The Dynamics of Knowledge Social Sharing in the Major Wikipedia Language Versions

Sebastian Skolik
Management Faculty, Czestochowa University of Technology, Poland

sebastian.skolik@pcz.pl

Abstract: The creation of Wikipedia, which is the most popular free culture project, involves the sharing of knowledge by hundreds of thousands of volunteers. In general, Wikipedia as a virtual community of practice is inclusive space and open to anyone who has access to the Internet. Active Wikipedians, however, try to control the contribution to the common work, referring to the developed rules, including those related to the verifiability of content, while maintaining a neutral point of view and respecting copyright. Nevertheless, in communities, the problem of limiting editing for users who often act against these rules sometimes comes to the fore. In some language versions, the possibilities of co-creating knowledge for unregistered users have been limited. There is no general plan for actions taken in relation to the amount and type of content posted on it. Despite this, certain regularities can be observed. The article presents an analysis of the dynamics of user activity, which influences into the growth of content in the largest language versions of this project. Previous studies have shown a number of factors that can affect the involvement of Wikipedians. In most cases, these were limited to the analysis of the state in a short period. In the presented article, the author tried to capture certain regularities occurring over a longer period. For this purpose, a statistical analysis was made of the number of edits (content modifications); the number of active users; the size of added content; and the number of edited pages over 8 years in 50 largest language versions of Wikipedia. The statistical data was not limited to a specific sample of users but covered the entire database of these language versions. The initial analysis of the results prompted the author to undertake a further part of the study, of a qualitative nature. A sentiment analysis was made for 240 comments in the English and Polish versions: 50 comments from registered users and 50 comments from anonymous users were compared in both versions, as well as 20 discussions on technical topics and general issues. Statistical data analysis shows that despite very significant differences between the individual language versions in terms of activity and the amount of content provided, the amount of content per edit is more or less constant. On average, it is between 200 and 700 bytes, with larger deviations occurring in the case of edits by anonymous users and those made by bots. Moreover, it was observed that the largest versions of Wikipedia studied are characterized by lower variability, taking into account the number of edits per article. It was also assumed that anonymous edits and automation of actions may be perceived as less predictable and therefore more likely to evoke negative emotions. However, sentiment analysis did not confirm this hypothesis in relation to the two selected language versions studied. The results of the presented research may be useful for virtual communities of practice in the context of creating policy regarding automated and anonymous actions.

Keywords: Dynamics of knowledge sharing, Wikipedia language versions, Virtual communities of practice, Sentiment analysis, Volunteers activity

1. Introduction

The development of digital technologies, and in particular the Internet, has fostered grassroots collaboration and the sharing of information. Alongside techno-elites, communities aligned with countercultural values emerged, including communitarian circles and hacker groups (Castells, 2009). The latter played a pivotal role in the emergence of the free software movement, which subsequently evolved into the broader free culture movement. From these milieus, members of the movement drew a set of values and a distinctive hacker ethic, grounded in the freedom to collaboratively create and share produced content (Castells and Himanen, 2002). The most recognisable project of the free culture movement became Wikipedia, which at the same time has been described as the largest collaborative undertaking in human history (Jemielniak, 2020). The phenomenon of spontaneous self-organisation aimed at producing a high-quality product, exemplified by the online encyclopaedia, captivated scholars across the social sciences, from media and communication studies to economics (Benkler, 2008; Tapscott and Williams, 2008; Levis, 2010). Particular attention was devoted to the dynamics of its growth, the exponential increase in users, articles, and the volume of edits, which collectively contributed to the progressive improvement in content quality (see Stvilia, Al-Faraj, and Yi, 2009).

After 2007, the exponential growth observed in the largest language versions of Wikipedia began to plateau, accompanied by a decline in the number of active Wikipedians (Morgan et al., 2013). The earlier period of rapid expansion gave way to a phase marked by stabilization, routinization of practices, and institutionalization of editorial procedures (Arazy, Lifshitz-Assaf, and Balila, 2018). Despite this, significant disparities remain, both between Wikipedia language versions and in terms of user engagement within them. Only a relatively small subset of editors continues to be responsible for the majority of Wikipedia's content (Shimada et al., 2023).

As growth metrics began to decline in the largest versions, attention shifted more substantially toward the social and cultural aspects of the project (Kukowska, 2022; Karczewska, 2023). This shift revealed a gap in understanding the evolving dynamics of change within Wikipedia. The aim of this article is to examine the dynamics of knowledge sharing under conditions of relative social and organizational order. The author poses the question of whether it is possible to identify certain common features within mature Wikipedia versions that point toward stabilization and increased predictability. The following sections of the paper provide a literature review focused primarily on editorial activity across various language versions of Wikipedia. The methodology section outlines the adopted research methods, formulated hypotheses, and data collection strategies. The research findings shall indicate that editorial activity tends to be more stable in older and larger language versions, while it is comparatively lower when edits are made by unregistered users or bots.

2. Literature Review

In the early years following Wikipedia's inception, the rapid increase in the number of articles across various language versions was paralleled by the expansion of the project's community. Although the platform gained widespread popularity, it also faced criticism for its reliance on amateur contributors and the perceived lack of oversight (see Keen, 2007). Nevertheless, the active involvement of internet users in the collaborative creation of the online encyclopaedia led not only to a growth in the number of articles, but also to a significant rise in the volume of revisions made to existing articles. Wilkinson and Huberman (2007), in their comparative analysis of articles rated as high quality by Wikipedians versus randomly selected articles, identified a positive correlation between the number of edits per article and the assessed quality of content. Subsequent research by Stvilia, Al-Faraj, and Yi (2009), focusing on three language versions (Arabic, English, and Korean), suggested that the number of edits may serve as a content quality factor, depending on specific cultural contexts.

In addition to the issue of quality, scholarly investigations have frequently addressed the matter of egalitarianism, particularly regarding the accessibility of participation in the project. This was due to the fact that disproportions in user activity among those contributing to Wikipedia began to emerge quite early on. Research by Priedhorsky et al. (2007) within the English Wikipedia version revealed that approximately 10% of the most active contributors (power users) were responsible for nearly 90% of the platform's persistent word view (PWV). This metric refers to the number of views of any word introduced by a single edit. Each displayed word in an article is multiplied by the number of times the article is viewed after the word is added. Since power users also enjoy a higher reputation, their edits are less frequently reverted. As a result, they have a potentially greater advantage over other editors than in a situation where only the number of edits would be considered. The cited research, conducted in 2006, involved 4.2 million users and 58 million edits.

The dynamics of change in the early years of the project not only influenced the development of its social structure, but also shaped the types of activities undertaken by Wikipedians. Kittur et al. (2007) observed that despite the exponential growth in content quantity and overall user activity, the amount of direct work put into editing articles decreased relative to other activities. In 2001, 90% of activity was devoted to editing articles, but this proportion had dropped to 70% by 2006. Meanwhile, the percentage of edits related to policies, procedures, and other Wikipedia-specific pages rose from about 2% to approximately 12%.

Moreover, cultural factors may influence the uneven development of Wikipedia. Different versions were created at different times, which resulted in varying growth curves depending on when the research was conducted. At the time of writing this paper, the English Wikipedia version was nearly six times larger in terms of the number of edits than the second-largest, the German, version, while almost seven times larger in terms of active users. In a 2012 study that analysed 25 language versions, one in four articles created by Wikipedians was written in more than one language. However, only 12% of articles were created in all the researched versions. A significant portion of the remaining articles was related to regional topics, often pertaining to societies that speak the given language as their native tongue (Massa and Scrinzi, 2012). These are typically articles about towns and biographical entries about representatives of the ethnic group to which the Wikipedians belong.

Variables related to article quality and the number of edits may be interconnected due to the perception of the status of the collaborating Wikipedians. As Adler et al. (2008) indicate, the dynamics of editing can reflect the credibility of the authors. Analysing the editing history of individual articles facilitates the determination of whose edits were modified by subsequent Wikipedians. It is assumed that the fewer the edits of an author are modified or reverted, the higher their reputation. The credibility of an article and the trust in its quality can, in turn, be indicated by the editing history of authors with a given reputation. However, this approach to credibility might suggest that an unmodified text can be considered trustworthy. Niche articles, which are also

unevenly edited, could present a challenge in this context. In these cases, sections of text may not undergo necessary editorial revisions, which can affect the perception of the entire article as having a flawed style (see Korsgaard and Jensen, 2009).

What ultimately contributed to Wikipedia's success as a collective endeavour was its openness to newcomers and the encouragement of bold editing, prominently promoted through the “be bold” guideline. However, as the number of policies and guidelines increased, initiating participation in the project became more challenging. The initial enthusiasm, driven by a sense of empowerment, gradually gave way to negative emotions. This shift is reflected in qualitative research conducted among students, which explored their reactions and emotional responses to Wikipedia guidelines (Vetter et al., 2024). As novice Wikipedia users, students frequently reported feelings of fear, anxiety, and frustration when encountering the policies and procedures they were expected to master. Nonetheless, they also expressed a desire to influence and improve the Wikipedia environment. Negative emotions often arise in situations of uncertainty, particularly when individuals must adapt to a new environment and acquire the technical competencies necessary for effective engagement.

Research on Wikipedia primarily highlights the diversity of its language versions and the unevenness of their development. Capturing this diversity enables the proposal of solutions that could be applied locally, as well as fostering greater sensitivity to the differing needs of Wikipedia communities. However, a notable lack of studies focusing on the similarities that emerge from the activities of Wikipedians still remains. Pursuing research in this direction could help identify stabilizing factors that mitigate feelings of anxiety and uncertainty among contributors.

3. Materials and Methods

The study was conducted among the 50 largest language versions of Wikipedia, ranked by the number of active users, covering the period from 2017 to 2024. Previous research indicated that during this timeframe, bureaucratic rules became more firmly established, and the Wikimedia Foundation, which supported the projects, developed frameworks for fostering user participation (Rijshouwer, Uitermark, and de Koster, 2023). In the first stage of the study, publicly available data *(Wikimedi*a Statistics) was analysed. The variables examined included user editing activity (number of edits), contribution size measured in bytes (net bytes difference), number of active users, and number of edited pages. The analysis accounted for user categorization into registered users, anonymous contributors, and bots. Data for the analysis was acquired in January 2025.

Subsequently, the presence and strength of relationships between the afore-mentioned variables were examined for data collected in January and July of each year from 2017 to 2024. Wikipedian activity typically increases at the beginning of the calendar year, while it tends to decline during the summer months (particularly in the Northern Hemisphere, whose communities dominate the platform). Spearman’s rank correlation coefficients were found to be statistically significant, with values exceeding 0.8 for $p < 0.05$ between nearly all variables. The strength of the correlations was weaker only when the number of bot edits and the volume of contributions made by bots were compared with other variables, and in four of the examined periods no correlations were found between activity, primarily that of bots, and the contribution volume of anonymous users.

The ratio of average contribution size per single edit on a monthly scale was analysed in the subsequent phase of the study. In this context, contribution size refers to the change in page size measured in bytes. The analysis focused on this ratio in light of findings by Shimadaa et al. (2023), which demonstrated that over time, the number of edits consisting of editorial corrections tends to increase at the expense of content-adding edits. In mature Wikipedia versions, one can therefore assume a tendency toward smaller increases in page size, as editorial corrections typically add fewer bytes to articles. This trend may also contribute to reduced variability over time.

Based on preliminary research findings, two hypotheses were formulated:

H1. The variability of contributions measured in bytes per edit (BPE) decreases as the size of the Wikipedia language version increases.

H2. The variability of contributions measured in BPE is lower for edits made by registered users and higher for edits made by bots and anonymous users.

To verify both hypotheses, data was collected for each month from January 2017 to December 2024 (a total of 96 consecutive months) regarding net bytes difference and the number of edits in each of the 50 analysed language versions. Subsequently, monthly average bytes per edit (BPE) values were calculated, followed by the computation of the average BPE per language version, the variance, and the coefficients of variation - $CV_{(BPE)}$. For H1, only edits made by registered users were taken into account, as they constitute the core of the Wikipedia community and significantly influence the formation of its rules and standards. The assumption stated in H2 regarding higher variability in bot edits stems from the nature of bot activity which involves irregularly introduced large-scale operations, such as mass content additions, deletions, editorial modifications, or technical adjustments carried out by bot operators. Bots are created for these tasks by Wikipedians with the appropriate knowledge and programming skills, and the experience of Wikipedians determines the scope of the bots' activities and the type of software used. Bot edits are by default invisible in the recent changes log, which means that the changes they make may not be quickly noticed by the authors of individual pages. Editing of multiple pages within a short timeframe by bots occurs sporadically and often provokes negative reactions among Wikipedians. In the case of anonymous users, unpredictable shorter or longer episodes of activity may also arise, sometimes defined by Wikipedians as engaging in disruptive behaviour such as article destruction (vandalism) or trolling.

An analysis was conducted of the emotional load appearing in discussions in two language versions, Polish and English, taking into account the findings from studies on the importance of emotions in actions within Wikipedia (Vetter et al., 2024). For this purpose, 50 comments from registered users and 50 comments from anonymous users were compared in both versions, as well as 20 discussions on technical topics (including those related to bot activities) and general issue. The CLARIN-PL application (Pawełoszek and Wieczorkowski, 2023) was used, which facilitated sentiment analysis in both of the afore-mentioned languages. In this part of the study, an additional hypothesis was assumed:

> *H3. More negative emotions, such as fear, sadness, or anger, appear in discussions conducted by anonymous users and during discussions on technical topics.*

4. Results

The size limit for Wikipedia pages is approximately 2 million bytes, meaning that one edit can add a contribution of up to that size or remove it if such large pages exist. Throughout years of observing the recent changes log in several language versions, the author noted that most edits involve adding or removing just a few or several bytes. Larger edits occur relatively less frequently, although on a daily basis, users also expand articles or other pages by adding several thousand or even tens of thousands of bytes at once. There is also a significant difference in the overall number of edits made in different versions. The English Wikipedia sees approximately 200,000 edits daily, while the Swahili Wikipedia sees only a few hundred. One might therefore expect considerable variability in the BPE values. However, the multi-year averages (calculated using monthly averages) were quite similar across the analysed language versions of Wikipedia. In particular, small differences were observed in the edits made by registered users: from 165 BPE in the Swedish version to 654 BPE in the Tamil version (Tab. 1). Furthermore, it should be noted that the larger the language version, the smaller the $CV_{(BPE)}$. For $p < 0.05$, there was a statistically significant relationship both between $CV_{(BPE)}$ and the number of articles on Wikipedia (Spearman's rho equals -0.578961) and between $CV_{(BPE)}$ and the number of active users on Wikipedia (Spearman's rho equals -0.642831). Therefore, H1 was accepted. The data on the number of articles and active users refers to December 2024, which was the time when the language versions of Wikipedia could have reached their greatest maturity relative to the analysed period.

Table 1: The multi-year average BPE and BPE coefficient of variation for the 50 largest Wikipedia versions based on the activity of registered users, anonymous users, and bots. The first column contains the language codes of the Wikipedia versions.

Lang.	Reg. users		Anon. users		Bots		Lang.	Reg. users		Anon. users		Bots	
	x	$CV_{(BPE)}$	x	$CV_{(BPE)}$	x	$CV_{(BPE)}$		x	$CV_{(BPE)}$	x	$CV_{(BPE)}$	x	$CV_{(BPE)}$
en	172	6.7%	32	141.9%	286	162.0%	**ca**	348	17.0%	-234	-150.3%	26	307.5%
de	191	8.0%	107	65.8%	554	66.3%	**vi**	436	21.3%	98	81.3%	1219	117.4%
fr	214	12.2%	6	886.0%	512	62.2%	**hu**	278	9.9%	53	220.7%	141	101.4%

Lang.	Reg. users		Anon. users		Bots		Lang.	Reg. users		Anon. users		Bots	
	x	$CV_{(BPE)}$	x	$CV_{(BPE)}$	x	$CV_{(BPE)}$		x	$CV_{(BPE)}$	x	$CV_{(BPE)}$	x	$CV_{(BPE)}$
ru	325	9.8%	73	69.2%	287	78.3%	th	423	18.6%	30	501.8%	810	89.0%
it	212	11.6%	65	38.7%	809	53.7%	bn	619	19.6%	155	105.2%	2207	105.1%
es	219	10.5%	80	55.0%	250	92.3%	el	496	18.8%	15	766.2%	1105	253.1%
nl	220	16.1%	-11	-858.6%	423	191.9%	eu	319	37.7%	251	203.3%	225	258.6%
pl	322	11.0%	132	132.8%	100	130.1%	hi	426	29.4%	331	46.0%	394	258.3%
sv	165	19.1%	-35	-303.3%	155	191.3%	ms	434	64.2%	157	188.4%	2090	100.6%
ja	261	12.3%	89	60.5%	115	126.5%	bg	371	14.0%	-11	-1068.3%	245	447.2%
pt	417	19.6%	231	189.2%	845	321.3%	zh-yue	277	37.9%	112	65.0%	462	49.1%
uk	463	27.1%	62	214.5%	567	181.3%	et	209	59.4%	228	251.2%	415	301.9%
ar	405	33.7%	129	178.5%	297	60.3%	uz	469	86.5%	256	267.6%	117	289.6%
zh	273	12.2%	74	42.6%	465	58.6%	sk	415	23.3%	34	272.8%	2212	575.6%
fa	637	10.3%	15	366.5%	108	102.2%	az	219	34.1%	138	72.0%	155	138.1%
he	210	14.3%	-3	-2706.5%	206	180.9%	hr	336	27.3%	62	172.6%	362	155.8%
tr	242	37.3%	186	76.5%	292	118.6%	sw	332	50.2%	1357	190.6%	369	162.1%
ko	219	23.2%	55	109.8%	144	89.9%	hy	650	30.2%	121	378.3%	239	371.9%
cs	335	14.3%	87	168.1%	118	214.1%	sl	473	24.3%	-31	-426.9%	565	248.9%
id	362	20.7%	37	208.6%	933	61.5%	lt	168	59.9%	135	389.1%	92	156.9%
no	243	45.4%	-112	-150.9%	488	143.9%	kk	383	25.7%	509	323.1%	243	27.0%
ro	334	35.9%	124	64.7%	414	184.4%	lv	292	25.0%	2	19873.1%	297	284.1%
sr	470	39.3%	263	55.4%	461	488.4%	be	505	51.1%	275	134.7%	198	385.5%
da	338	23.6%	74	136.0%	475	170.5%	ta	654	29.3%	205	124.1%	387	119.6%
fi	250	89.4%	265	379.5%	897	118.6%	mk	626	56.7%	206	79.6%	831	169.6%

The research also allowed to accept H2. In all language versions, the $CV_{(BPE)}$ was higher for edits made by bots compared to the $CV_{(BPE)}$ of registered users. The situation was similar when comparing the $CV_{(BPE)}$ between the activity of registered and anonymous users. The value of this coefficient was lower for the editing activity of anonymous users only in seven versions of Wikipedia, created in Dutch, Swedish, Hebrew, Norwegian, Catalan, Bulgarian, and Slovenian languages. However, this is due to the fact that the $CV_{(BPE)}$ took on a negative value. Yet, if the absolute value were to be considered, it would be higher in these cases as well. Nonetheless, the negative value of this coefficient results from the fact that anonymous users more often removed content from pages than added new content. Such removals are often associated with acts of vandalism, which also destabilize projects. In the case of monthly average BPE, this value was negative only five times, three of which were in a single language version for the activity of registered users. For the edits of anonymous users, in only four language versions did the negative value for the monthly average BPE not appear at all.

The sentiment analysis conducted using the CLARIN-PL application did not support the acceptance of H3. In the case of the Polish version, relatively more negative emotions were observed in comments from

anonymous users compared to registered users, while more frequently in general discussions compared to discussions on technical topics. In the English version, no differences were observed in either case. Among positive emotions, joy was the most frequent, while the most common negative emotions were sadness and anger.

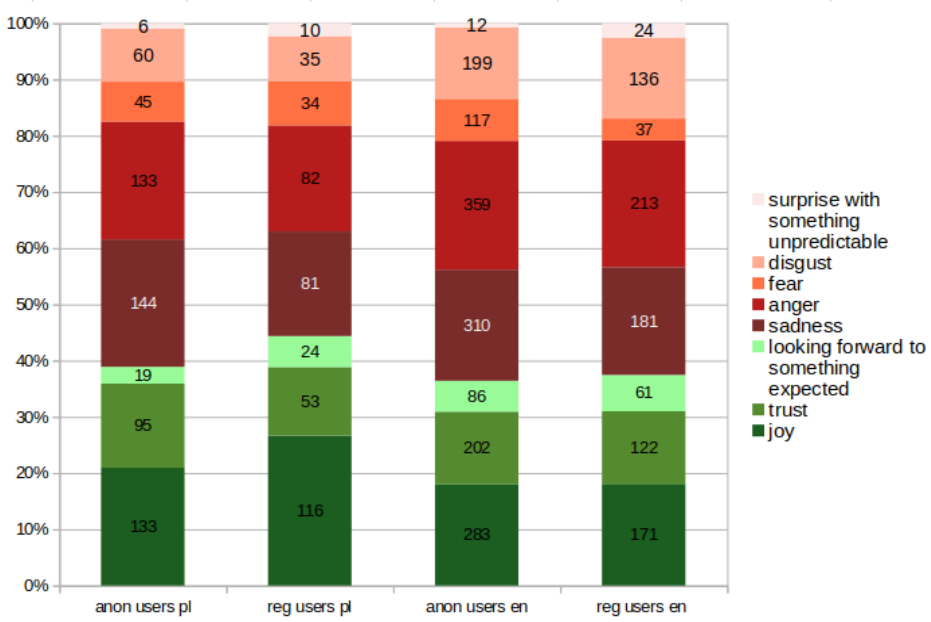

Figure 1: Comparison of the frequency of negative and positive emotions in entries made by registered users and anonymous users in the Polish and English versions of Wikipedia

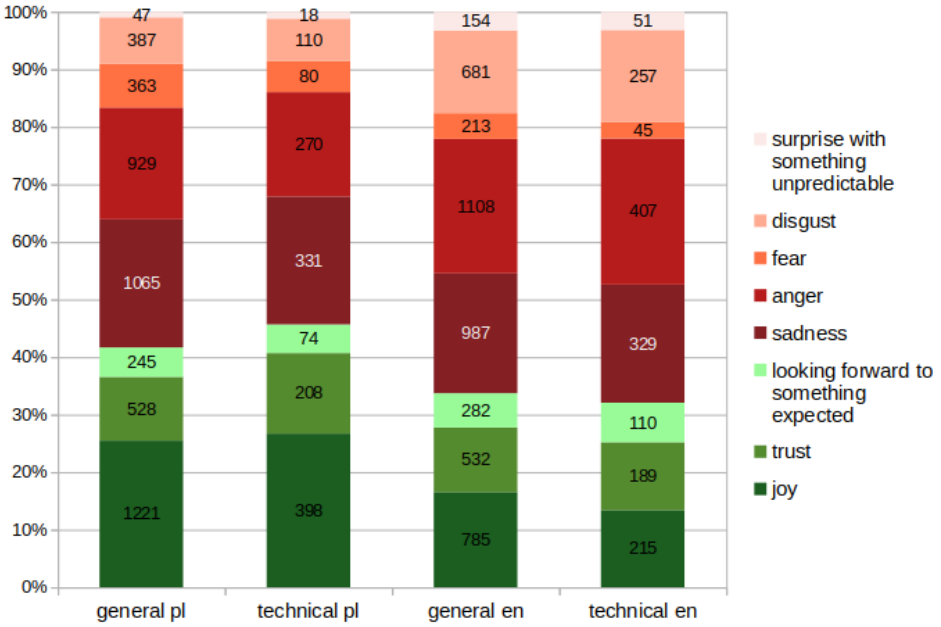

Figure 2: Comparison of the frequency of negative and positive emotions in discussions on general and technical topics in the Polish and English versions of Wikipedia

The lack of expected emotional differentiation may be due to certain limitations of the tool used. Emotional loads assigned to individual words are based on the probability of the word's usage in different contexts in the Polish and English language corpora. As such, some words may be associated with multiple emotions, both negative and positive. Detailed data is presented in Figure 1 and Figure 2. The numerical data refers to the sum of emotional loads generated by individual words.

5. Discussion and Conclusions

In earlier studies, the focus was primarily on the quality of content. It was noted that over time, Wikipedians tend to focus more on improving existing content rather than adding new content. A higher number of edits in a given article tends to result in better quality. These studies were conducted on a limited scale, mainly focusing on English Wikipedia (Kittur et al., 2007; Wilkinson and Huberman, 2007; Shimada et al., 2023). The Wikipedia language versions were created at different times and reached different sizes of communities and articles, which also depended on the overall number of people using a given language as their native tongue. Previous research showed certain correlations between editorial activity and cultural conditions (Kukowska, 2022; Karczewska, 2023).

The findings presented in this paper, however, indicate that the differences in terms of individual contributions are minimal. Although the English version has approximately 300 times more active users than the Lithuanian version, the multi-year average BPE value is almost the same in both versions. One might assume that both have reached a certain "maturity," and their contributors primarily focus on editing. On the other hand, the Lithuanian version has a significantly higher $CV_{(BPE)}$ (59.9%) compared to the English one (6.7%). It can be assumed that the considerably larger number of users and edits made each month also leads to less variability. It is also plausible that activities are increasingly subject to routinization in mature Wikimedia projects, where the core consists of power users with a large number of edits (Skolik, 2023). Although occasional spontaneous actions of mass article creation or, at times, removals occur, these tasks are typically performed by bots. The higher $CV_{(BPE)}$ in the case of bot activity results from the fact that their actions are executed over a short period, sometimes taking a few days or weeks, although planning such activities and obtaining consensus takes significantly more time.

A high dynamics of changes is also evident in the edits made by anonymous users. Not only is there a high $CV_{(BPE)}$ in this case, but the monthly average BPE values also frequently become negative. This indicates the relatively frequent removal of content by unregistered users on Wikipedia, which is a factor that more strongly destabilizes projects. In various language versions, restrictions are considered for individuals "editing from an IP address." In the English version, unregistered users are not allowed to create new articles, while in the Portuguese version, they cannot even edit existing ones.

The author assumed that the variability resulting from the activity of anonymous users and bots could lead to the emergence of negative emotions among the project participants. However, sentiment analysis did not confirm this assumption. It may have been more reliable if the texts had been analysed by independent judges. However, even in such cases, it is often difficult to determine the intent of the individuals posting comments. For example, texts with a positive emotional tone might be a form of sarcasm, making them hard to capture. Moreover, while anonymous comments could be emotional, bot actions themselves do not carry any emotional charge. Therefore, an attempt was made to find a metric related to the potential revelation of technophobia among Wikipedians. However, in discussions on technical topics, where irresponsible actions related to the deployment of bots are sometimes pointed out, the tool used did not detect any specificity compared to discussions on general topics.

The aim of the conducted research was to capture the constant elements of dynamics in the largest language versions of Wikipedia. One of these elements turned out to be the average contribution size of users, measured in bytes per edit, especially for registered users. Searching for additional metrics with low variability over time and across the entire Wikimedia environment may help shape strategies within this environment towards greater stability and predictability.

AI Declaration: I declare that I did not use AI in this article, all the text was manually written.

Ethics Declaration: I declare that the study is based on publicly available data and open-source data and as such, the nature of this study did not warrant a review by an ethics committee.

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