Monitoring the broader impact of the journal publication output on institutional level: A case study for the University of Vienna

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Abstract: This study serves as a monitoring practice example concerning the broader impact of journal publication output on institutional level. All publications affiliated to the University of Vienna within the timeframe 2014-2016 and indexed in Web of Science Core Collection were analysed in PlumX. Furthermore, the most current and active knowledge areas were identified and analysed by means of different metrics and their evolution according to their publication year. Finally, we explored potential correlations: first, between same metrics collected in different data sources, and second, between different metrics collected in the same data sources. The obtained results are very similar to those already gained on country level in a previous study and illustrate the prominent role of the University of Vienna among all organisations contributing to the Austrian scientific output. They also reinforce the importance of usage metrics particularly in the Arts & Humanities. The percentage of publications with social media scores (Total Social Media), especially tweets, has significantly increased within the three reported publication years. The highest values are observed for the Health and Life Sciences, followed by Engineering & Technology and the Social Sciences. The relative insignificance in the Arts & Humanities is noteworthy. Finally, our study shows very low correlation values between the different measures traced in PlumX and supports the hypothesis that these should rather be considered as complementary sources. Observed correlations between different metrics should be taken with a pinch of salt, due to their different obsolescence patterns. From a technical point of view, PlumX has proven to be a very useful tool in order to monitor the broader impact of the publication output at institution level. Unfortunately, PlumX does not offer the possibility to select different measuring windows. Therefore, temporal monitoring currently only works by archiving obtained results and a later comparison of different time intervals. Apart from surveys monitoring exercises have proven to be the most practicable and state-of-the-art to study

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the further development and acceptance of these tools by the scholar community, which is particularly interesting for own organisations and countries.

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1. Introduction

New metrics are indispensable in the daily life of modern libraries challenged by continuously changing demands. Responsible use and qualified practices offer many opportunities to provide innovative services specifically tailored to academic and administrative communities in order to: 1) face the new challenge and to stimulate a positive attitude towards the use of new metrics; 2) support scientists in the 'publish or perish' dilemma: planning a scientific career and developing adequate publication strategies (especially for junior scientists); 3) enhance the visibility: at institutional level (rankings and web presence) as well as at individual level (adoption of permanent identifiers, help and assistance in the promotion game) and 4) prevent administration from bad use of these new metrics and incorrect interpretations (informed peer review).

This does not only include the support of strategical decisions in licensing and collection management, but it is likewise important for the enrichment of research documentation systems and repositories, as well as for the monitoring of policies (e.g. Open Access policies), and the development of new indicators. The monitoring of adopted policies (e.g. Affiliation policy, Open Access policy, etc.) and of the institutional web impact belongs to the services, which our department currently offers (see http://bibliothek.univie.ac.at/bibliometrie/services.html and Gorraiz, 2012).

This paper aims is a monitoring practice case study. It concerns the quantitative assessment of the broader impact of journal publication output on institutional level. We furthermore discuss the opportunities and limitations when providing similar reports. Modern applied bibliometric assessment should not only be based on citation analyses, but also include other available metrics (de Bellis, 2009; Moed, 2017). Therefore, we analysed the publications of three years by means of traditional and new metrics, including altmetrics, and discuss possible interpretation. Moreover, we analysed which disciplines (or knowledge areas) are the most current and active by means of different metrics and according to their evolution within the three reported years.

Finally, we explored potential correlations: first, between the metrics (usage and citation) collected in different data sources (WoS and PlumX); and second, between the intensity of the signals or scores observed for different dimensions or categories (mentions, captures, citations and usage data) retrieved in the same data source (in this case via PlumX). A similar analysis on country level was performed recently (Gorraiz, 2018), and the results are compared in the "Conclusions" section.

2. Data samples and methodology

The Web of Science Core Collection including all the comprised indices (proceedings, books, etc.) was used as the underlying data source. All publications assigned to the University of Vienna as „organization enhanced "and including a DOI were retrieved and downloaded for the publication years: 2014, 2015 and 2016. For overall metrics data collection and aggregation, we used the fee-based PlumX altmetrics dashboard. In order to gather data in PlumX, a plain text file containing all the DOIs for all publications retrieved in WoS Core Collection was uploaded to PlumX and processed by the tool. After processing a new dataset including all the resulting "artifacts" - as data records are named in PlumX - and the corresponding altmetric scores gathered from each tool covered by PlumX was provided. This dataset was exported for each data record type to Excel in CSV format and was then analysed for each year (2014, 2015 and 2016).

The processed datasets for each year are described below in Table 1. It is noteworthy that for more than 99% of the retrieved records the publication year (PY) was correctly assigned.

Table 1. Processed Datasets in PlumX

Year	**Number of WoS-CC records = PlumX input**	**PlumX output**	**Number of WoS-CC records with matching record in PlumX (via DOI)**	**Share of WoS-CC records with matching record in PlumX (via DOI)**	**Number of WoS-CC records without matching record in PlumX (via DOI)**
2014	2,384	2,359	2,359	99%	25
2015	2,500	2,477	2,477	99%	23
2016	2,887	2,851	2,851	99%	36

The resulting dataset also includes the scores of all measures according to their origin. The measures are categorised into five separate dimensions: Usage, Captures, Mentions, Social Media, and Citations (Torres Salinas et al., 2017). This categorisation may be subject to criticism, but one big advantage of PlumX is the differentiation of results in the dataset for each measure and its origin. This allows aggregation according to the user criterion.

In order to analyse the differences between knowledge areas, all publications retrieved in WoS Core Collection were reclassified according to the field “research areas” in six main knowledge areas: 1) Life Sciences, 2) Physical Sciences, 3) Engineering & Technology, 4) Health Sciences, 5) Social Sciences and 6) Arts & Humanities.

2.1. Metrics comparisons in WoS CC and PlumX

Correlation analyses were performed for the number of citations attracted in the Web of Science Core Collection (field TC in WoS data export) and in the whole WoS platform (field ZA in WoS data export) versus the number of citations attracted in Scopus and CrossRef according to PlumX. For the other citation indexes consulted via PlumX the data sample was not comprehensive enough for a sound correlation analysis.

Furthermore, the results of the usage metrics, included since 2015 in WoS Core Collection (via Clarivate Analytics), have been correlated with the ones provided by PlumX (via EBSCO). According to Clarivate, the WoS metric reflects the number of times the article has met a user’s information needs as demonstrated by clicking links to the full-length article at the publisher’s website (via direct link or Open-URL) or by saving the article for personal use in a bibliographic management tool (via direct export or in a format to be imported later) (see also https://images.webofknowledge.com/images/help/WOS/hp_usage_score.html).

In our study, both indicators, U1 (last 180 days = this is the count of the number of times the full text of a record has been accessed or a record has been saved within the last 180 days) and U2 (since 2013 = this is the count of the number of times the full text of a record has been accessed or a record has been saved since February 1, 2013) were compared with the corresponding number of abstract views traced by PlumX via EBSCO.

2.2. Correlations between different metrics in each data source

Spearman correlations for all PlumX measures with a significant number of data have been performed for each publication year. These are: number of readers in Mendeley (Captures), number of citations in Scopus (Citations), numbers of tweets in Twitter (Social Media)”, number of abstracts, as well as number of HTML/PDF views in EBSCO (Usage). A correlation analysis was also performed in WoS Core Collection for citation and usage counts traced exclusively in this tool.

Finally, correlations were computed between the number of authors or number of affiliations and the most representative measures traced in each data source: citation and usage counts in WoS Core Collection, number of readers in Mendeley, citations in Scopus, number of tweets in Twitter and abstracts views in EBSCO in PlumX.

3. Results

The results from PlumX show a large diversity of signals and scores traced for each measure in each dimension (around 39 measures per publication year), however, many of them are insignificant. The most relevant measures in each dimension or category (availability or coverage percentage higher than 1% in the first four categories, and 5% in the usage) are summarised in Tables 2, 3 and 4 for each publication year (2014, 2015 and 2016) respectively. The data include following information: 1) data availability = number of data records traced in PlumX: see information at the top of each table; 2) data with scores = number of data records traced in PlumX with at least one score (>1); 3) data with scores (%) = number of data records traced in PlumX with at least one score (>1) in relation to the number of the WoS CC records searched; 4) intensity = sum of all signals or scores; 5) mean = numerical mean of all samples; 6) density (mean available) = sum of all signals or scores in relation to the number of all WoS records traced in PlumX with at least one score (>1); 7) median = median of all samples; 8) maximum = maximum number of signals or scores; 9) standard deviation; and 10) T confidence interval = with a value of 0.05 for the variable α. Furthermore, the measures are categorised in five separate dimensions typical for PlumX data: Captures, Citations, Social Media, Mentions, and Usage (Torres Salinas et al., 2017). Note that the total values for each dimension were only calculated for a quick overview of the percentage of documents with available data. Nevertheless, the dimensions reflect different types of collected data that should not be conflated.

A highly skewed distribution of all collected signals or scores was observed for each measure as evident from the statistical analysis also included in the tables (median, standard deviation, etc.).

The highest coverage or degree of data availability is provided by the number of readers in Mendeley, followed by abstracts views for all three publication years. Mentions are responsible for the lowest degree of data availability (less than 10% for all three years) and are almost insignificant.

Concerning intensity and density, the results show that usage counts are quantitatively predominant in comparison to the other metrics. Abstracts views are responsible for the highest values followed by other usage measures and captures (number of readers in Mendeley.

It is expected that the percentage of coverage or data availability, the intensity and density decreases for each metric or measure according to the publication year of the documents, due to the decreasing measured time windows (three, two and one year for publications of the years 2014, 2015 and 2016 respectively). This is clearly observed for three dimensions or categories (captures, citations and usage), but it is just the opposite for social media (see table 4). While mentions remain constant in all three years, the percentage of documents with data available in social media steadily increases from 31% to 40%. Tweets are mainly responsible for this increase. The tweets intensity increased from 10,000 for publication year 2014 to around 25,000 for 2015 and 14,000 for 2016. The last decrease is probably explicable due to the extremely short time window.

Category or Dimension	Measure	Year 2014 (input: 2,384 / output: 2,359)								
		Items with data available	Items with data available (%)	Intensity (Sum)	Mean	Density (Mean available)	Median	Maximum	Standard deviation	T confidence interval ($\alpha = 0.05$)
Captures	Exports-Saves:EBSCO	1,298	55%	16,822	7.13	12.96	1	464	26.42	1.07
	Readers:Mendeley	2,161	92%	54,198	22.97	25.08	11	834	44.09	1.78
	Total Captures	2,227	94%	71,020	30.11	31.89	14	848	54.70	2.21
Citations	Scopus	2,007	85%	27,524	11.67	13.71	5	872	28.27	1.14
	PubMed	643	27%	4,815	2.04	7.49	0	186	8.08	0.33
	CrossRef	1,935	82%	25,423	10.78	13.14	5	843	27.09	1.09
	Total Citations	2,091	89%	58,067	24.62	27.77	11	1,715	59.38	2.40
Social Media	+1s:Google+	69	3%	488	0.21	7.07	0	263	5.52	0.22
	Tweets:Twitter	634	27%	10,202	4.32	16.09	0	2,481	65.06	2.63
	Shares, Likes & Comments:Facebook	259	11%	9,869	4.18	38.10	0	1,021	37.88	1.53
	Total Social Media	726	31%	20,559	8.72	28.32	0	2,533	85.73	3.46
Mentions	Blog Blog	51	2%	91	0.04	1.78	0	9	0.34	0.01
	Links:Wikipedia	94	4%	146	0.06	1.55	0	17	0.49	0.02
	News News	43	2%	87	0.04	2.02	0	11	0.37	0.02
	Total Mentions	163	7%	424	0.18	2.60	0	33	1.28	0.05
Usage	Abstract Views:EBSCO	2,093	89%	311,800	132.17	148.97	26	6,427	388.16	15.67
	PDF + HTML Views:EBSCO	800	34%	56,193	23.82	129.42	0	3,139	n.a.	n.a.
	Link-outs:EBSCO	1,346	57%	31,065	13.17	23.08	1	808	50.90	2.05
	Total Usage	2,102	89%	918,135	389.21	436.79	34	69,260	2084.36	84.16
Total All		2,310	98%	1,068,205	452.82	462.43	81	69,885	2128.60	85.94

Table 2. Most relevant results for the publication year 2014.

Category or Dimension	Measure	Year 2015 (input: 2,500 / output: 2,477)								
		Items with data available	Items with data available (%)	Intensity (Sum)	Mean	Density (Mean available)	Median	Maximum	Standard deviation	T confidence interval (α = 0.05)
Captures	Exports-Saves:EBSCO	880	36%	10,492	4.24	11.92	0	285	16.19	0.64
	Readers:Mendeley	2,256	91%	45,749	18.47	20.28	9	1,196	39.79	1.57
	Total Captures	2,292	93%	56,241	22.71	24.54	11	1,205	44.55	1.76
Citations	Scopus	1,998	81%	16,850	6.80	8.43	3	571	16.66	0.66
	PubMed	542	22%	3,134	1.27	5.78	0	216	6.46	0.25
	CrossRef	1,998	81%	16,356	6.60	8.19	3	522	15.66	0.62
	Total Citations	2,106	85%	36,371	14.68	17.27	7	1,309	37.75	1.49
Social Media	+1s:Google+	45	2%	439	0.18	9.76	0	252	5.19	0.20
	Tweets:Twitter	837	34%	25,680	10.37	30.68	0	15,007	305.12	12.02
	Shares, Likes & Comments:Facebook	238	10%	21,469	8.67	90.21	0	4,399	122.35	4.82
	Total Social Media	879	35%	47,588	19.21	54.14	0	15,179	346.15	13.64
Mentions	Blog Blog	88	4%	278	0.11	3.16	0	113	2.32	0.09
	Links:Wikipedia	84	3%	163	0.07	1.94	0	24	0.64	0.03
	News News	119	5%	396	0.16	3.33	0	47	1.32	0.05
	Total Mentions	232	9%	2,103	0.85	9.06	0	1,136	23.22	0.91
Usage	Abstract Views:EBSCO	2,079	84%	289,236	116.77	139.12	17	27,287	617.80	24.34
	PDF + HTML Views:EBSCO	631	25%	32,618	13.17	51.69	0	1,357	67.98	2.68
	Link-outs:EBSCO	1,371	55%	35,196	14.21	25.67	1	1,466	62.40	2.46
	Total Usage	2,097	85%	557,099	224.91	265.66	22	27,345	892.40	35.16
Total All		2,433	98%	699,402	282.36	287.46	56	27,791	1,003.18	39.53

Table 3. Most relevant results for the publication year 2015.

Category or Dimension	Measure	Year 2016 (input: 2,887 / output: 2,851)								
		Items with data available	Items with data available (%)	Intensity (Sum)	Mean	Density (Mean available)	Median	Maximum	Standard deviation	T confidence interval ($\alpha = 0.05$)
Captures	Exports-Saves:EBSCO	775	27%	7,434	2.61	9.59	0	458	13.81	0.51
	Readers:Mendeley	2,460	86%	40,019	14.04	16.27	6	834	32.98	1.21
	Total Captures	2,494	87%	47,453	16.64	19.03	7	850	38.28	1.41
Citations	Scopus	1,849	65%	9,411	3.30	5.09	1	403	11.12	0.41
	PubMed	406	14%	1,754	0.62	4.32	0	378	7.42	0.27
	CrossRef	1,822	64%	9,312	3.27	5.11	1	505	12.28	0.45
	Total Citations	2,011	71%	20,480	7.18	10.18	3	1,286	29.41	1.08
Social Media	Tweets:Twitter	1,096	38%	14,072	4.94	12.84	0	937	32.20	1.18
	Shares, Likes & Comments:Facebook	262	9%	22,045	7.73	84.14	0	1,913	75.15	2.76
	Total Social Media	1,128	40%	36,258	12.72	32.14	0	2,759	97.97	3.60
Mentions	Blog Blog	93	3%	299	0.10	3.22	0	45	1.22	0.04
	Links:Wikipedia	51	2%	88	0.03	1.73	0	14	0.36	0.01
	News News	158	6%	675	0.24	4.27	0	58	1.64	0.06
	Total Mentions	241	8%	1,150	0.40	4.77	0	108	2.89	0.11
Usage	Abstract Views:EBSCO	2,235	78%	226,746	79.53	101.45	10	11,480	327.53	12.03
	PDF + HTML Views:EBSCO	405	14%	41,280	14.48	101.93	0	11,536	253.66	9.32
	Link-outs:EBSCO	1,294	45%	23,582	8.27	18.22	0	1,926	52.50	1.93
	Total Usage	2,266	79%	466,927	163.78	206.06	12	23,040	800.29	29.39
Total All		2,717	95%	572,268	200.73	210.62	33	23,096	842.08	30.92

Table 4. Most relevant results for the publication year 2016[1].

Moreover, the top 10 documents with the highest number of scores in the four most significant measures (number of readers in Mendeley, tweets, citations and views) were compared. Only one document (more exactly one review article containing guidelines) was top 10 in all four measures (number of readers in Mendeley, tweets, citations and views). Otherwise, only some overlaps were notified, all in agreement with the calculated correlation values (see "Results from the correlation analyses").

3.1. Results according to the six main research areas

Table 5 informs about the total degree of availability (percentage of data with scores), for each dimension, main area and publication year.

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[1] Note that the degree of availability for signals collected from +1s:Google+ are lower than 1% for the publication year 2017 and are, therefore not represented in this table.

Table 5. Degree of availability for each dimension, main research area and publication year[2]

PY	Subject category	Total # of items	% items with counts in all	% items with counts in Captures	% items with counts in Citations	% items with counts in Social Media	% items with counts in Mentions	% items with counts in Usage
2014	Arts & Humanities	54	89%	67%	37%	6%	4%	89%
	Eng. & Technology	309	98%	96%	92%	39%	11%	86%
	Health Sciences	168	99%	99%	91%	48%	10%	96%
	Life Sciences	712	99%	97%	94%	40%	9%	92%
	Physical Sciences	785	99%	94%	91%	15%	4%	85%
	Social Sciences	331	94%	91%	76%	36%	5%	91%
	Total	2,359	98%	94%	89%	31%	7%	89%
2015	Arts & Humanities	61	87%	66%	26%	11%	0%	85%
	Eng. & Technology	326	99%	97%	89%	44%	14%	77%
	Health Sciences	190	96%	93%	83%	56%	12%	94%
	Life Sciences	764	99%	96%	91%	47%	13%	93%
	Physical Sciences	812	99%	89%	87%	18%	5%	76%
	Social Sciences	323	97%	92%	74%	34%	8%	90%
	Total	2,477	98%	93%	85%	35%	9%	85%
2016	Arts & Humanities	83	90%	49%	13%	5%	2%	84%
	Eng. & Technology	423	97%	94%	71%	48%	19%	78%
	Health Sciences	223	99%	94%	73%	58%	8%	88%
	Life Sciences	830	99%	96%	84%	59%	11%	89%
	Physical Sciences	821	94%	83%	72%	18%	4%	67%
	Social Sciences	460	89%	80%	54%	33%	3%	82%
	Total	2,851	95%	87%	71%	40%	8%	79%

The lowest percentage of total coverage is observed for the area Arts & Humanities. The percentage of uncited data in this area is at least twice or three times higher than in the other five considered areas. This is expected due to the longer citing half -life and the lower reference densities characteristic for this discipline. Nevertheless, the degree of availability for the dimension "usage" is higher in Arts & Humanities as in Engineering & Technology or Physical Sciences.

The behaviour of the four hard sciences (in this case, Engineering & Technology, Health Sciences, Life Sciences and Physical Sciences) and the Social Sciences is similar in "captures and citations", except in the social media, where Health and Life Sciences account for highest percentages of data availability, followed very closed by Engineering & Technology and the Social Sciences.

Mentions values are very low and almost insignificant in all areas. In general, all percentages are decreasing according to the decreasing measuring window,

[2] One item from publication year 2015, and 11 in 2016 could not be clearly assigned to one of these main categories.

except for the social media, where values are significantly increasing in all four hard knowledge areas.

Table 6 informs about the percentage of documents with scores, the intensity (sum of all scores) and the density (sum of scores in relation to the number of all WoS records traced in PlumX with at least one score (>1)) for each publication year and main area[3]: 1) number of readers in Mendeley (captures in blue), 2) citations from Scopus (in mauve), number of tweets in Twitter (social media in yellow) and number of abstracts views as well as PDF and HTML views in EBSCO (usage in green). None of the measures considered in the category or dimension "Mentions" was significant enough to be included in this analysis.

Table 6. Degree of availability, intensity and density of the most representative measures traced in PlumX for each publication year and main knowledge area.

PY	Subject category	% documents with Readers in Mendeley	Readers Intensity in Mendeley	Readers density in Mendeley	% documents with citations in Scopus	Citation Intensity in Scopus	Citation Density in Scopus	% documents with Tweets inTwitter	Tweets Intensity	Tweets Density	% documents with Abstract Views in EBSCO	Abstract Views Intensity in EBSCO	Abstract Views Density in EBSCO	% documents with HTML/PDF Views in EBSCO	HTML/PDF Views Intensity in EBSCO	HTML/PDF Views Density in EBSCO
2014	Arts & Humanities	50%	138	2.56	31%	42	0.78	6%	3	0.06	87%	11,402	211.15	57%	2,279	42.20
	Eng. & Technology	95%	10,326	33.42	88%	4,571	14.79	34%	4,701	15.21	86%	51,494	166.65	36%	10,458	33.84
	Health Sciences	98%	4,395	26.16	86%	2,070	12.32	43%	577	3.43	96%	29,689	176.72	30%	5,444	32.40
	Life Sciences	96%	21,981	30.87	91%	9,248	12.99	36%	3,928	5.52	92%	68,604	96.35	30%	5,904	8.29
	Physical Sciences	90%	9,345	11.90	89%	9,611	12.24	13%	226	0.29	85%	20,733	26.41	16%	2,712	3.45
	Social Sciences	86%	8,013	24.21	70%	1,982	5.99	28%	767	2.32	91%	129,878	392.38	40%	29,396	88.81
	Total	*92%*	*54,198*	*22.97*	*85%*	*27,524*	*11.67*	*27%*	*10,202*	*4.32*	*89%*	*311,800*	*132.17*	*28%*	*56,193*	*23.82*
2015	Arts & Humanities	46%	141	2.31	26%	26	0.43	11%	21	0.34	85%	12,268	201.11	49%	2,617	42.90
	Eng. & Technology	97%	9,546	29.28	86%	3,457	10.60	39%	20,182	61.91	76%	47,848	146.77	30%	7,960	24.42
	Health Sciences	93%	3,968	20.88	80%	1,297	6.83	53%	664	3.49	93%	19,936	104.93	25%	1,492	7.85
	Life Sciences	96%	17,857	23.37	88%	5,683	7.44	46%	3,049	3.99	92%	91,863	120.24	30%	4,602	6.02
	Physical Sciences	88%	8,938	11.01	82%	5,260	6.48	18%	853	1.05	75%	22,551	27.77	13%	1,494	1.84
	Social Sciences	89%	5,283	16.36	66%	1,126	3.49	33%	911	2.82	89%	94,765	293.39	37%	14,453	44.75
	Total	*91%*	*45,749*	*18.47*	*81%*	*16,850*	*6.80*	*34%*	*25,680*	*10.37*	*84%*	*289,236*	*116.77*	*25%*	*32,618*	*13.17*
2016	Arts & Humanities	31%	65	0.78	13%	14	0.17	5%	31	0.37	84%	6,565	79.10	23%	660	7.95
	Eng. & Technology	94%	9,675	22.87	65%	1,866	4.41	47%	5,428	12.83	76%	48,693	115.11	21%	7,049	16.66
	Health Sciences	92%	3,123	14.00	69%	679	3.04	55%	794	3.56	87%	13,545	60.74	14%	2,993	13.42
	Life Sciences	95%	16,230	19.55	78%	3,378	4.07	58%	6,080	7.33	88%	64,977	78.29	16%	14,578	17.56
	Physical Sciences	82%	6,061	7.38	68%	2,911	3.55	17%	809	0.99	65%	15,231	18.55	6%	605	0.74
	Social Sciences	78%	4,826	10.49	43%	561	1.22	32%	918	2.00	81%	77,704	168.92	17%	15,395	33.47
	Total	*86%*	*40,019*	*14.04*	*65%*	*9,411*	*3.30*	*38%*	*14,072*	*4.94*	*78%*	*226,746*	*79.53*	*14%*	*41,280*	*14.48*

The results corroborate an increase of the activity (intensity as well as density) in Twitter in all categories according to the publication year and despite the reduced time window.

3.2. Results from the correlation analyses

The results of the citation, usage and altmetrics correlation analyses show very similar values to the ones reported on country level (Gorraiz et., 2018). The citation intensity (total number of citations) in Scopus is higher than in Web of Science and in CrossRef as reported in recent studies performed for journal

[3] In this case, we used the most representative measures of each dimension instead of the total sum of signals due to the heterogeneity of the data collected in each tool (as already mentioned above).

articles uploaded to Zenodo (Peters et al., 2017). The results of the Spearman correlations performed for the four citation counts show a very high correlation between the citations counted in the three data sources. As expected, the correlations between citation counts in WoS and in Scopus via PlumX are very high (between 0.95 and 0.99) in agreement with previous results (Archambault et al., 2009; Peters et al., 2017). However, the correlation with CrossRef is much higher as reported in the oreviously mentioned study. This might be explicable due to the short citation window and larger sample sizes in our study, but needs further exploration.

On the other hand, the correlations computed for the usage data provided in WoS Core Collection and PlumX via EBSCO (abstracts views) are low in comparison to the ones calculated for the citation measures. They range between 0.12 and 0.30 with increasing values for the last publication year 2016. This could be explained by the fact that the user groups are different in both data sources with different interests.

Spearman correlations were also calculated between the most representative measures from each dimension (parameters with a significant coverage, intensity and density) according to the results obtained in PlumX (see Tables 2-4). These are: Readers in Mendeley, Citations in Scopus, number of tweets in Twitter, and Abstracts Views in EBSCO. Furthermore, PDF Views and HTML Views in EBSCO were used as an approach for downloads in EBSCO. Our analysis shows a very low, almost insignificant correlation between the different dimensions (between 0.1 and 0.3). Only correlations between the number of readers in Mendeley and the number of citations attracted in Scopus were median (between 0.4 and 0.6), i.e. the same trend as observed at country level. Correlations computed in WoS between citation (times cited in WoS Core Collection or TC and times cited in the complete WoS platform) and usage counts (U1 and U2, as described in the Methodology) were higher as reported for all Austrian publications. Spearman values fluctuate between 0.4 and 0.8 and were higher for U1 and for the most recent publication year (2016). Last but not least, correlations were computed between the number of authors or the number of affiliations and the most representative measures traced in each data source. The obtained Spearman correlation values were always insignificant (below 0.1) except for the last publication year and for captures (around 0.4) and citations (0.8 for the number of authors and 0.7 for the number of affiliations).

4. Conclusions

The results of our monitoring exercise on institutional level are very similar to the results gained on country level (Gorraiz et al., 2018) and illustrate the prominent role of the University of Vienna among all organisations contributing to the Austrian scientific output according to the data collected from Web of Science Core Collection. The results for the University of Vienna reinforce the importance of usage metrics in order to assess the broad impact of journal articles, especially in disciplines related to the area Arts & Humanities. This confirms that publications in this area are often viewed or downloaded due to the fact that they are used for other purposes (pure information, learning, teaching, etc.) apart from the ‘publish or perish game’ (Bollen et al., 2008; Schlögl et al., 2010). The importance of citation data will increase with the longer citation window according to the different cited and citing half–lives characteristic for each area and discipline.

However, the highest coverage or degree of data availability is provided by the number of readers in Mendeley independently of the knowledge area in agreement with previous results (Zahedi et al., 2013). Almost 90% of WoS Core Collection publications by the University of Vienna including a DOI were captured at least by one reader in this reference manager even in the last three more recent complete years.

Concerning intrinsically altmetrics (Glänzel et al., 2015), the percentage of WoS CC publications by the University of Vienna with social media scores (almost only tweets) is strongly increasing from ~31% in 2014 to ~40% in 2016, in agreement with the increasing popularity and advancement of these tools in recent years and the results reported on country level. Actually, the increase on country level is slightly lower. The highest percentages of data availability in social media are reported in the Health and Life Sciences, followed by Engineering & Technology and the Social Sciences, where they can play a significant role. The low reported percentage of publications tweeted in the Physical Sciences as well as the relative insignificance in the Arts & Humanities are noteworthy and were also observed on country level.

According to our results – very low correlation values between the measures traced in PlumX - different dimensions might provide only partial views and hint at quite different user communities for each data collecting tool. Therefore, they should rather be considered as complementary sources in order to reach a higher completeness of data as already suggested in other papers (e.g. Gorraiz et al., 2016). High correlations between the same measures or metrics originating from different data sources were only reported for citations, but not for usage data. Medium correlation values were observed between usage and citation counts in the database WoS Core Collection. These results are in good agreement with previous results reported by Chi and Glänzel (2017). However, it should be taken into accout that usage data and citations have different obsolescence patterns. Most articles are viewed or downloaded immediately upon their online availability, whereas it takes a couple of years until articles receive their citation peak depending on the research area.

The same authors reported that a higher number of co-authors was not associated with higher usage counts or more citations. This hypothesis (correlation of the signals intensity with the number of affiliations or authors) was also checked in our study for all the significant measures collected in this study. No evidence was found, except for the last publication year and for captures and citations. This could be explained by the high proportion of self-citations and self-archiving in the most recent year.

The aim of our study was to provide a first monitoring example for the broader impact of publication output on institutional level. It seems that quantitative monitoring practices help to reveal new trends and to assess the degree of implementation in each institution. New metrics, and especially altmetrics, should not (yet) be used for evaluation purposes, but rather in order to trace and monitor the interest and attention attracted by the publication output of an institution, and to keep track of their evolution in time. This could be beneficial for the development of more suitable library services for scientists, institutions and countries as well as for increased visibility on the web.

A clear restriction of our study is that more than 90% of the publications with DOI retrieved in WoS were journal articles and reviews. An analysis of the web impact of the total publication output should, of course, also consider other publication types, even if they lack a DOI. For other publication types, e.g. books, big differences are expected (see Torres Salinas et al, 2017). Another restriction is the very broad classification used (six main knowledge areas), and further studies are needed in order to clarify the behaviours in each research discipline.

From a technical point of view, PlumX has proven to be a very useful tool for this monitoring exercise. Our example also strengthens the philosophy of the tool PlumX providing a variety of measures grouped in different dimensions, but refraining from providing a simple and composite indicator. In doing so, the multidimensional aspect is better addressed, even if it is far from trivial in dealing with such an amalgam of different types of information retrieved from a plethora of data sources (Gorraiz et al., 2017). Further research is necessary to clarify the stability and reproducibility of all the collected data, in order to get a thorough and transparent documentation of their temporal evolution and to trace and understand potential score changes. Unfortunately, PlumX does not offer the possibility to select different time windows, therefore, temporal monitoring currently only works by archiving obtained results to be compared later for the different time intervals.

Last but not least, correlations between different metrics should be taken with a pinch of salt, due to their different obsolescence patterns. It should be taken into account that we are dealing with different types of indicators. We can distinguish long term versus short term measures or indicators according to the different temporal windows that are required for obtaining significant results (Moed, 2017; Gorraiz, 2018). Most of them (like usage, captures and social media) can be accessed very quickly - almost real-time - and can be more relevant than citations for less publication-intense fields for measuring broad impact. Sometimes they can also be used as predictors for citations, but only if the addressed target group is the "publish or perish" community.

The new metrics are very promising tools, but obviously susceptible to manipulation. None of them is yet completely ready, stable and reliable. Their completeness (globally available data), interrelationship, standardization, scalability and normalization are further issues to be tackled. Furthermore, a cornucopia of different indicators or units („readers ", „hits ", „views ", „members ", „likes ", „posts ", „tweets ", etc.) is available. This fact further complicates their classification into categories or dimensions, and impedes conceptualization: what is their real nature and for what exactly are they reliable proxies?

As revealed in this study, many of these metrics do not provide significant or relevant information and therefore even hamper content assessment. This sparks the debate whether this development really means progress for scholarly communication or not. In other words, we might already have started with building the literal "Information Tower of Babel", where millions of scientists talk or write at the same time and produce billions of papers, talks, emails, blog entries, tweets, etc., to be evaluated, discussed, mentioned, commented, re-blogged, re-tweeted and scored by others. Mutual understanding might still be assured on the lower floors (normalized databases, traditional research communication channels and mechanisms, etc.), but the higher we go the bigger the risk of losing comprehension in the middle of an increasingly unmanageable world of scientific communication and information overload.

Undisputedly social media, and as a consequence new metrics, increase the visibility of individuals and their research output. They can therefore be used as a measure of attention or interest attracted on the web.

In conclusion, one of the challenges we face as modern academic librarians is to observe the future development of altmetrics tools and their acceptance vs. rejection by the scholarly community, particularly in our own organisations and countries. For this purpose, monitoring exercises are most practicable and state-of-the-art apart from surveys.

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References

Archambault, E., Campbell, D., Gingras, Y, Lariviere, V. (2009). Comparing of Science Bibliometric Statistics Obtained From the Web and Scopus. *Journal of the American Association for Information Science & Technology*, 60 (7), 1320-1326.

Bollen, J., Van de Sompel, H. (2008) Usage impact factor: The effects of sample characteristics on usage-based impact metrics. *Journal of the American Society for Information Science and Technology*, 59(1), 136-149.

de Bellis, N. (2009). Bibliometrics and citation analysis: from the Science Citation Index to Cybermetrics. Lanham, MD, USA: Scarecrow Press.

Glänzel, W., Gorraiz, J. (2015). Usage metrics versus altmetrics: confusing terminology? *Scientometrics*, 102, 2161–2164.

Gorraiz, J., Gumpenberger, C. (2012) Bibliometric practices and activities at the University of Vienna. *Library Management*, 33 (3), 174-183.

Gorraiz, J. (2018). A thousand and one reflections of the publications in the mirrors' labyrinth of the new metrics. *El profesional de la información*, 27 (2), 231-236; http://www.elprofesionaldelainformacion.com/contenidos/2018/mar/01.pdf

Gorraiz, J.; Blahous, B. and Wieland, M. (2018). Monitoring the broader impact of the journal publication output on country level: A case study for Austria. In press in *Lectures Notes in Computer Science*.

Moed, H.F. (2017). Applied Evaluative Informetrics. Springer International Publishing. ISBN: 978-3-319-60521-0

Schlögl, C., Gorraiz, J. (2010). Comparison of citation and usage indicators: the case of oncology journals. *Scientometrics*, 82, 567-580.

Peters, I.; Kraker, P-; Lex, E.; Gumpenberger, C. and Gorraiz, J. (2017). Zenodo in the spotlight of old and new metrics. *Frontiers in Research Metrics and Analytics*; https://doi.org/10.3389/frma.2017.00013

Torres-Salinas, D., Gumpenberger, C., Gorraiz, J. (2017). PlumX As a Potential Tool to Assess the Macroscopic Multi-dimensional Impact of Books. *Frontiers in Research Metrics and Analytics*; https://doi.org/10.3389/frma.2017.00005.

Zahedi, Z., Costas, R., Wouters, P. (2013) How well developed are Altmetrics? Cross disciplinary analysis of the presence of 'alternative metrics' in scientific publications (RIP). In J. Gorraiz, E. Schiebel, C. Gumpenberger, M. Hörlesberger, & H. Moed (eds.), *Proceedings of the 14th International Society of Scientometrics and Informetrics Conference*, 2013, v. 1, pp. 876-884.