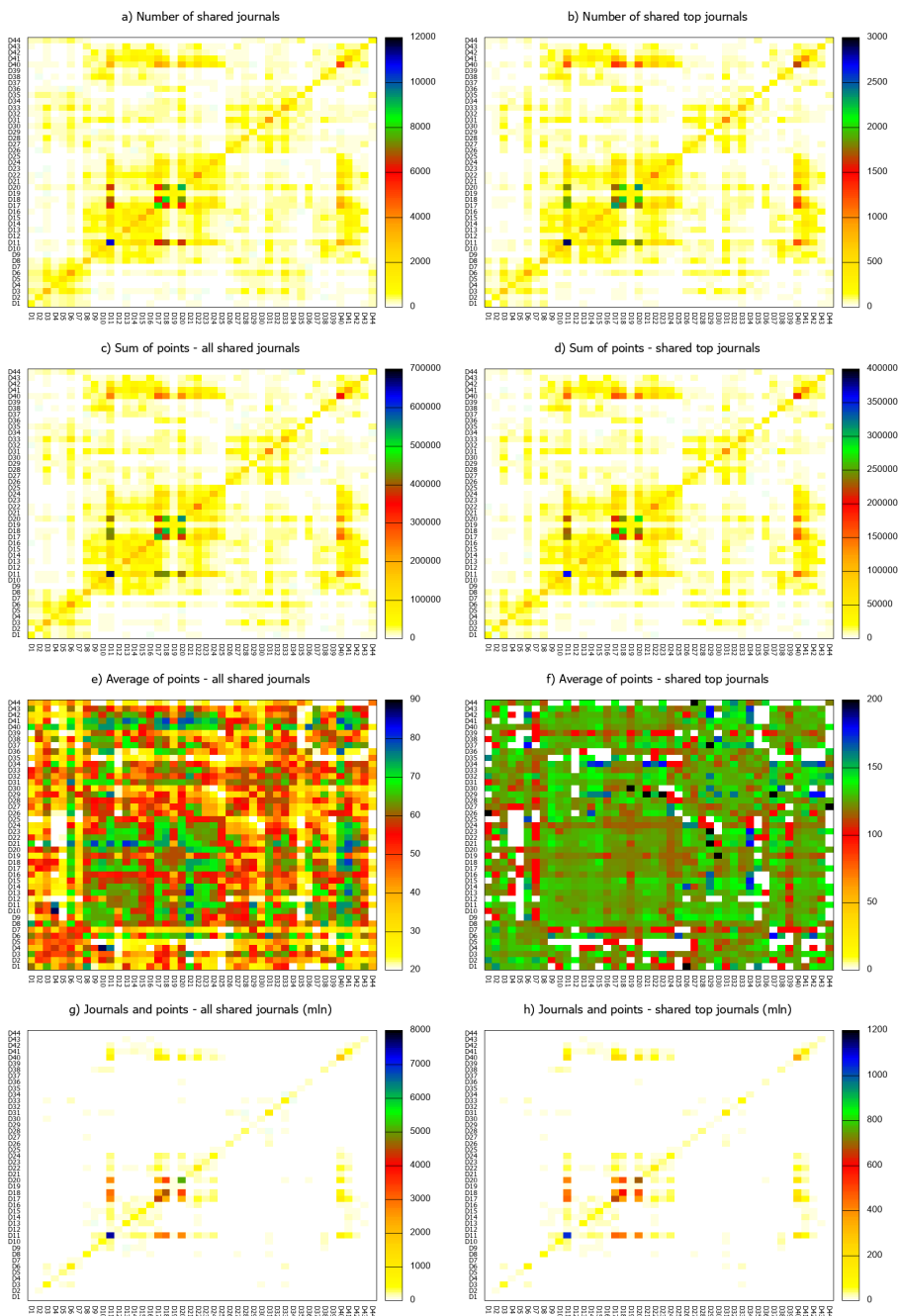


Source: Author's own study.

The differences between the average values of points that it was possible to obtain in various disciplines are not huge, they varied from 55 to 65 points. However, the degree of diversity indicates that researchers from different fields of science should have different limits in their evaluation systems because they can score more or less points for their publications depending on the field of science they represent. In considering the average values of evaluation points, from the point of view of economics and management, researchers in the chemical, biological, technical, pharmaceutical, medical and technical sciences should be given preferential treatment. Nevertheless, cooperation with the following fields: literature, art sciences, canon law and theology should be carefully thought out or even avoided.

From an evaluation point of view, the number of journals assigned to the discipline and the number of points that are achievable is significant. However, researchers looking for research partners from different disciplines should remember that before starting a cooperation they should check if the set of journals assigned to the external discipline is not only highly scored, but more importantly, to analyse whether it is shared with the main discipline of the researcher. Otherwise, even after favourable research, it could be very difficult to publish the outcomes in a highly respected journal which guarantees cooperating researchers from various disciplines a large number of evaluation points. If this issue is not addressed, then despite the commitment of considerable research, organisational and administrative efforts, some members of the research team will not obtain any evaluation points, which may result in a lack of funding for their future research.

In order to address this issue the author checked the similarity of the sets of assigned journals by considering the number of shared journals, the total amount of possible evaluation points, the average value of the evaluation points of the shared journals and two factors (number of journals and sum of points) together. The analysis was performed for all journals and a separate analysis was only conducted for the top scoring journals (100, 140 and 200 points) because, according to the Polish national research evaluation system, for the best publication (100 points and more) the number of evaluation points is not divided between co-authors (Konstytucja dla nauki [Constitution for Science], 2020).

Figure 5. Similarity among the disciplines by number of journals and total evaluation points

Note: The codes of disciplines were presented in Table 1.

Source: Author's own study.

A thorough analysis of the matrix charts above would be very extensive because we must consider the relationship between all 44 defined disciplines. In general, a darker colour means a closer relationship between disciplines and a greater chance of finding more suitable journals or more highly scored journals for the publication of interdisciplinary research outputs, which guarantees all of the team members many evaluation points. For the sake of improving the readability of the analysis the author concentrates on one particular discipline of management and quality sciences (D31). For less experienced researchers who may wish to create an effective research team (from the evaluation point of view), the analysis should concern all shared journals (Figure 5, left column), while for more experienced researchers, the well regarded scientific periodicals should be analysed (Figure 5, right column).

If they only wish to consider the number of shared journals (Figure 5a) researchers from the management and quality area should look for research partners mainly in economics and finance, sociological sciences, technical computer science and telecommunications, socio-economic geography and spatial management. These disciplines have respectively 1,292, 911, 775 and 737 joint places for publication. However, they should avoid archaeology, linguistics, zootechnics and fishing, astronomy, theological sciences. Each of these fields has less than 50 journals which are shared with management and quality sciences. When considering the total sum of the shared journals (Figure 5c) researchers in the area of management and quality sciences should create joint research teams with economics and finance, sociological sciences, technical computer science and telecommunications, socio-economic geography and biomedical engineering. When we take into account the average total points (Figure 5e) obtained for creating an interdisciplinary research team consisting of experienced researchers who would like to get a high number of evaluation points then business researchers should consider culture and religion sciences, architecture and urban planning, automation, electronics and electrical engineering, but also biomedical engineering, biological sciences. Their joint journals offer on average, over 68 points. Finally, in considering both the number of shared journals and the total number of evaluation points, representatives of the field of management and quality sciences should be interested in joint research that could be conducted together with economics and finance, architecture and urban planning and also sociological sciences. It would not be advisable for their areas of research to be related to archaeology, linguistics, art sciences, zootechnics and fishing, and theological sciences.

The Polish research evaluation system presents many possibilities for inter-disciplinary cooperation. The most important factor which should be considered by the researcher is their own interests, skills, and previous experience. However, at present, when many scientific projects are complicated, extensive, and require considerable resources and interdisciplinary expertise and skills, it is worthwhile creating joint research teams. The analysis of the requirements for an evaluation system allows researchers to not only choose a more profitable research area, but also to choose researchers from relevant disciplines, and find the most well-regarded journals for the dissemination of results in order to score high evaluation points for all of the team members.

5. Conclusions

Academic research has become a multi-area endeavour and research is for the most part a complicated, long lasting process. Extended research, organisational, and administrative procedures therefore require the creation of more and more extensive and interdisciplinary research teams. Research is frequently evaluated to make accurate funding decisions, encourage more effective research, accelerate the development of competition, or boost the discovery of knowledge. An evaluation may have various purposes and measurement factors, therefore many countries have introduced their own national research evaluation systems. In the paper, the issue of building interdisciplinary research teams in accordance with the Polish research evaluation system was explored. It was assumed that team creation should reflect evaluation requirements, the author developed several measurement factors to determine the degree of similarity between disciplines, thereby indicating which research areas merit cooperation.

The author analysed over 30 thousand journals and forty-four scientific disciplines. Following the example of the recently introduced Polish research evaluation system, an analysis of the possibility of creating joint research teams was presented. Academics who join research teams should be aware of the basic principles resulting from the evaluation system otherwise, despite the commitment of considerable research, organisational and administrative efforts some members of the research team will not obtain any evaluation points, which may result in a lack of funds for their future research and development.

The analysis performed indicates that, according to the Polish research evaluation system, journals are not evenly divided between scientific disciplines. However, accurate final conclusions may only be arrived at after a comparison

has been made between the journal list and the record of researchers assigned to the various disciplines. The distribution of journals within the discipline is corrected by the relatively high number of less highly scored journals suitable for young researchers – beginners and a low number of highly scored places for the publications of experienced scientists. In considering the average values of the evaluation points, economics and management researchers should cooperate with the chemical, biological, technical, pharmaceutical, medical sciences. An investigation of the shared journals indicates that business and economics academics should search for partners in the sociological sciences, technical computer science and telecommunications, and in the study of socio-economic geography.

An analysis of the shared journals may be successfully used for the creation of joint teams. In the Polish science system, researchers from various disciplines may cooperate to perform high-quality research and have the chance to publish their outcomes in many prestigious (highly scored) journals. The requirements analysis of the evaluation system allows researchers to not only choose a more profitable research area (one that is assigned to a more valued discipline), but also to choose research partners from relevant disciplines, and find the most well regarded journals for the dissemination of their results.

The paper addresses efficiency, as it is one of the fundamental economic terms. The author investigates the distribution and allocation of research forces in order to determine their most valuable uses and minimise waste. In the author's opinion, the results may be used in the wider area of research team management. The outcomes presented in the paper may be useful both for researchers, research team managers and for the authorities who run research units and create effective research teams. Based on the presented analysis, young researchers can build interdisciplinary research networks which include research areas that have a lot of common and highly scored journals. Experienced scholars can use the evaluation system requirements to identify new interdisciplinary areas for cooperation, and research team managers can use the results to prepare the appropriate paths and directions for the development of researchers in order to increase the effectiveness of their research activities. Finally, the results may be useful for the authorities who run research units who wish to promote certain research teams, increase their impact, and obtain funding for future research activities. Furthermore, the analysis shown in the paper may also be used by evaluation units from other counties which are developing their own evaluation systems and searching for cases and solutions for the purposes of making comparisons.

The analysis was based on the Polish national research evaluation system which limits the generalisability of the results. The outcomes cannot be directly applied to other countries. The analysis and recommendations were based on Polish evaluation system requirements, while the solutions used in different countries may be based on other assumptions. Therefore, in order to prepare more universal recommendations a comparative analysis of other evaluation systems is required.

6. Future research

Building effective interdisciplinary research teams has become a challenge not only for researchers but also for the university authorities and central national evaluation units. Performing high quality research necessitates a wide scope of cooperation, the research performed and its dissemination must also meet the requirements of the relevant national evaluation system in order to obtain sufficient funding. Therefore, in future research the author would like to ask researchers from different areas: social, natural and formal sciences about their opinions concerning the Polish national research evaluation system. Research will also be conducted with the purpose of finding out how to encourage researchers to share their experiences concerning the processes of building, working in and managing interdisciplinary teams. Finally, an interesting area of research is the analysis and comparison of national research evaluation systems between countries with different mechanisms of science funding and different levels of research development.

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