

Knowledge Sharing Co-operative Structures: The Case of WikiProjects

Katarzyna Kukowska

Częstochowa University of Technology, Częstochowa, Poland

katarzyna.kukowska@pcz.pl

Abstract: The effects of cooperation that may be observed based on voluntary activities of a global institution online like Wikipedia illustrate the social potential arising from the spontaneous need for activity. The basic activity of a Wikipedia user by way of assumption comes down to the creation of verbal content. The maintenance of high quality in the contents presented through controlling their verifiability is already a multi-faceted form of cooperation. The quintessence of such cooperation is the organization of Wikipedia users around internal WikiProjects. The research presented in the paper aimed to verify the magnitude of WikiProjects from the viewpoint of the number of users of Wikipedia, the most frequent number of participants of WikiProjects, and their compliance with the numeracy of groups and communities in the notion of Dunbar. Moreover, it was assumed that the number of WikiProjects in a given language version, while also the number of their participants is associated with the indicator of individualism-collectivism (IDV) according to Hofstede. The method applied was the analysis of entries of the activities in WikiProjects, as well as the number of their participants. The research has shown that WikiProjects, as groups of Wikipedians working as a team, show a similarity to the layered community formation proposed by Dunbar. A positive correlation was also found between IDV and the number of WikiProjects for individual language versions. A high IDV mainly relates to countries with a high GDP per capita. In these countries, we are dealing with a developed IT infrastructure. The high level of participation in WikiProjects with a high IDV may also be motivated by the desire to build user's position, as well as the desire to have an impact on the community as individuals. WikiProjects may fulfil the function of clubs, in which participants may try to build their autonomy in terms of activities to a certain extent, regardless of the entire system in which they operate. WikiProjects as a group of Wikipedia users working as a team indicate the similarity to the tiered creation of communities proposed by Dunbar.

Keywords: activity in virtual communities, collaboration in WikiProjects, sharing knowledge

1. Introduction

Wikipedia is a global project based on the work of individuals who share their knowledge. It is important to maintain a high quality of content that can be created by anyone. Keeping the entries compliant with encyclopaedic format and content reliability requirements necessitates multi-aspect cooperation with other Wikipedians. Wikipedians constitute a very diverse and geographically dispersed group, yet through the creation of the content, they build mutual relations and a common identity. One specific form of the cooperation of Wikipedians focused on a specific problem which is the organization of the content creators in WikiProjects. WikiProjects are perceived as embedded organizational structures engaged in content creation that support both the entire group and the individual members of the latter (Forte et al. 2012).

The research presented in this paper has been inspired by two subject areas: 1) the issue of the cultural dimension of cooperation based on the analysis of Hofstede and 2) the isolated quantity of the social strata according to the concept of the relation closeness defined by Dunbar (2016, pp 92-97). The research area covered the organized cooperation structures focused on WikiProjects and the goal of the research was to verify the number of user groups engaged in the individual WikiProjects and to determine the most common quantities of the WikiProject members and their compatibility to the numbers presented by Dunbar. It was also assumed that the number of WikiProjects in one language version and the number of WikiProject members are related to the IDV as defined by Hofstede (Kukowska, Skolik 2021). Research also accounted for the possible differences in the WikiProjects engagement for the particular language version related to GDP per capita PPP and IDV of particular countries.

2. Literature

Dunbar determined a natural size of the human communities that amounts to about 150 individuals. He proved that the capability to maintain stable interpersonal relations is limited by human cognitive abilities (the so-called social brain hypothesis). In the comparative research, Dunbar indicated many examples of the emergence of relatively autonomous communities with a size of approx. 150 individuals: Neolithic villages, villages in medieval England, production units in the Gore-Tex Inc. factory and private contact networks in cyberspace. The groups of roughly 150 individuals have existed in all human communities for tens of thousands of years and we can treat them as a common cultural factor (Dunbar 2016). Determining the levels of the relationship closeness,

Dunbar proves that the communities emerge in layers in accordance with the following structures (Dunbar 2016; Gamble, Gowlett, Dunbar 2017):

- personal group: approx. roughly 5 individuals and consisting of the family members or closest friends, people with whom we usually share a household;
- support groups: approx. 15 individuals that are usually our close friends and relatives, the contact with such group is either direct or maintained through telephony and digital media; these groups allow us to mitigate stresses created in larger structures and can provide everyday support, both emotional and material;
- good acquaintances: approx. 50 individuals, this group is often composed of our co-workers whom we meet throughout the working day;
- acquaintance communities: approx. 150 individuals;
- groups of approx. 500 individuals and composed of people we barely know and with whom we usually trade and among whom we form marriages;
- approx. 1500 individuals are distant acquaintances we might not know well but we can still remember their names and faces.

The layers presented by Dunbar determine not only the emotional closeness and time spent on interactions, but also the functional specifics of the individuals and communities (Dunbar 2016). The number of individuals in respective layers determined as 50, 150, and 500 are considered optimal for social relations. The population size oscillates around those numbers. The risk of disintegration of a given community increases as a community size diverts from the presented numbers either up or down (Dunbar, Sosis 2018).

The concept of Dunbar's number has been challenged by, e.g., de Ruiter, Weston and Lyon (2011). They pointed out that Dunbar disregarded the cultural practices and social structures that are supposed to counteract the limitations of the physiology of the human brain related to the successful operation within a network of complex social relationships. The research team also presented empirical observations of the various group sizes, many of which were not limited to Dunbar's numbers. Recent research by Lindenfors, Wartel and Lind (2021) also challenged the concept of the social brain and the natural size of the community equal to 150 individuals. Admittedly, the empirical evidence has been criticized by Dunbar himself, who noticed that the form of regression analysis (LSR) utilized by Lindefors and others to determine the relationship between group size and brain size provided misleading results. In addition, Dunbar claimed that the authors mentioned above ignored the evidence provided by neural imaging (Dunbar 2021).

The subject of Dunbar's number in the Wikipedia environment has been described in the paper by Lothar-Marcus (2018) which presents a theoretical model of self-organizing decentralized open systems (SODOS). This proposed model assumes structural limitation of the group interaction and member coordination to 150 group members. When describing conditions for the model functionality, the author used the example of Wikipedia, including WikiProjects. An empirical examination of the WikiProjects has been conducted by, e.g., Qin Cunningham and Salter-Townshend (2015) who attempted to investigate the structural properties of the discussion page network and their influence on the WikiProjects efficiency in the English language version of Wikipedia.

Knowledge sharing creates a space for cooperation that is inherently influenced by cultural factors. Many authors invoked Hofstede's analysis of the cultural dimensions in the context of cooperation and coordination in Wikipedia space. Nemoto and Gloor (2011) attempted to identify cultural differences in the Internet cooperation networks connected with innovation by comparison of Wikipedia pages. Cultural differences related to the articles and other forms of communication were also part of the investigation. Petrushyna, Klamka and Jarke (2014) analysed IDV differences in 13 European and Asian language versions, researching the involvement of registered and anonymous users in the Wikipedia content creation. Usman and Yennita (2018) used surveys to examine differences between the groups of Italian and Indonesian Wikipedia users and their levels of involvement in Wikipedia usage. Their results have shown that the users recruiting from a collectivist Indonesian culture are more eager to promote their own community and have a stronger intent to share knowledge than the Wikipedians representing a more individualist Italian culture. Lemmerich et al. (2019) surveyed 210,000 readers of 14 language versions of Wikipedia. Their research involved the correlation between Hofstede's cultural dimensions and reading behaviours. The IDV dimensions have shown a clear relationship between Wikipedia usage and the influence of media, work, or school, with the members of more collectivist

societies being less likely to visit Wikipedia due to the media influence. The authors in question also proved that Wikipedia usage correlates with the socio-economic traits of the user's country.

The cooperation context fits in with the cultural dimension of individualism and collectivism that defines the bonding between the individuals. While individualist cultures promote caring about themselves and the immediate family, collectivist cultures form cohesive internal groups. The level of individualism in a culture is tied to the national wealth, with countries dominated by individualist culture that are wealthier than more collectivist countries (Hofstede, Hofstede, Minkov 2010, pp 125-127). The author of the study, together with the team, assessed the relationship between the IDV of the national cultures Wikipedians recruit from and the indicators related to the activity levels and regulation of actions. It has been shown that a smaller number of internal rules users adhere to and a large number of edits per page correlate positively with IDV, whereas in the cultures with low IDV, there is a lower tendency to change the content that has already been posted (Kukowska, Skolik 2021).

Analysis of the subject literature has shown that the scientific debate concerning the natural size of the social groups, the structure of which has been confirmed among, e.g. Facebook groups or online game communities (Dunbar 2021) is still ongoing. The concept of Dunbar's number has not been explored to a significant extent in relation to the structures of the Wikipedia community, where users create groups focused on particular WikiProjects. Thus, WikiProjects form cooperation structures within a decentralized Wikipedia. In addition, these spontaneously created social structures remain an interesting scientific opportunity for the research of the cultural background of such activities. The author of this study fills the research gap and continues the research focused on the IDV, thus enhancing them with new parameters.

3. Methodology

This paper presents the results of quantitative research conducted in 2021 and 2022 and focused on 36 selected language versions of Wikipedia edited by communities characterized by homogeneous national cultures. All selected versions were required to show at least 300 active users per month. The method used in the study was based on the analysis of the activity logs and the number of participants of the WikiProjects. Data on the number of users was obtained from the publicly accessible comparative summaries of the language versions of Wikipedia (*List of Wikipedias*). In addition, a database containing data detailing e.g. user activity (*Wikimedia Statistics*) was used. The analysis included 55 WikiProjects that were popular in different language versions. It is worth mentioning that the analysed pool of the WikiProjects selected for the research did not guarantee the occurrence of a particular project in all 36 language versions.

The research was based on the following hypotheses:

H1: There is a relation between the number of WikiProjects and the number of their members, and a level of individualism presented by the users recruiting from their national cultures.

H2: The increased number of users organizing themselves for WikiProjects facilitates such activity both in terms of the number of users participating in a given project, as well as in terms of creating new projects.

H3: The activity level of the WikiProjects members is relative to the GDP per capita PPP of the countries represented by the members and to the IDV level of their national cultures.

H4: WikiProjects that are understood as groups of Wikipedians show similarities to the layered formation of communities according to Dunbar's 'rule of three' (Dunbar 2016, p. 93)

In order to verify the hypotheses, the following variables were selected:

1. the number of active users in language versions – data included all users of selected language versions who made edits (created or modified the Wikipedia page contents) in January 2022;
2. the average number of participants in WikiProjects – data was limited to the selected 55 WikiProjects for particular language versions;
3. the number of WikiProjects – the number of all the WikiProjects presented in the Wikipedia statistics for particular language versions that also included the projects that could have been finished or await active users;

4. the number of active users/number of active WikiProjects – the number of the active users in all active WikiProjects in separate language versions presented in Wikipedia statistics;
5. IDV – individualism and collectivism in the world values according to Hofstede (Hofstede, Hofstede, Minkov 2010, pp 95-97);
6. number of WikiProject domains – number of WikiProjects from the initial pool of 55 selected projects belonging to particular knowledge areas of WikiProjects, present in a given language version;
7. GDP per capita PPP – the value of GDP per capita calculated for the Purchasing Power Parity and expressed as a Purchasing Power Standard relative to the average for the European Union in the period of 2020-22 (<https://tradingeconomics.com/country-list/gdp-per-capita-ppp>).

Collected data was standardized due to their high variance in scales, which was then used for the agglomerative cluster analysis using the Euclidean distance as a metric.

4. Research findings and discussion

The minimization of the sum of the cluster deviations squared using Ward's agglomerative grouping method enabled control over the resulting group number, thus facilitating the presentation of the most natural clusters of the study elements (Szajt 2014). The resulting hierarchical tree graph clearly indicated two groups numbering three variables each. The first group consisted of more closely associated variables, while in the case of the latter, the variables were connected more loosely. Using these results in the latter part of the study, the researchers attempted to analyse the influence of the variables considered to be the determinants of the active user numbers relative to the number of active WikiProjects, and specific Wikipedia language versions (Fig. 1).

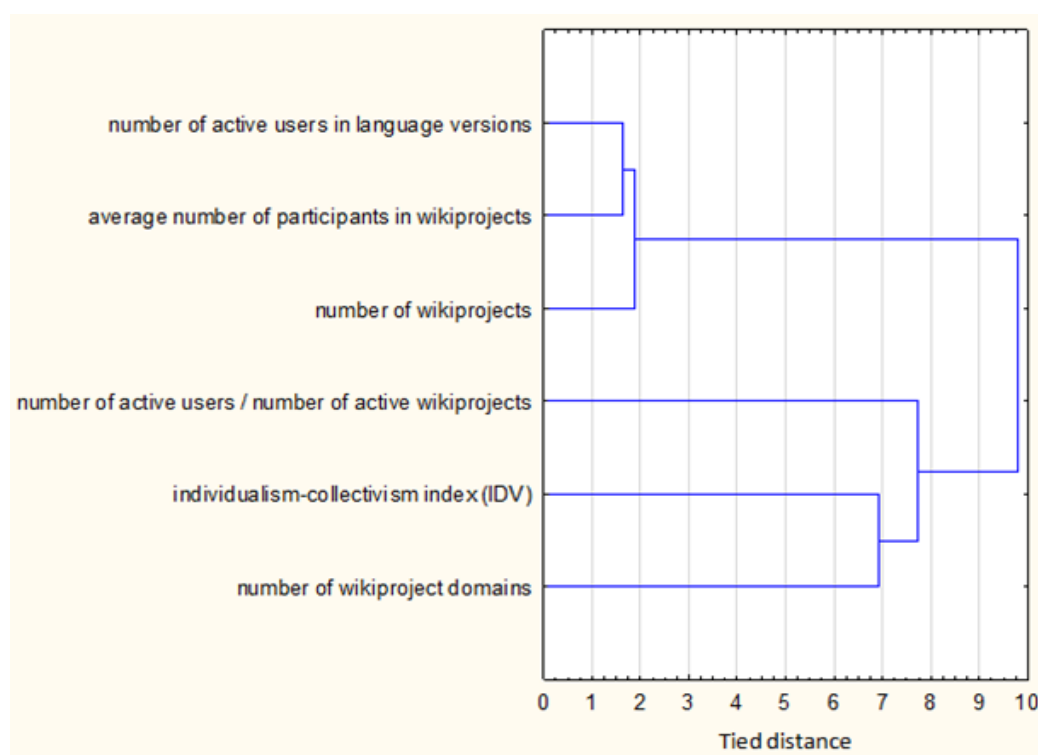


Figure 1: Cluster analysis using Euclidean distance for selected variables

4.1 Testing and verification of H1 and H2

4.1.1 Relation between the number of WikiProjects and the number of their participants, and IDV

Simulation has been conducted in Statistica software using the distance-weighted least-squares smoothing method.

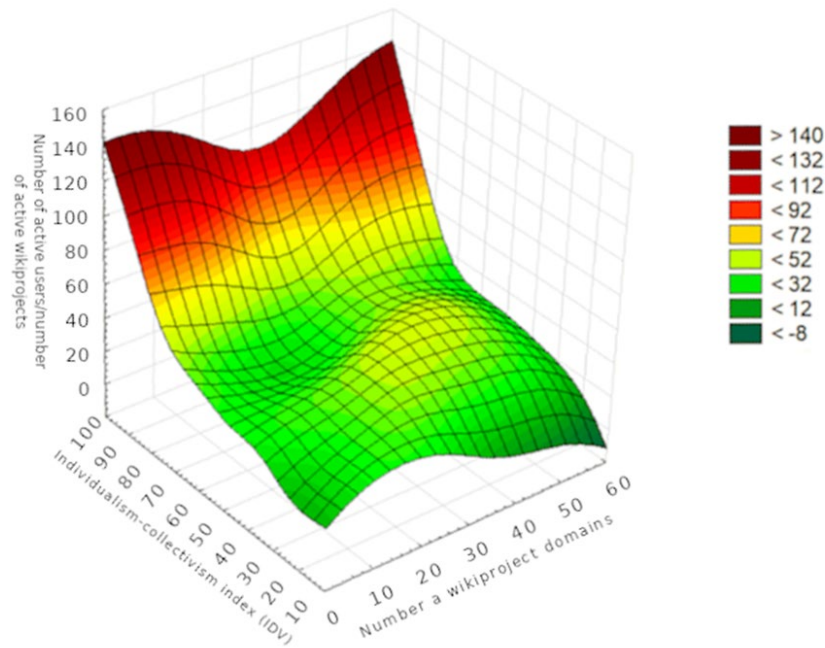


Figure 2: Simulate of the relationship between the number of active users/number of active WikiProjects, the IDV and number of WikiProject domains

The number of active WikiProjects from the pool of WikiProjects selected for the study in specific language versions (the number of WikiProject domains) influences the increase of the active users to a slight extent, with the influence being more pronounced in the case of the community of Wikipedians sharing a moderately low IDV and less pronounced in case of those with a high IDV. In addition, an increase of IDV to 80 causes a significant (albeit not rapid) increase in the number of active users in the communities of 30-50 members. The increase of IDV beyond 80 results in an almost exponential increase in the number of active WikiProjects members (Fig. 2).

4.1.2 The relation between the number of WikiProjects' participants and the activity of participants, and the number of WikiProjects

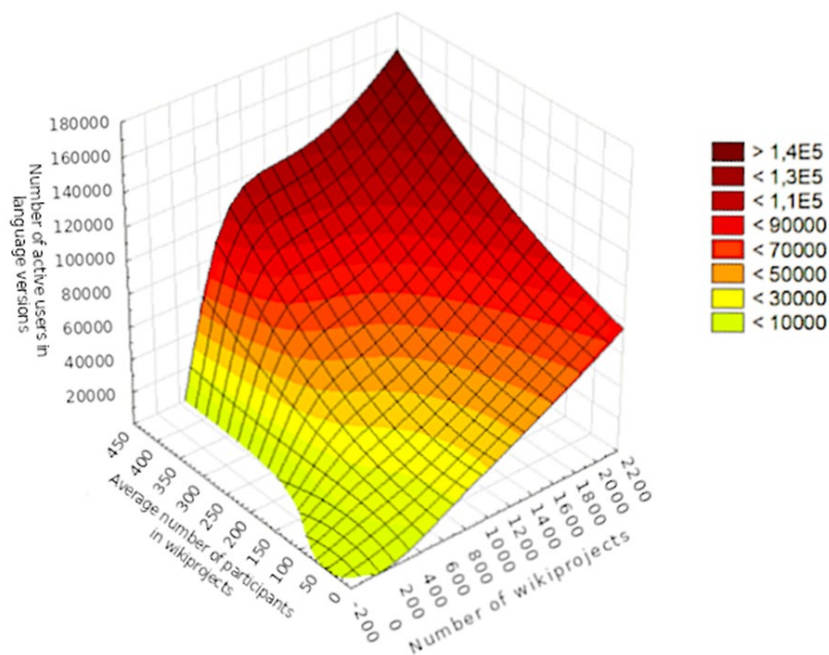


Figure 3@ Simulation of the relationship between the number of active users in language versions, the average number of participants in WikiProjects and the number of WikiProjects

As for the number of active users of a given version, with a low-moderate number of WikiProjects members, the increase in the number of WikiProjects results in an almost linear increase. As the average number of WikiProject members rises, the increasing number of WikiProjects translates to a progressively dynamic increase in the number of active users, especially up to a certain level (roughly 10,000) after which the dynamics of the growth drop slightly. With the currently identified levels of the maximum determinants, the number of active users of a particular version should not exceed 160,000 (Fig. 3).

4.1.3 Testing of H1 and H2 with the use of Spearman's ranks

Table 1: Values of Spearman correlation indicators for selected variables ($p < 0.05$)

variable	measure	number of WikiProjects	number of active users/number of active WikiProjects	IDV	average number of participants in WikiProjects	number of WikiProject domains
number of active users in language versions	r	0,8075	0,7006	0,2462	0,8502	0,7539
	p	0,0000	0,0000	0,1477	0,0000	0,0000
number of WikiProjects	r		0,2696	0,4026	0,7704	0,8652
	p		0,1117	0,0149	0,0000	0,0000
number of active users/number of active WikiProjects	r			0,1153	0,5380	0,2448
	p			0,5030	0,0007	0,1501
IDV	r				0,1454	0,2918
	p				0,3976	0,0842
average number of participants in WikiProjects	r					0,7803
	p					0,0000

The strongest correlation was observed between the total number of WikiProjects for the particular language versions and the frequency of WikiProjects subjects from the studied pool of 55 subjects. The correlation was equal to 0.8652. This result facilitates the assumption that the WikiProjects subjects are representative of the selected sample. It can therefore be expected that the statistical analysis accurately mirrors the realities of the group functioning within the WikiProjects. Spearman's rho correlation between the number of active users and the number of WikiProjects within a given language version was equal to 0.8075, thus indicating a strong relationship. A slightly lower correlation value of 0.7006 was found in the case of the influence of the number of active users on the variable: number of active users/number of active WikiProjects. A strong relationship (0.8502) was also observed between the number of active users and the average number of active users of the WikiProjects in each language version. The number of active users correlates with the number of WikiProjects belonging to the selected knowledge domains from the pool of 55 WikiProjects that existed in the investigated language versions with a correlation equal to 0.7539. The weakest correlation (0.4026) was found between the number of WikiProjects and IDV, although it still statistically significant. The relationship between the number of WikiProjects and the average number of participants in WikiProjects is statistically significant (0.7704). Spearman's rho correlation between the ratio of active users and all active WikiProjects in particular language versions and the average number of the members in the investigated WikiProjects was equal to 0.5380. This in turn translates to a moderate level of statistical significance. A statistically significant correlation (0.7803) was observed between the average number of members in the investigated WikiProjects and the number of WikiProjects present in the studied pool for a given language version.

The research findings confirm H1, which assumed a relationship between the number of WikiProjects and the number of their members, and IDV for the investigated language versions. Taking into account all the WikiProjects registered in particular language versions with relation to IDV, the correlation between these variables is lower than average. In the case of the WikiProjects selected for the study, the higher activity of the WikiProject members is on average more pronounced in the collectivist cultures. Yet, when the values achieve the level of $IDV > 80$, indicating cultures that are strongly individualist, the number of the active users in the WikiProjects quickly increases.

H2 is verified by a strong correlation. Together with the increase in the average number of WikiProjects members, the number of WikiProjects in a given language version also increases. Hence, the organization of a higher number of users in WikiProjects facilitates the creation of new WikiProjects. The more Wikipedia users

are active, the more WikiProjects they generate and, on average, such WikiProjects have more members. Activity related to WikiProjects measured by the number of the latter and the number of their members influences a dynamic increase in the general user activity. Keeping in mind that such activity is measured as the involvement in editing and discussions, we can say that cooperation within WikiProjects positively influences individual involvement.

4.2 Verification of H3 – the activity of WikiProjects' participants depending on GDP per capita PPP, and IDV

Hofstede argued that the level of individualism within a culture is relative to the national wealth (Hofstede, Hofstede, Minkov 2010). Therefore the GDP per capita PPP was included as one of the investigated variables. The study attempted to answer whether in the case of the investigated 36 language versions of Wikipedia, the relation between IDV and the personal wealth of the users will be observed and whether the variance of these variables will be modulating the number of users involved in WikiProjects.

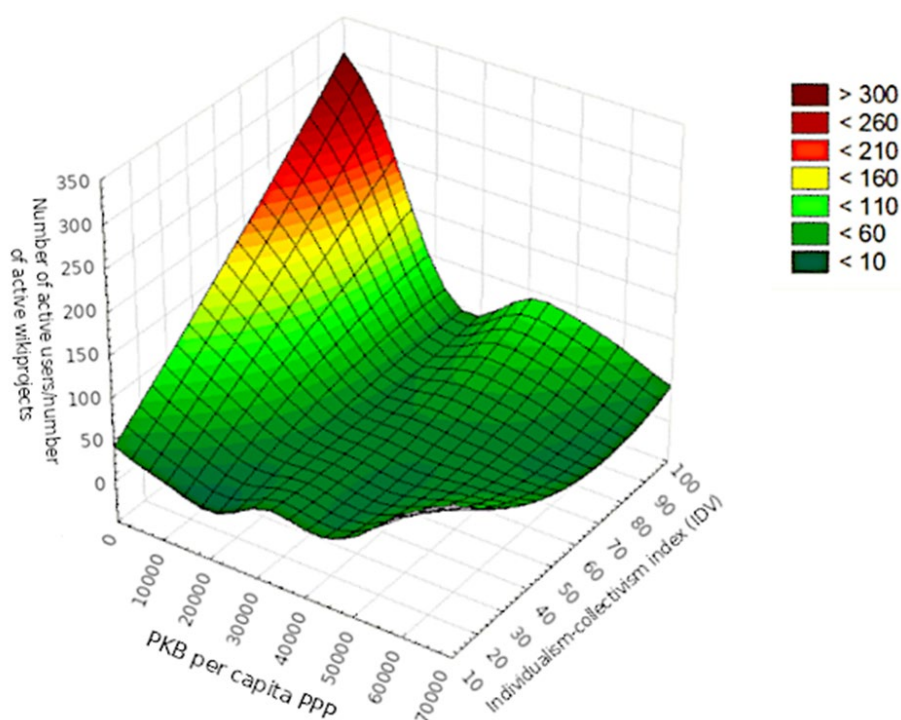


Figure 4: Simulate of the relationship between the number of active users/number of active WikiProjects, the PKB per capita PPP and the IDV

In the case of a low level of GDP per capita PPP, an increase of IDV results in a dynamic, quasi-linear increase in the number of active users relative to the active WikiProjects. The increase of the wealth in the community Wikipedians recruit from leads to the significant reduction of such reaction to the IDV increase. For the value circa USD 2000 per capita PPP or higher, the aforesaid reaction is almost non-existent. A change in the number of active users can be observed for the areas characterized by moderately high wealth (USD 3000-6000 per capita) only for an individualism level of IDV>70 (Fig. 4).

The obtained results confirm H3, i.e. prove that the activity of the WikiProjects members is relative to the GDP per capita PPP of the countries the said members represent, and is also relative to the IDV of their national cultures. Hence, the IDV influence on the activity in WikiProjects is observed among the user from the two extreme environments, namely the low-income countries and countries that are moderately wealthy. Ultimately, the highest level of involvement in WikiProjects may be observed in the countries with relatively high GDP per capita PPP and high IDV.

4.3 Verification of H4 – conformity of the size of WikiProjects to the Dunbar's 'rule of three'

The study verified user activity via their participation in WikiProjects. For a better illustration and a certain level of smoothing of the high-variability data, the calculation used in the study involved the average measured for the k (equal to 5, 7, 9 and 11, respectively) of the consecutive user groups. The boundary value for the test is equal to 1.96. The change of the user number in particular WikiProjects was very fast for the WikiProjects

numbering 19-20 members, with these dynamics decreasing when the group size rises to approx. 35-37 members. The next significant change occurs when the groups achieve the size of 53 and decreases when the groups number 62-63 members (67 for the 11-period sequence). The final statistically significant drop in the number of active WikiProjects users (up to 180 members) is observed for groups with 124-132 members. For $k=11$ significant drops are observed in groups numbering 158-160 members. Interestingly, a statistically significant increase in group size was observed for the groups counting 115-116 members for $k=9$ (Fig. 5).

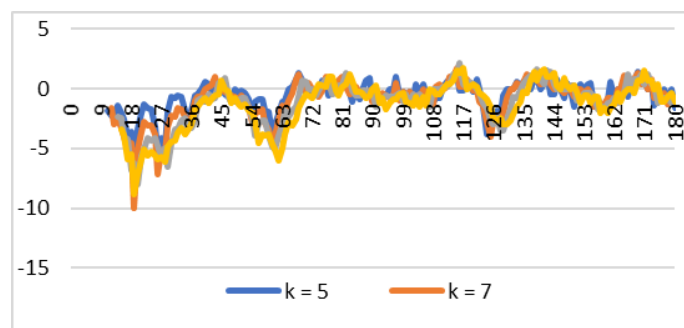


Figure 5: Average test values or the numbers of WikiProjects with a specified number of members relative to the size of WikiProjects

The verification of the number of members in the WikiProjects selected for the study confirmed the hypothesis stating that the size of the group formed by Wikipedians involved in WikiProjects is compatible with the concept of the layered formation of communities based on Dunbar's number. The study findings have shown significant changes in the numbers of the WikiProjects members in the ranges typical of the layers proposed by Dunbar.

Morgan et al. (2013) noted that the defined boundaries of the WikiProject membership is a trait typical for the traditional groups and the previous studies assumed that the work focused on the content generation is proof of the identification with a group. However, their direct conclusions stated that the actions are loosely coordinated, so this activity does not promote strong bonding that is typical of traditional groups. The results of the study presented in this paper prove that WikiProjects present the typical traits of groups and show similarity to the naturally emerging social layers. This may be explained by the actual influence that separate WikiProject members exert on the mutual behaviours. Lotan-Marcus (2018) proposed a theoretical model of the self-organizing decentralized open systems and assumed that the size of social networks equal to 150 individuals is commonplace. However, she remarked that the decentralized structures of Wikipedia is representative of are quite rare and translation of these paradigms onto the realities of modern lifestyles might be quite difficult. This study confirmed the functionality of Dunbar's number in the scope of WikiProjects. Hence, the assumptions of the theoretical SODOS model appear to be correct.

Pfeil, Zaphiris and Ang (2006) assumed that the higher number of activities would be related to the language version identified with collectivist cultures. However, the study findings presented above have shown that the greatest engagement in WikiProjects is expressed by the users recruited from wealthy countries where societies are characterized by a high level of individualism and well developed IT infrastructure. Their residents might have more free time, so they can more easily get involved in activities other than labour. Bigger WikiProjects groups formed by residents of countries characterized by higher IDV might be explained by the stronger need to influence the community and to build one's individual position in the Wikipedia's structure.

5. Conclusions

This paper is a contribution to research on the determinants of knowledge sharing within the structures of spontaneously emerging virtual communities. The main group of recipients that might be interested in the results presented here are knowledge management and teamworking practitioners who continuously look for the possibilities that would allow them to optimize the coordination of activities in professional settings. This is why the knowledge related to the emergence of the social structures following specific rules might be an argument for the solidification of the principles determining the formation of successful worker teams and task groups. The studies conducted on the number of WikiProjects members prove once more that online communities form in accordance with the processes present in the formation of social structures in real life.

The research findings presented may be a source of experience and inspiration for the management of other virtual organizations. They may also be an example for the organizations that manage online work, especially when the workplace is culturally diverse. It is worth noting that Wikipedia, being an example of a decentralized structure, functions on the level of individual motivations. It seems that this is an ideal system of social utility. Therefore, the analysis of the cultural determinants accompanying such activities might be practically applied in the organization in the new forms of cooperation structures.

6. Limitations

Although the results of the statistical relations of the analysed variables appear to confirm the initial assumptions, extending the scope of further studies can significantly influence the overall results. The problem related to data collection is the intrinsic uncertainty of the actual number of active users who work on particular WikiProjects as not all language versions update such information sufficiently. In addition, there is a persistent problem of type of research related to the cultural determinants of the Wikipedia space, resulting from the existence of a certain percentage of people recruiting from a different cultural background.

References

- Dunbar, R. (2016) *Człowiek. Biografia*, Copernicus Center Press, Kraków.
- Dunbar, R. (2021) *Dunbar's number: why my theory that humans can only maintain 150 friendships has withstood 30 years of scrutiny*, <https://theconversation.com/dunbars-number-why-my-theory-that-humans-can-only-maintain-150-friendships-has-withstood-30-years-of-scrutiny-160676> (01.03.2022)
- Dunbar, R., Sosis, R. (2018) "Optimising human community sizes", *Evolution and Human Behavior* 39, pp 106-111.
- Forte, A., Kittur, N., Larco, V., Zhu, H., Bruckman, A., Kraut, R.E. (2012) *Coordination and Beyond: Social Functions of Groups in Open Content Production*, CSCW '12: Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work, pp 417-426.
- Gamble, C., Gowlett, J., Dunbar, R. (2017) *Potęga mózgu. Jak ewolucja życia społecznego kształtowała ludzki umysł*, Copernicus Center Press, Kraków.
- GDP per capita PPP*, Trading Economics, <https://tradingeconomics.com/country-list/gdp-per-capita-ppp> (28.02.2022)
- Hofstede, G., Hofstede, G.J., Minkov, M. (2010) *Cultures and Organizations. Software of the mind. Intercultural Cooperation and Its Importance for Survival*, McGraw-Hill Professional.
- Kukowska, K., Skolik, S. (2021) *Wikipedia as a Space for Collective and Individualistic Knowledge Sharing*, In: A. Garcia-Perez, L. Simkin (eds.), Proceedings of the 22nd European Conference on Knowledge Management, Coventry University, United Kingdom, pp 459-466.
- Lemmerich, F., Sáez-Trumper, D., West, R. and Zia, L. (2019) *Why the World Reads Wikipedia: Beyond English Speakers*, WSDM '19: Proceedings of the Twelfth ACM International Conference on Web Search and Data Mining, pp 618-626.
- Lindenfors, P., Wartel, A., Lind, J. (2021) "'Dunbar's number' deconstructed", *Biology Letters* 17: 20210158.
- List of Wikipedias*, https://meta.wikimedia.org/wiki/List_of_Wikipedias.
- Lotan-Marcus, K. (2018) "The Pyramid Fallacy: Self-Organizing Decentralized Open Systems for Sustainable Collective Action", *SAGE Journals*, pp 1-16.
- Morgan J.T., Gilbert M., McDonald D.W., Zachry M. (2013) *Project talk: Coordination work and group membership in WikiProjects*, WikiSym '13: Proceedings of the 9th International Symposium on Open Collaboration, pp 1-10.
- Nemoto, K., Gloor, P.A. (2011) "Analyzing Cultural Differences in Collaborative Innovation Networks by Analyzing Editing Behavior in Different-Language Wikipedias", *Procedia - Social and Behavioral Sciences* 26, pp 180-190.
- Petrushyna, Z., Klamka, R., Jarke, M. (2014) "The Impact of Culture On Smart Community Technology: The Case of 13 Wikipedia Instances", *Interaction Design and Architecture(s) Journal* 22, pp 34-47.
- Pfeil, U., Zaphiris, P., Ang, C.S. (2006) "Cultural Differences in Collaborative Authoring of Wikipedia", *Journal of Computer-Mediated Communication* 12, pp 88-113.
- Qin, X., Cunningham, P., Salter-Townshend, M. (2015) "The influence of network structures of Wikipedia discussion pages on the efficiency of WikiProjects", *Social Networks* 43, pp 1-15.
- De Ruiter, J., Weston, G., Lyon, S.M. (2011) "Dunbar's number: group size and brain physiology in humans reexamined", *American Anthropologist* 113(4), pp 557-568.
- Szajt, M. (2014) *Przestrzeń w badaniach ekonomicznych*, SWWZPCz, Częstochowa.
- Usman, B. and Yennita (2018) "A Glimpse into the Virtual Community of Practice (CoP): Knowledge Sharing in the Wikipedia Community", *Asian Journal of Business and Accounting* 11(2), pp 249-276.
- Wikimedia Statistics*, <https://stats.wikimedia.org>