The Digital Platform Otto.de: A Case Study of Growth, Complexity, and Generativity

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Abstract. We analyze the growth, complexity, and generativity of the digital platform Otto.de, a revelatory case of a large German company that has opened up its internal IT platform to outside developers. We find indication for a superlinear growth pattern fueled by external developers and the introduction of microservices as well as the emergence of a structural separation within the platform. Furthermore, our research shows ways to explain the generativity of a digital platform based on the attention and activity received.

Keywords: Digital platform, generativity, complexity, platform evolution

1 Introduction, Related Work, and Purpose

The literature on digital platforms has noted important issues of architectural design determining their long-term "evolvability" and success [1–3]. In this paper, we draw on important contributions which highlight the *modularity* and *generativity* of digital platforms. Modularity conceptualizes digital platforms as being composed of a set of more or less independent modules, which are connected via well-defined interfaces to ensure the platform's core functionalities [1]. This gives rise to combinatorial innovation since peripheral modules can be changed without altering the platform's core [4]. *Generativity* in turn allows for new functions and services to be created on top of the platform. It describes a platform's ability to generate new outputs, structures, or behaviors beyond the creators' original intentions [3, 5, 6] and as such is an important impetus and mechanism of innovation. Together, modularity and generativity facilitate further development opportunities and platform evolution.

However, while previous contributions (such as [1–3, 6]) have expanded our understanding on platform evolution, we currently lack a detailed understanding of platform evolution and generativity especially in the context of companies which transform their internal operations and IT platforms into a platform model.

The purpose of this paper is to give insight into the *growth, complexity, and generativity of the digital platform Otto.de*. In doing so, we give a detailed architectural overview of the platform's main characteristics and development since its inception in 2012. This is interesting since in the course of digital transformation many companies

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embark on a journey of opening up their internal IT platforms to outside contributors, but there are few examples of companies that have successfully transformed a legacy business model into a fully digitally one, as from catalogue shipping to e-commerce. For Otto, the platform today handles more than 90% of the company's order volume (€2.7 billion; 2 million site visits per day; up to ten orders per second) and is vital for its transformation. Moreover, the platform is interesting because it evolved fully from a single business unit's initiative toward the company's main revenue/value creator. Furthermore, it is one of Germany's largest agile development projects in a traditional enterprise—allowing insight into scaling agile in the large. The initiative started with a team of 100 staff members and has, since then, grown to its current size of 250 employees. These are organized in interdisciplinary development teams across functional areas (search, navigation, product presentation, etc.), as detailed in [7]. Finally, it is noteworthy from an architectural point of view since the platform was restructured using a microservice approach over the past years.

2 Methodological Approach and Conceptual Framework

We employ a case study approach [8]. Our data is the GitHub repository of the platform Otto.de[1]. In this paper, we do not focus on the "multi-sidedness" of the platform towards professional sellers, which had just begun in 2017. Yet, the interesting aspect here is that the platform had been "opened up" to external developers, which moves it away from an internal IT platform to a model where combinatorial innovation becomes possible through the contributions of external developers writing code which is integrated into the platform on the level of particular modules (i.e., repositories). We extracted the entire public repository via a Python script; this covers panel data tracing back from the platform's external opening in 2012 until June 2018 (6.5 years). This "digital trace data" [9] was preprocessed and resulted in a detailed overview of the platform's 59 repositories, 351 Contributors, and 8,733 Commits. Several conversations with leading managers and developers of the platform business unit confirmed the representativeness of the data for the project's development in general. For analyzing platform growth, we used the *cumulated sum of the size* (in KB) as a function of *time* (in month), as well as time series analysis drawing on phase average and linear regression methods. For analyzing complexity, we firstly extracted the bipartite relations between repositories and developers and secondly collapsed this into a one-mode network of inter-repository relations via joint developers. Gephi, an open source network analysis tool, was used for visual analysis and metrics calculation. To analyze generativity, we conceptualized *generativity* in terms of the *number of forks* of a repository. The number of forks captures the number of times external projects / developers re-use a repository for their own project or purpose. It thus illustrates the ability to generate new "output" [5] from a particular input (repository) beyond the intention of the original creators. Correlation analysis was used where we posit that *attention on* the repository (measured in terms of the *number of watchers*) and *activity* on the repository (measured in terms of number of open issues) are associated with generativity. Furthermore, we posit that *generativity* is associated with *popularity* of a

[1] https://github.com/otto-de

repository (measured in terms of number of stars). If a repository perceives a high level of attention and activity this may act as a signal for developers to further increase their own activity here, thereby contributing to its overall generativity and popularity [10].

3 Findings

Results of the growth analysis in Fig. 1A point to a stepwise growth; the sharp increase since 2015 indicates a superlinear pattern. This would correspond to the examples of open source software development presented in the work of Scacchi [11]. A conclusion can be drawn from the shape of the growth curve and the trend figure: the activity of the actors is linked to the creation of new repositories. No repositories were created in 2014 and commits stagnated. In 2015, however, 28 repositories were newly created and the activity increased. The pause in 2014 can be explained by the planning and development of concepts for future development. Regression and phase average analysis pointed to further seasonality effects reaching their lowest point in the summer months.

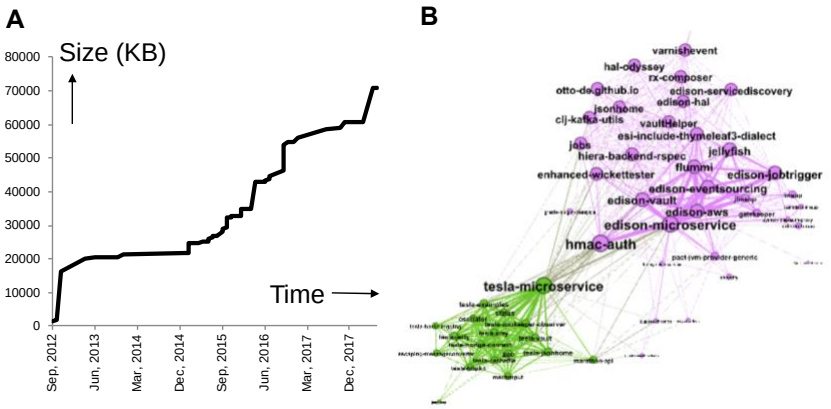

Figure 1. Growth of size in time (a) and network (b) of Otto.de repositories

Complexity analysis pointed to the emergence of two different clusters (see Fig. 1B), which were demarcated by two main hubs (i.e., Tesla and Edison Microservice). This is in consonance with the findings of Singh et al. [12] and Um et al. [13] that the development of a network has a basic structural pattern. The distributed architecture of the digital platform allows the individual "building blocks" to be developed separately. Platform microservices (e.g., Tesla and Edison) are written in different programming languages and controlled by different teams, but adhere to standards on RESTful APIs in order to ease the process of transferring data. The relationship mapping also allows conclusions about the generativity and the knowledge exchange in such externally-infused projects, suggesting that more than 100 third-party developers participated.

Further analyses regarding *generativity* using Spearman's Correlation Coefficient suggested robust to strong associations between *attention* (watchers) and *generativity* ($r(57)=.29$, $p<0.05$), *activity* (open issues) and *generativity* ($r(57)=.35$, $p<0.01$), as well as *generativity* and *popularity* (stars) ($r(57)= .68$, $p<0.001$). Further research aims at

developing a multivariate model for *explaining* generativity including controls such as age or quality of a repository. Moreover, it would be interesting to link generativity to user base-related popularity measures such as platform usage or user satisfaction.

4 Concluding Remarks

The study has preliminary implications for academics interested in platform evolution and companies wishing to open their internal IT platforms. First, modularitization of the platform enables superlinear growth, but also creates the possibility that structural patterns and separations emerge which are reinforced over time. Second, retaining outside contributions from external developers over longer time periods seems possible, but we need a greater understanding of the mechanisms of disembedding platforms from local contexts and developer participation in mixed corporate-volunteer contexts. Further research should thus investigate in more detail how the e-commerce company and others collaborate online and offline with different developer and stakeholder groups working on different components of a digital platform.

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