An Empirical Test of the Impact of Inter-Population Overlap in the Drupal Community on Its Innovativeness

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Abstract

The award-winning open source content management system (CMS) Drupal has a strong community support with a variety of populations including core developers, module developers, themers, site developers, educators, and clients. Based on the cross-functional team, network, and ecological perspectives, the impact of the inter-population overlap in the Drupal community on the innovativeness of Drupal system is explored. An empirical test also demonstrates the existence of this relationship and it is proposed that future test could be conducted by collecting more projects data from the Drupal system and its community.

Introduction

Web-based content management system (CMS) is a platform based on which web systems can be developed to enable e-commerce and e-business. As one of the top CMSs, "Drupal is an open source content management platform powering millions of websites and applications. It's built, used, and supported by an active and diverse community of people around the world" (Drupal.org). At this time of writing (December 2, 2012), based on the data from Drupal.org, there are *908799* people in *228* countries speaking *181* languages power Drupal. Among these people, there are populations such as module developers (22242 at the time of writing), themers, site developers, and educators, and etc. These populations and their members form the eco-system of the Drupal community and by checking the background of those members' profiles, it is found that some of them play multi-roles. For example, while some of them are module

developers, they may also use Drupal as the platform to develop web sites (i.e., playing the role of site developers) and write Drupal tutorials and document Drupal system design to educate the community (i.e., playing the role of educators). In the current paper, we treat these multi-role players as the overlap among different populations in the eco-system of the Drupal community and we further conceptually explore and empirically test the impact of this overlap on Drupal innovativeness by collecting and analyzing publically available on-line member profile data from a selected representative module in the Drupal system. This exploration and test works as an initial test of the overlap proposition and is the first step towards empirically testing the impact of inter-population on Drupal innovativeness.

Drupal Community and Its Populations

As already indicated above, the Drupal community consists of quite a few different populations including clients, core module developers, contributed module developers, themers, siet developers, and educators. First, owners of sites developed with the Drupal platform are the people and organizations that form the Drupal client population. The ultimate value of Drupal should be demonstrated through the value set by these clients as demonstrated in other industries. Second, core module developers are responsible for designing the overall architecture and its implementation and they form the core module developer's population. These developers have the authority to make decisions on whether a contributed module (i.e., the extended functionalities of an OS CMS) can be added to core modules and whether it can be released. These Drupal core developers are founders and people/organizations that are key to the evolution of this OS CMS. Third, developers of contributed modules are natural extensions of the core developer's population. As indicated in Shi (2010), they should have solid understandings of the overall Drupal architecture and most of the time, they are the main stream users and major

educators of Drupal system and thus, “the number, the degree of commitment, and the level of talents of these members are critical for the CMS to attract users and build its reputation”.

Fourth, themers are people and organizations who may develop configurable theme templates and use those templates to provide customized theming services as a member of a web site development team. The number, quality, and customizability of these theme templates will surely make web layout design less tedious. Thus, themers’ work may attract more site developers to use Drupal as the platform to design web systems and thus grow the Drupal community. Further, it is natural to believe that site visitors (i.e., customers of clients of Drupal) will also form their impressions of a web system based on the outlook and layout presented through a theme and thus a well-designed library of themes favored by site visitors will help grow the community. Consequently, the themer population will have positive impacts on the growth of site developer and client population.

Fifth, site developers are those people and organizations who understand how to use Drupal platform to develop customized web sites meeting clients’ needs (Shi, 2010). Sixth, documentation developers are responsible for writing technical documents detailing usage and functions of different technical components including modules, themes, and the way of extending exiting functionalities. These developers are treated as educators since their work is the foundation for existing and new site developers to learn how to use Drupal. Besides including documentation developers, educators can also be developers of Drupal tutorial materials and they teach potential and existing Drupal members about the Drupal technology and thus, help grow the Drupal community by converting potential members to actual members and ensure existing

members continue working with Drupal. These people and organizations form the Drupal educator population. In addition, educators, to a certain degree, may also perform the marketing and public relations activities as a marketing department of a company does in a commercial setting.

We believe that these populations have symbiotically interdependent relationships from the resource exchange perspective as proposed in Beard and Dess (1988). For example, with more modules developed by the developer population, the demand for themes is naturally increasing since at least there is a need to appropriately place the functions and information output from those newly developed modules in the web system in such a manner that visitors can easily recognize and access. Further, while the increasing demand for more customized functions from the client population will naturally demand more output from developer's and thermer's populations (i.e., market pull), the development of more modules and themes by developer and themer's populations may also attract more clients due to the availability of more choices and the increased level of comfort clients may feel from the increasingly powerful Drupal technological platform and capable service providers. Thus, the development of more modules and themes may very well increase the size of client population (i.e., technology push for new market creation). In addition, with more developed modules and themes, educators are challenged and motivated to develop documentation and tutorial materials to train new and existing site developers on how to use these Drupal elements. With more educating materials, potential members may actually be transformed into actual site developers, module developers, and themers and thus grow these populations, which may then help better establish the Drupal brand and increase the market share of Drupal in the CMS industry and ultimately, grow the Drupal community as a whole.

Consequently, it is safe to say that these populations are symbiotically interdependent.

Inter-population Overlaps among Drupal Populations

As already defined, inter-population overlap means that an individual or an organization involved in the Drupal community can be a member of multiple populations and thus play multi-roles. For example, a site developer (who uses Drupal to develop web sites for clients) can also be a module developer. A client itself can also be a site developer and module developer. Further, a site developer and module developer may also be an educator. This feature of overlapping among different populations is rarely seen in non-open source software communities or in other communities such as PC, healthcare, beer brewing, labor unions, newspapers, etc. The following figure provides an illustrative view of the populations and the inter-population overlap in the Drupal community.

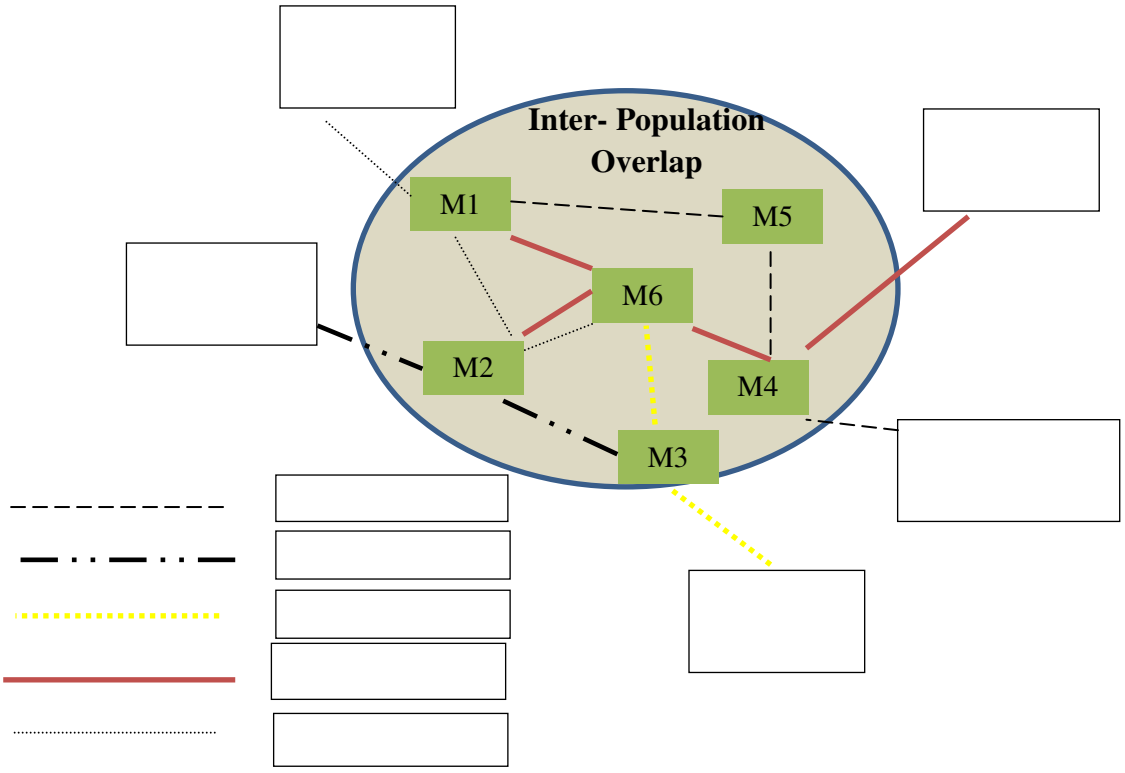

Figure 1: the Drupal Community

Roles played by the Inter-population Overlap Members: M1: educator, themer, and designer; M2: developer, educator, themer M3: developer, client; M4: themer, designer; M5: designer; M6: themer, client, designer

The focus of this study is on how the inter-population overlap may produce the mutualistic effects among different populations of the OS CMS that will help enhance the innovativeness of the Drupal system.

Theoretical Development: Impact of Inter-population Overlap on Innovativeness

Community ecological perspective: this perspective emphasizes the investigation of the birth of new and death of existing populations, the inter-dependent symbiotic or competitive relationships among different populations of a community, and the interactions among different communities (Astley, 1985). This perspective has been applied to study a variety of communities including the PC community consisting of populations such as software producers, PC manufacturers, disk driver producers, and users (Wade, 1995, 1996), the health care organization community consisting of populations such as insurance companies, hospitals, HMOs, and relevant agencies (Ruef 2000, Scott et al. 2000), the communities of craft and industrial labor unions (Hannan and Freeman, 1988), the communities of newspapers and political parties (Dovrev, 2001), and the community of financial institutions including the population of financial cops and that of banks in Singapore (Debrev, Ozdemir, and Teo, 2006).

With a focus on technological communities, first, we would like to clarify the definition of a community. Based on Wade (1995), there are two definitions of a technological community. One is based on a focal set of technological designs or standards. All the firms that have a stake in the focal set of technological standards or designs are in that technological community. The second is based on inter-firm relationships, which center on a sponsor that may have multiple sets of technological standards and designs (such as HP with both server and printer technological designs) and the related community includes all related firms such as suppliers, partners,

customers, etc. The difference between these two definitions is that the first focuses on only one set of related standards and those firms supporting that focal set of standards and the second focuses on the inter-firm relationships around a sponsor which may have multiple sets of standards and designs that are supported by a variety of parties. However, when the sponsor has only one set of related technological standards or designs, then the communities defined based on the above two definitions are converged into the same one without difference. In our case, the Drupal community has only one set of web-based content management technological standards and its major sponsor is the firm named Acquia (http://www.acquia.com/), which is established by the founder of Drupal and his close partners. Acquia has this only set of technological designs and standards that is supported by a variety of populations including site developers, core module developers, contributed module developers, themers, clients, educators, etc.

Second, one feature of these populations in the open source Drupal community that is different from communities in many other industries such as PC community and healthcare community is that these populations may have a significant amount of overlap. As indicated earlier, module developers can also be site developers and clients themselves. This overlap helps establish strong interactive relationships among different populations, facilitating information and creative ideas exchange and knowledge creation. One interesting research question is how this overlap among populations can enhance the innovativeness of the Drupal system. Indeed, we have found that while it is rarely seen in IS research, the community ecological perspective has been applied in the study of how the overlap among different work groups and populations influences the Internet standards development process. Nickerson and zur Muehlen (2006) investigated how standard ideas and relevant people move among different work groups within the same and

across different standards institutions such as IETF, OASIS, and W3C with each institution representing one population of work groups and several institutions forming a community of populations of work groups. Their study found that the ecological perspective applies well to explain the lengthy process of Internet standard making and one issue related to our research focus on the effects of the inter-population overlap is that as members of the Internet standard making community move between work groups within the same population or across different populations, these members carry standard ideas and insightful discussions from one work group to another, from one population to another population, and these activities may very well foster synergistic effects in terms of facilitating the development of the most appropriate Internet standards meeting both the short term efficiency goal and the long term effectiveness goal of incorporating technological, economic, and political considerations into those standards throughout Internet's continuous growth and expansion. In this paper, with a similar idea based on this ecological perspective, we propose that the overlap among different populations in the Drupal community will also transform the Drupal development into a more efficient and effective process facilitating development of more innovative Drupal platform.

Cross-functional team perspective: Sethi, Smith, and Park's (2001) study on how the characteristics of cross-functional teams can influence the innovativeness of product design provides a theoretical foundation based on which we can argue that inter-population overlap may improve the innovativeness of the Drupal platform. The Drupal community may be loosely treated as an organization and different populations within the community can thus be regarded as different departments within this organization. Since members of inter-population overlap in this community are simultaneously working in different populations as we defined, these

members together may be regarded as forming a virtual cross-functional team representing different functional perspectives (e.g., site developers', themers', developers', and clients' views) in designing the Drupal platform.

With this kind of virtual cross-functional team, there are two benefits. First, diverse views and perspectives will be more easily absorbed during the Dupal platform development process due to the fact that these overlap members themselves are involved in different functional activities and have links/exchange relationships with other members in individual functions. And second, due to the multi-perspectives each member in the virtual cross-functional team brings to the team, he/she will be less likely hold deeply rooted biases and stereotypes toward members from other functions (populations). This fact will enable the establishment of a superordinate identity within the virtual cross-functional team. Both of the above two benefits positively relates to product innovativeness. Indeed, Pinto, Pinto, and Prescott (1993) empirically identified the positive impact of superordinate goals on cross-functional cooperation and perceived task performance. Further, in Sethi, Smith, and Park's (2001) research, they also found positive impact of customer influence on product innovativeness. In the case of Drupal community, if there are many overlapping members between client population and other populations. Then these members are playing two or more roles simultaneously which will certainly enhance this positive relationship by reducing communication costs and the efforts needed to integrate customers' input, and consequently, increase the effectiveness of the cross-functional team for product innovativeness.

Social network/capital perspective: Reagans, Zuckerman, and McEvily (2004) published a very relevant paper on how internal network density and external network range can positively impact

team performance. Again, if we treat those overlap members in the Drupal community as a virtual team, then they will play a very important role of increasing both the internal network density and external network range simultaneously. First, internal density means the degree to which members of the team share same/similar working experience, knowledge background, and working habits and etc. If internal density is high, it will facilitate mutual identification among members and promote a degree of trust supporting social exchange and coordinated actions and result in more innovative Drupal platform design.

Second, while members in a virtual team share a certain role such as the site developer role and thus they may more easily identify with each other for trust relationship establishment, they also play other different roles, generating links to members with different information, resources, and perspectives, which enhance the team's learning effectiveness and creative problem solving capacity. For example, one member plays the site developer and client roles and the other plays the site developer and module developer roles. By linking to other clients and module developers, these two members, as site developers, not only identify with each other; but, as a module developer and a client, they also bring the client's perspective and module developer's perspective into their professional discussions and thus they may have enhanced learning and improved creative capacity. As a result, the team could generate more innovative solutions to enhance the overall Drupal platform functionality, user experience, reliability, and scalability.

In summary, based on the above presented ecological, cross-functional team, and network perspectives, we hypothesize that the overlap among Drupal community populations will enhance the innovativeness of the Drupal system. The next section is about data collection and empirical test of this hypothesis.

Research Method

Data Collection

Views module (http://drupal.org/project/views) is selected for the test of the inter-population overlap hypothesis. The key functions of this module include 1) facilitating the development of SQL queries to retrieve data from tables in the Dupal database and 2) displaying the retrieved data in a required format such as a list, a table, or a slideshow, etc. The data include texts, pictures, audios, and videos and these data can be the results from multi tables. At this time of writing (October 8, 2012), views module has been installed on **518537** sites and downloaded 2,606,167 times. It is the most installed module among 11194 full projects. There are 143 module developers who contributed to the design and constant improvement of this module by the date we complete data collection. The profile data of these members are publically available on line at www.drupal.org. The following table list questions members may respond in their profile page.

Table 1: Profile Questions on Drupal.org

1. I contributed Drupal patches
2. I contributed Drupal modules
3. I contributed Drupal themes
4. I contributed Drupal installation profiles
5. I contributed to Drupal issue queues
6. I contributed Drupal documentation
7. I contributed Drupal translations
8. I contributed Drupal automated tests
9. I reviewed Project applications
10. I help in the Drupal support forums
11. I provide Drupal-related services
12. I give support on IRC
13. I help mentor new contributors
14. Conferences attended

Information such as name, gender, country of citizenship, and other bio information can also be provided on the member profile page.

Measurement Design:

Inter-population Overlap: To measure the degree of inter-population overlap among members who are involved in developing views module. We follow four steps. First, we calculated the module development involvement score of each individual member. Module development involvement is reflected on whether the member is involved in patch contribution to existing modules, new module development, issue queue contribution, project translation, project application review, participation of module test, and development of installation profiles. If one member is involved in one of these activities, he/she will have one point for module development involvement. The overall formula used to calculate individual module development involvement score is *sum of involvement in the above 7 activities / 7*10.* Second, we derived the Individual Theme Design Involvement score *by* checking one question in the profile page. The formula used is *Theme design involvement*10.* Theme design involvement will be 1 if she/he is indeed involved with theme development.

Third, *Individual Education Involvement score* is calculated by checking whether the member participates forum discussions and IRC communications, whether he/she mentors new members and the extent of conference participation (i.e., the number of conference attended / the number of conferences available by the sampling time) and documentation contribution (i.e., individual commits /(maximal commits among all the members for the Views module). The final formula used is *sum of involvement of the above 5 activities / 5 *10.* Fourth, the individual inter-population overlap score is calculated by following the following formula: *The individual*

*overlap score= Module development involvement*Theme development involvement + Module development*Education involvement + Theme development involvement *Education involvement.*

Innovativeness: We measure this construct through dividing the total commits by an individual member by the number of weeks since the individual registered with the Drupal community site. Commits represent the bug fixes and new feature implementations and they represent innovations. The intensity of innovations represents innovativeness. This intensity can be calculated using our formula described earlier.

Data Analysis

Out of 143 members who are involved in developing views module, male members are dominant and occupies 117/143=81.81%. In terms of country involved, US (27.97%), Germany (9.79%), Canada (5.59%), UK (5.59%), Belgium (4.20%), Spain (4.20%) and other European members are the major participating countries. Only US (5) and Canada (1) have female members and each country has 13% of female members. The following table presents more detailed demographic data.

Country	Male	Trans-gender	Not Specified	Total	Male Percentage	Country Percentage
US	30	2	3	40	75%	27.97%
Germany	14	0	0	14	100%	9.79%
Canada	4	0	3	8	50%	5.59%
UK	8	0	0	8	100%	5.59%
Belgium	6	0	0	6	100%	4.20%
Spain	5	0	1	6	83%	4.20%
France	5	0	0	5	100%	3.50%
Hungary	5	0	0	5	100%	3.50%
Netherlands	3	0	2	5	60%	3.50%
Argentina	4	0	0	4	100%	2.80%
Italy	4	0	0	4	100%	2.80%
Russian Federation	3	0	0	3	100%	2.10%

South Africa	2	0	1	3	67%	2.10%
Sweden	2	0	1	3	67%	2.10%
Ukraine	3	0	0	3	100%	2.10%
Not Specified	1	0	2	3	33%	2.10%
Austria	2	0	0	2	100%	1.40%
Denmark	1	0	1	2	50%	1.40%
Romania	2	0	0	2	100%	1.40%
Serbia	2	0	0	2	100%	1.40%
Slovakia	1	0	1	2	50%	1.40%
Slovenia	1	0	1	2	50%	1.40%
Brazil	1	0	0	1	100%	0.70%
Greece	0	0	1	1	0%	0.70%
HK	0	0	1	1	0%	0.70%
Japan	1	0	0	1	100%	0.70%
Kazakhstan	1	0	0	1	100%	0.70%
Mexico	1	0	0	1	100%	0.70%
Peru	1	0	0	1	100%	0.70%
Poland	1	0	0	1	100%	0.70%
Portugal	1	0	0	1	100%	0.70%
Switzerland	1	0	0	1	100%	0.70%
Thailand	1	0	0	1	100%	0.70%
Total	**117**	**2**	**18**	**143**	**82%**	**100%**

In addition, 60 out of 143 members (42%) who contributed to the views module are Drupal association members and 29 out of 143 these members (20.3%) contributed to theme development. The average amount of time since registration is 264 weeks with a standard deviation of 119.7 weeks. The following two tables present statistics about percentages of members who are involved in various module development and education activities.

Table 3: Module Development Activities and Member Involvement

Module development activities	**patches**	**modules**	**Issue Queue**	**translation**	**reviewed project applications**	**automated test**	**Installation Profiles**
Total members	129	108	78	51	24	46	17
Percentage (out of 143)	90.2%	75.5%	54.5%	35.7%	16.8%	32.2%	11.9%

Table 4: Education Activities and Member Involvement

Education Activities	forum	documentation commits	IRC	mentor new contributors	Conferences
Total members	55	97	67	18	96
Percentage (out of 143)	38.5%	67.8%	46.9%	12.6%	67.1%
Average		56.6(157.8)			4.4 (3.4)

From table 4, we can see that the average of number of conferences attended by the 96 members is 4.4 conferences with standard deviation of 3.4 and the average number of documentation commits for those 97 members is 56.6 commits with standard deviation of 157.8. The following table 5 presents the innovativeness for members involved in the Views module. The average number of commits to Views module is 49.5 and the average total commits is 671.1 and the average number of projects covered by these members is 31. One observation is that all the standard deviations are bigger than the average and it demonstrates the contributions from members are quite different and some of these members can be called heavy weight contributors while others may be called light weight contributors.

Table 5: Innovativeness by Individual Members

Individual Contributors	Commits to Views Module	Total Commits	Projects Covered
Average	49.5	671.1	31.0
SD	336.1	1242.6	52.4

Model Testing

Regression analysis used to test the impact of inter-population on the member innovativeness. The variable of projects covered is used as the control variable in the regression model. This is because with more coverage of projects, one member will have a larger problem space for innovations so that he/she may have more commits than those who do not cover as many projects. Thus, to separate this effect from that of inter-population overlap, this variable is used in the regression model as a control variable.

Table 6 presents the R and R Square values and the R-square is 0.396 demonstrates that the model explains a significant amount of variance in the innovativeness variable by using overlap and project covered as independent variables. Table 7 shows the coefficients and demonstrates that inter-population overlap indeed significantly and positively impact individual innovativeness. Further, based on tolerance and VIF, no independent variable can explain a significant amount of the variance of the other independent variable and this is no collinearity (Hair, etc., 1995, page 127).

Table 6: Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.629[a]	.396	.387	133.455

Table 7: Coefficients and Collinearity Tests

Model	Standardized Coefficients	t-value	Sig	Tolerance	VIF
(Constant)		1.634	.105		
Projects_covered	.528	7.477	.000	.864	1.157
Overlap Score	.199	2.814	.006	.864	1.157

Regression analysis is also implemented by giving more weight to documentation commits when calculating education involvement score. This is because with good and complete documentation, it is believed that more people may benefit from the educational effects of documentation. Table 8 and 9 present model fit indices and coefficients and collinearity statistics. Model fit is enhanced and the contribution of inter-population on innovativeness also becomes more significant (p-value is 0.003 rather than 0.006). Again, no collinearity is found basedon variance and VIF values.

Table 8: Model Summary (Documentation Commits Given More Weight)

R	R Square	Adjusted R Square	Std. Error of the Estimate
.634	.402	.393	132.793

Table 9: Coefficients and Collinearity Tests (Documentation Commits Given More Weight)

Model	Standardized Coefficients	t-value	Sig	Tolerance	VIF
(Constant)		1.574	.118		
Projects_covered	.524	7.473	.000	.869	1.150
Overlap_with two_times_weight on documentation_commits	.215	3.065	.003	.869	1.150

Discussions and Conclusion

The empirical test supports our hypothesis that inter-population overlap enhances individual innovativeness. This evidence reinforces theoretical perspectives such as ecological perspective, cross-function team theory, and network perspective using open source system community as the data source. As software is becoming more complicated in terms of technology advancement and business process complexity, a well-organized software development virtual team is becoming increasingly necessary. This paper will help managers be more aware of this need. Future

research could collect more individual profile data from multiple projects in the Drupal system and re-test this hypothesis. Further, research can also be conducted at the project level instead of the individual level in this paper to identify project specific factors for innovativeness.

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