

Relating Health to Platform Success: Exploring Three E-commerce Ecosystems

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ABSTRACT

The market for e-commerce systems is saturated with more than 60 different solutions that compete and try to accommodate different needs. However, it appears that three main platforms account for roughly half of the market share: Magento, PrestaShop, and WooCommerce. This paper evaluates these platforms from a software ecosystems health perspective. By shedding light on the success factors of these ecosystems, we aim at establishing what makes an e-commerce ecosystem healthy. This knowledge provides ecosystem orchestrators with an overview of the current health of these ecosystems, and researchers with an application of ecosystem health assessment.

Categories and Subject Descriptors

D.2.9 [Management]: Productivity; D.4.8 [Performance]: Measurements

General Terms

Management; Measurement; Performance.

Keywords

Software Ecosystem, Health Assessment, e-Commerce Platform, Magento, PrestaShop, WooCommerce.

1. INTRODUCTION

Starting an online store is a great and challenging step for starting businesses, and one of the most important decisions they have to make is choosing an appropriate platform. A bad decision in this domain can be detrimental to the long-term well-being of an organization. A recent study conducted by Datanyze¹ shows that, among the top 1 million sites as provided by Alexa, there are more than 60 e-commerce platforms that compete against each other and try to accommodate different customers' needs. Within these, more than half of the market is distributed as follows: Magento (28.3%), WooCommerce (17.9%) and PrestaShop (7.5%). Magento, an eBay Inc. company, is an open-source content management system for e-commerce web sites that was launched in 2008. PrestaShop is another open source e-commerce solution that was launched in August 2007. WooCommerce is currently the most popular e-commerce plugin for Wordpress, and it was launched in late 2011. Considering the different demands of customers, it is not surprising that these platforms cannot meet all their specific needs (e.g., data analytics, stock tracking, payment gateway, etc.). Given this situation, such platforms are tailored in a way that accept third-party extensions that add features to their core functionality.

Jansen et. al [11] define software ecosystems as 'a set of actors functioning as a unit and interacting with a shared market for software and services, together with the relationships among them. These relationships are frequently underpinned by a common technological platform or market and operate through the exchange of information, resources and artifacts'. Thus, third-party developers, together with the end-customers of such extensions, and the platform owners can be regarded as members of a software ecosystem. Drawing on the defining sentence based on the four static qualifiers proposed by Jansen and Cusumano [10], these three software ecosystems can be described as follows:

- The Magento software ecosystem is based on a software platform and is coordinated by a privately owned entity with an extension market to which participants can submit extensions for free.
- The PrestaShop and WooCommerce software ecosystems are based on a software platform and are coordinated by a privately owned entity with a commercial extension market to which participants can submit extensions for free.

Figure 1 depicts the three ecosystems categorized according to their extension architecture based on the work of Jansen and van Capelleveen [12].

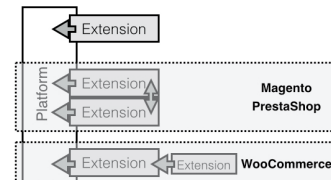


Figure 1. Extension models of each platform. Adapted from Jansen and van Capelleveen [12]

Both Magento and PrestaShop incorporate an extension model through which extensions can either be consumers or providers of resources and services, thereby making it possible for extensions to interact and have dependency relations among each other. WooCommerce is an interesting case of a platform on top of a platform because it is itself a Wordpress extension, i.e., it is part of the Wordpress software ecosystem. Previous research has targeted content management systems for performing an ecosystem health assessment [13]. However, the research domain of e-commerce from the perspective of software ecosystems has yet to be investigated. This has led to the following research question Q_1 : *What makes e-commerce ecosystems such as Magento, WooCommerce, and PrestaShop healthy?*

The practical contribution of this study is twofold. First, it gives information on how these platforms orchestrate their respective ecosystems, and insight on their current market situation, thus providing the ability to ascertain which aspects of their partner ecosystem might require attention. Second, it complements the existing scientific knowledge on software ecosystems. By

¹ <http://www.datanyze.com/market-share/e-commerce-platforms/>

contributing to the software ecosystems field with these observations, we argue that our results can serve as a basis for creating and validating models about software ecosystem governance and frameworks for ecosystem health assessment. Furthermore, these results can be used for comparing other e-commerce ecosystems. Finally, our examination of the WooCommerce ecosystem represents one of the first accounts that provides insight on a “platform of platforms” i.e., a platform where fourth party extensions are possible.

This section introduced the research problem and its importance. The remainder of this paper is organized as follows. Section 2 presents the theoretical background on software ecosystems health. Next, Section 3 elaborates on the research method that was followed for this research. In Section 4, the results of our study are presented and subsequently analyzed in Section 5. The limitations of the study, and potential threats to the validity and reliability of the results are discussed in Section 6. Finally, Section 7 concludes the paper and proposes future work.

2. THEORETICAL BACKGROUND

The livelihood of an open source ecosystem is of paramount importance to different ecosystem participants. Participants of an ecosystem (e.g., software developers, end-users, investors) want to know whether the ecosystem is healthy and performing well. Iansiti and Levien [6] show that the different actors in a healthy ecosystem can appear in the role of keystone players, dominators or niche players. The first role provides standards or platform technologies that drive the ecosystem forward. These standards or platform technologies are in turn used by niche players for generating business value. Finally, a dominator is someone who progressively assimilates or eliminates others [9].

The concept of ecosystem health can take many forms. A simple yet concise definition proposed by Lucassen et. al [14] is “longevity and propensity for growth”. This definition was later operationalized by Jansen [8] in the Open Source Ecosystem Health Operationalization framework (OSEHO), which establishes the health of a complete software ecosystem based on data about open source projects that belong to the ecosystem. The metrics considered in the OSEHO framework are classified into three groups as defined by Iansiti and Levien [5], namely:

- **Productivity:** efficiency with which an ecosystem converts inputs into outputs. Metrics that address growth (e.g., change over a unit of time) are usually put under this category.
- **Robustness:** capability of an ecosystem to face and survive disruptions. Metrics within this category give an indication as to how well the ecosystem will deal with change and how quickly it will recover.
- **Niche creation:** capacity to create meaningful diversity through the creation of valuable new functions, or niches.

These three pillars are in turn divided into three layers, to wit: theory level, network level, and project level. The first level represents the theoretical model proposed by Den Hartigh [2] for operationalizing the concept of ecosystem health. The second layer defines the health operationalization at the network level for open source ecosystems. Finally, the third layer provides a comprehensive overview of project-related health metrics, which can be used to provide an indication of the overall health of an ecosystem.

Overall, it can be argued that the OSEHO framework provides an integrated view that considers different studies that have been undertaken under the umbrella of ecosystem health, centering its

focus on the open source domain. Given these circumstances, it was decided to use this framework to assess the health of the three ecosystems in terms of the key pillars mentioned above. Thus, our main research question was expanded to accommodate the following research sub-question: *S.Q1. What is the current health of these ecosystems in terms of productivity, robustness, and niche creation?*

Before ending this section, it must be noted that the framework was used with some remarks. First, the metrics were adapted so as to reflect the data that was available on the marketplaces (i.e., Magento Connect, PrestaShop add-ons, and Wordpress Plugin Directory). Second, as we did not have detailed information for each extension (e.g., source code, mailing lists, forks), we made no distinction between project-related and network-related metrics. The limitations of this approach are further discussed in Section 6.

3. RESEARCH METHOD

This research set out to analyze the three most successful e-commerce platforms in terms of market share and determine whether such success is accompanied by proper ecosystem health. It could be argued that the success of a platform is not entirely attributable to the platform itself, but the extensions that it offers. As previously noted, these extensions are commonly developed by third-party developers, and they led to an increase in the functionality and, possibly, the popularity of the platform. Given the importance of the partner ecosystem, we decided to approach our research from the perspective of the extensions developed by third-party developers. Considering the nature of our research, we used case research as a primary methodological approach to guide this study. An initial literature review was performed to set the scope of the research as well as to enable the formulation of the research questions. First, as noted in Section 2, it was decided to use the OSEHO framework to assess the health of the three ecosystems. In addition, the specific metrics within these three categories, depicted in Table 1, were chosen in accordance with the data that was available on the marketplaces. Due to this availability restriction, it has to be mentioned that not all platforms have a value for each metric (e.g., average number of supported languages was only available in the case of PrestaShop). This situation is reflected in Table 1, where each metric has been classified according to the platform in which it was present. Moreover, we followed the Analysis Method proposed in the OSEHO framework, namely: (1) set goals, (2) select ecosystem scope, (3) select metrics, (4) assess and define needed data, (5) collect data, and (6) analyze the data. The majority of the data used for this study were collected through web scraping, since none of the platforms offered public APIs for accessing the information available on their respective marketplaces. Specifically, a series of tools for scraping the marketplaces were developed with the Python programming language and Scrapy, an open source framework for crawling websites.

As discussed by Thelwall and Stuart [16], web crawling can sometimes be detrimental for the affected websites (e.g., it can affect the normal function of the website), and so the crawling was performed in a way to minimize the negative impact of our tool. First, all requests were sent under the same IP address. Second, a crawl-delay interval was enforced to (a) minimize the risk of disturbance from multiple requests, and (b) avoid prohibitions. The data for each platform were collected in the course of three days, from 27th November to 30th November 2014, and were subsequently entered, cleaned, coded and

analyzed by SPSS version 22. The data analysis results were used to report the findings of the research, and after several review rounds the research finalized.

Table 1. Overview of the selected health metrics

	Productivity	Robustness	Niche creation
Magento	- New releases per month - New developers per month	- Unique developers by partner category - Extensions developed by partners	-
PrestaShop	-	- Number of certified extensions	- Average number of supported languages
All platforms	- Distribution of last updates over the last years - New customers per month - Leavers per month	- Number of extensions - Market share - Unique developers - Rated extensions - Platform findability	- Variety of categories

WooCommerce was particularly troublesome during the initial stages, since the information shown on the main extension website was not enough to extract meaningful metrics. Moreover, the lack of standardization of the website would have made it difficult to collect data. Given that WooCommerce is itself a plugin of Wordpress, it was decided to use the structured Plugin Directory of Wordpress² and search for the keyword “WooCommerce”. Outliers that were not directly associated with WooCommerce and thus provided misleading results were filtered, which resulted in the removal of 23 cases (e.g., generic Wordpress plugins). The pitfall of this approach was that paid extensions were not displayed, so pricing information was not obtained for this ecosystem.

In hopes of easing the process of future similar endeavours, we have released the source code with an open call for the research community so that it can be browsed and downloaded through the website associated with this publication³.

4. RESULTS

The following subsections present the health metric results in terms of productivity, robustness, and niche creation.

4.1 Productivity

This subsection presents the specific metrics for productivity: distribution of *last updates over the last years* (Table 2), *releases per month and new developers per month* (Figure 2), and *new customers and leavers per month* (Figure 3).

Table 2. Distribution of last updates over the last years

Year	Magento Updates	PrestaShop Updates	WooCommerce Updates
2008-2011	757 (13%)	-	-
2012	1013 (17%)	426 (9%)	9 (1%)
2013	1330 (23%)	554 (12%)	109 (12%)
2014	2700 (47%)	3711 (79%)	787 (87%)
TOTAL	5800	4691	905

Regarding Table 2, the number of last updates does not reflect the entire set of extensions for each ecosystem. For instance, while 27% of the Magento extensions did not offer last update information, the situation was much different in the case of PrestaShop (0.6%). In addition, it should be noted that WooCommerce was released in mid-2011.

² <https://wordpress.org/plugins/>

³ <http://bit.ly/1PG7IGt>

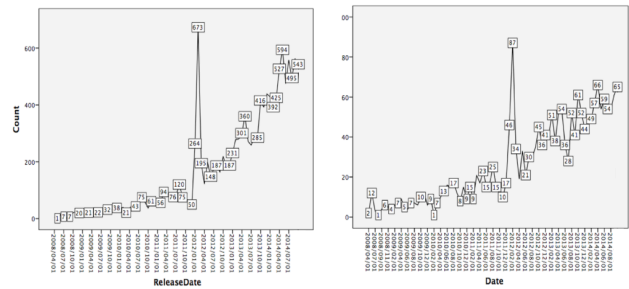


Figure 2. (left) New releases per month and (right) new developers per month, Magento ecosystem

Figure 2 depicts the number of releases (left) and developers per month (right) for the Magento ecosystem. In both cases, the data were extracted from the release notes of the different extensions. To calculate the number of developers per month, we used the date of their first release, as we assumed that it offers a fairly estimate of when the developers joined the ecosystem. Hence, each developer was associated with the date of the first extension he released. It is interesting to note that both figures follow a similar upward tendency, and that they reach their respective peaks during the same period of time (February 2012). According to the history of Magento [15], several events took place that might have had an influence: announcement of a developer certification scheme (September 2011), release of free *Magento U* courses (October 2011), and achievement of more than 4 million downloads for Magento free Community Edition (February 2012).

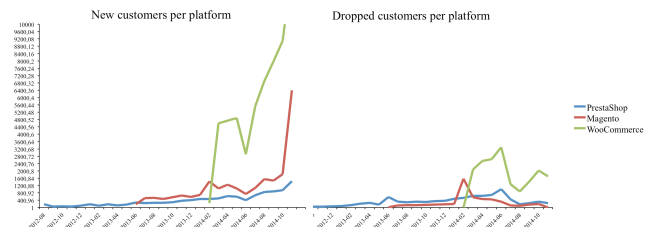


Figure 3. Customer migration analytics: new customers/leavers

Finally, Figure 3 shows customer migration analytics as provided by Datanyze [1]. It can be seen that WooCommerce is leading the growth of new customers that are currently migrating to this platform, whereas PrestaShop remains steady. With regards to leavers, WooCommerce is also leading the largest drop, perhaps due to the novelty of the platform.

4.2 Robustness

This subsection introduces the specific metrics for robustness, depicted in Table 3: *number of extensions, market share, number of unique developers, unique developers by partner category, number of certified extensions, extensions developed by partners, number of rated extensions, and platform findability*.

Table 3. Robustness metrics per platform

Metrics	Magento	PrestaShop	WooCommerce
Extensions	7981	4720	905
Market share	28.3%	7.5%	17.9%
Unique developers	2212	731	672
Developers by category	2 Platinum, 13 Gold, 26 Silver, 34 Bronze, 2136 non-partners, 1 Magento itself	-	-
Certified extensions	-	1508 (32%)	-

Extensions developed by partners	715 (9%)	-	-
Rated extensions	3872 (49%)	1073 (23%)	699 (77%)
Platform findability [3]	Steep increase from 2007 till early 2010. Stable since 2010.	Gradual increase from 2008 till early 2012. Stable since 2012.	Sharp increase since late 2011.

The following key findings can be considered:

- Magento and PrestaShop have significantly more extensions than WooCommerce. However, WooCommerce has experienced a sharp expansion, having now a market share greater than that of PrestaShop.
- Magento has more developers than PrestaShop and WooCommerce. Although WooCommerce is the youngest, it has almost the same number of unique developers than PrestaShop.
- Of all Magento developers, only 3.4% are partners, and they account for 9% of the total number of Magento extensions.
- Only a 32% among the total number of PrestaShop extensions are certified (i.e., a status symbol granted by the platform).
- WooCommerce is the ecosystem with the largest number of rated extensions. In the case of Magento nearly half of the extensions have been rated, whereas PrestaShop accounts for only 23% extensions.
- Although Magento and WooCommerce have a larger market share than PrestaShop, WooCommerce is the least popular in terms of platform findability [3]. A possible explanation is the fact that, since WooCommerce is part of the Wordpress ecosystem, users of this platform directly access it through Wordpress, as opposed to using Google search.

4.3 Niche Creation

In this subsection, the specific metrics for niche creation are presented in Table 4, i.e., *variety of categories*, and *average number of supported languages*.

Table 4. Niche creation metrics per platform

Metrics	Magento	PrestaShop	WooCommerce
Variety of categories	6 categories	27 categories	12 categories
Avg. supported languages	-	$M=3.35 (SD=2.67)$	-

The following findings can be extracted from Table 4:

- PrestaShop has the greatest variety of categories.
- The information about the number of supported languages was only available for PrestaShop extensions.

In these subsections, the results for the different ecosystems have been introduced. The inexistence of a baseline for other e-commerce ecosystems eliminates the possibility of comparing the results with other ecosystems. Nevertheless, we argue that these results can be used in future studies for establishing comparisons between other e-commerce ecosystems in terms of health. In the section that follows, an analysis of the results is presented.

5. ANALYSIS

This section offers an analysis of the metrics presented in the previous section. The first subsection gives an overview of the statistical tests performed for some of these metrics and for each ecosystem. Finally, the second subsection provides an overview of the main findings.

5.1 General Analysis

An analysis of the data for the Magento ecosystem showed that paid extensions represent more than half (66%) of the total number of extensions. Magento presents a hierarchical partnership model with the following levels: Platinum, Gold, Silver, Bronze, and non-partners. With regards to the price of extensions, a Kruskal-Wallis H test showed that there was a statistically significant difference in price between the different partnership levels, $\chi^2(4) = 268.56, p < 0.001$. Interestingly, the highest price is being set by Silver ($M = 228.11, SD = 1090.92, Median = 79.39$) and Platinum partners ($M = 98.85, SD = 75.22, Median = 79.39$). Due to the high variability in the data, it is difficult to establish whether there is a correlation between partnership level and price. However, results indicate that there is a significant but very weak monotonic association between price and partnership level, $r_s = .166, n = 7964, p < .001$. Thus, higher partnership level is not directly associated with a higher extension price.

An exclusive concept in the Magento marketplace is that of popularity score. This measure consists of the number of times the extension is installed directly from the marketplace for free extensions, and the number of referrals to the developer's site for paid extensions. An analysis of the different popularity scores for the extensions showed that the distribution of such scores is the same for Silver, Platinum and non-partners, $\chi^2(2) = 1.610, p = 0.45$, indicating that extensions developed by partners are not necessarily more popular. Moreover, extensions developed by Bronze and Gold partners are the most popular, with Gold extensions being even more popular than its Bronze counterparts ($U = 6225, p = .002$).

Regarding PrestaShop, nearly all of the extensions (99%) are not free. Of those that are free, 71% are being developed by PrestaShop, so it can be argued that the extension market for this ecosystem is heavily commercialized. A Mann-Whitney U test indicated that the price for certified extensions ($M = 103.75, SD = 47.62, Median = 119.99$) was statistically significantly higher than non-certified extensions ($M = 69.31, SD = 51.66, Median = 47.99$), ($U = 1159091.50, p < .001$). Another aspect is that there exists a dominant key partner, Template Monster, who is responsible for 20% of the total number of extensions. This developer is multi-homing across different markets (i.e., they develop templates for several CMS and e-commerce platforms). The strong dependence on Template Monster might explain the fact that all their templates are currently certified by PrestaShop. Also, a Pearson correlation coefficient was computed to assess the relationship between price and languages supported by an extension. There was a positive correlation between the two variables, $r_{pb} = .304, n = 4720, p = 0.002$. Overall, results indicate that certified extensions tend to have a slightly higher price.

Finally, as far as WooCommerce is concerned, it is interesting to note that the extensions pertaining to this ecosystem explicitly state the number of developers that have contributed to its development, as opposed to the other two ecosystems. An analysis of these data shows that a large majority of extensions (72%) are developed by only a single person. The second most common situation represents two developers per extension (2.8%), followed by three developers (2.77%). Note that 12.6% of the extensions provided no information for this field. The next studied aspect was the relationship between the rating of an extension and its download count. In this case, results indicate that there is a significant association between these two variables, $r_s = .370, n = 882, p < .001$. Thus, downloads tend to increase as the rating increases.

To conclude this section, it should be mentioned that in the case of Magento and PrestaShop, nearly 80% of the total number of extensions are developed by 20% of the developers (i.e., Magento = 20% developers; 71% extensions, PrestaShop = 23% developers; 80% extensions), thus following a Pareto distribution. For WooCommerce, the situation is different (20% developers; 50% extensions). This might have practical implications for developers, as discussed in the following subsections.

5.2 Health Comparison

The fact that certain metrics are not available for all of the studied ecosystems makes it difficult to establish a comparison between them in terms of productivity, robustness, and niche creation. Since this was a constituent part of our research question, this section aims to provide an answer.

As far as productivity is concerned it appears that WooCommerce is the healthiest ecosystem. Nearly 90% of the extensions developed for the WooCommerce ecosystem have been updated in 2014 followed by PrestaShop (79%) and Magento (47%). In terms of robustness Magento appears to be the healthiest, as it: (a) is the platform with the highest market share of the three, (b) accounts for the highest number of extension developers and extensions, (c) has a partnership model, unlike the other two, and (d) has the highest platform findability. Finally, with regards to niche creation, it is impossible to deem one ecosystem as the healthiest, as the only metric that was available for the three ecosystems was *variety of categories*. Although PrestaShop has the highest number of categories according to their own defined taxonomy, it does not really imply anything about *real* niche creation. It is likely that the ecosystems offer the same third-party functionality.

5.3 Overview of Findings

As the metrics in the previous sections have shown, the three platforms are supported by a healthy ecosystem consisting of users, developer, and partners that mainly interact through extension marketplaces. In all cases, third parties can submit their extensions and compete against each other for the attention of prospective customers, thereby enabling the existence of two-sided markets. Regarding the main findings of our work, a number of interesting issues arise:

- **Partner shakeouts as a governance tool.** In the case of Magento, nearly 9% of the extensions are developed by partners. This casts a shadow over whether the incentives Magento offers for being a certified partner are good enough in terms of cost-benefit analysis. On a related note, in late 2013 Magento announced a new partnership program after a partner shakeout, where roughly 100 partners were removed from the partner listing [7]. This new partnership model eliminated the Bronze level. However, the extension market still reflects the old system. Given this mismatch, it is impossible to hypothesize over the success and benefits of the current partnership model. Nonetheless, partner shakeouts appear to be an effective tool for improving the quality of the partners in an ecosystem (i.e., having committed partners rather than aiming for quantity), which arguably reflects in better ecosystem health over time.
- **Relationship between ratings and downloads.** In the case of WooCommerce, more than three-quarters of the extensions (77%) are rated, although it should be noted that the overall number of extensions in the case of WooCommerce (905) is lower compared to those of

PrestaShop (4720) and Magento (7981). This leads us to question whether this tendency will continue as the ecosystem matures, which will be accompanied by an increase in the number of extensions. The percentage of rated extensions for Magento (49%) is of particular significance, considering that it is the platform with the greatest number of extensions. In contrast, PrestaShop falls short in terms of this metric, accounting only for 23% of rated extensions. This raises the question of whether the platforms are internally interested in having users rate and provide feedback on the extensions, and whether incentives (either offered by the platform itself or the developers of a given extension) should be in place for doing so. Empirical evidence indicates that platforms are indeed interested in such approach (e.g., Google Play and App Store). Our results indicate that downloads tend to increase as rating increases (and vice versa). This appears to be in contradiction with Hyrynsalmi [4], who suggested that the correlation between positive customer feedback and higher sales is low in the Google Play ecosystem, an ecosystem where micro-pricing models are used. It should be considered that e-commerce extensions have on average a higher price than regular mobile apps, and this fact could explain our findings. Nonetheless, the mismatch between ratings and downloads across different types of ecosystems indicates the need of future research to understand consumers' decision-making processes in different scenarios.

- **Popularity as a key factor on the number of extension developers.** Popularity, which can be measured in terms of market share or new customers per month, appears to be correlated with the number of third parties present in an ecosystem. We found that, although the WooCommerce ecosystem is fairly new, it almost has the same number of unique developers as PrestaShop does, which has been in the market for more than 7 years. In addition, the Magento ecosystem appears to host the biggest community, with more than 2200 extension developers. However, the great majority of these (97%) are not partners. In addition, as was noted in the previous section, the distribution of extensions vs. developers follows a Pareto distribution for the Magento and PrestaShop ecosystems, but does not in the case of WooCommerce. A plausible explanation for this is that WooCommerce has not as mature an ecosystem as the other two, meaning it has yet to stabilize.
- **Multi-homer ecosystem fidelity maximization.** The best scenario for an ecosystem would be to have committed contributors that do not multi-home. However, there will inevitably exist key multi-homers that play an important role in an ecosystem that ecosystem orchestrators should not miss. A possible strategy for retaining keystone multi-homers is to attract them into the partnership network by considering their specific characteristics (e.g., limited availability and non-exclusivity).
- **Fast growth of WooCommerce.** WooCommerce is leading the growth of e-commerce platforms in terms of new number of developers as well as customers per month. On a practical level, we regard the WooCommerce ecosystem as a market opportunity for those developers willing to enter in new niche markets. Over time, we foresee that key players will start forming in the WooCommerce ecosystem, and that the ecosystem may stabilize.

6. DISCUSSION

Any research endeavour has limitations and this study is no exception. Restricting the collection of data to the extension markets was a decision based on logic and practical considerations. First, a marketplace arguably contains a representative sample of the available extensions for a given platform. Second, an exploration of extensions outside of the official marketplaces was out of scope due to time constraints and the infeasibility of such approach.

Moreover, although the e-commerce platforms under study are open source, some of the extensions created by third-party developers are not. In addition, our research has targeted the extension market of each platform, which provides no direct access to source code or developer activity metrics (e.g., commits, lines of code). In that sense, based on the data that were initially available on the marketplaces, there were some restrictions with regards to the metrics that could be initially selected to answer our sub-research question. Moreover, since both Magento and PrestaShop are, in part, commercial ecosystems, it would have been interesting to consider the metrics for commercial ecosystems proposed by Den Hartigh [2]. Unfortunately, most of these metrics are kept private by organizations and thus are not easily obtained. The selection of the different metrics also proved to be a difficult task. Some metrics were only available for certain platforms, thus restricting the possibility of establishing comparisons. This constitutes a problem not easily overcome, since it depends on the information displayed in the marketplaces. From our experience, the OSEHO has been applied to some extent, but based on our observations, the extension marketplaces of a platform do not seem to offer a complete picture of ecosystem health due to data unavailability. A potential solution is to rely on multiple sources of data, as we suggest in the following section.

7. CONCLUSION AND FUTURE RESEARCH

Our work has focused on a one-time assessment of health metrics that offer a snapshot of the current situation of the ecosystems based on the information available on their respective marketplaces, although historical data such as new developers per month or releases per extension have been retrieved for some platforms as well. Hence, for this study to become more mature and to allow for a more elaborate comparison between -and within- the platforms, future research should aim to perform similar continuous assessments over time. During our data collection, we were not able to retrieve extension-specific data (e.g., lines of code, multi-homers, and contributor information) mainly due to the unavailability of such data on the marketplaces. We observe that historical data in many cases is lost and that if the software ecosystems field is to grow mature, more historical data needs to be stored and reported on. GitHubArchive, Google's BigQuery archives of Github, and BlackDuck's repositories are but drops in the sea of data that needs to be collected to reliably study software evolution in ecosystems. For our study, future research should inspect those repositories looking for extensions belonging to a platform in order to provide a comprehensive view of the health of the underlying ecosystem.

Furthermore, we argue that the extensive datasets form a valuable resource for future work in software ecosystems. For instance, ripple effects in the topic of API evolution (i.e., how quickly do developers adopt new releases of the keystone platform?) can be studied using a combination of the release data of the different extensions in the Magento ecosystem and the Magento API release notes. Our research can also be complemented by conducting a qualitative study among partners to determine

aspects such as their dependence on the platform, their perceived health of the platform, their main contributions to the ecosystem, etc. Finally, based on the results that we have obtained from the development activity of the different partnership types and our proposed implications for the Magento ecosystem, a better-fit partnership model that stimulates certain partnership types could be proposed. For instance, the partnership model could be modified in a way so as to incentive non-partners, which represent the vast majority of developers, to become certified partners, thereby improving the health of the ecosystem.

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