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# Motivational Drivers to Develop Apps for Social Software-Platforms: The Example of Facebook

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## ABSTRACT

Online social networks like Facebook or MySpace have enjoyed a formidable success in recent times which is partly due to the provision of software-platforms for the development of social applications through third-party complementors. Consequently, the study of aspects on the role and motivations of these complementors becomes increasingly important. Our empirical study contributes by revealing how the different motivations of social application developers are interrelated and how these motivations influence application developers' effort intensity on the platform. Drawing on established motivation theories, we develop a theoretical model and test it using empirical data from Facebook application developers. PLS-based structural equation modeling demonstrated that "external rewards" and "status and job opportunity" motives were the dominating motivational drivers. Moreover, we found that external rewards undermine intrinsic motivation, while internalized motives strengthen it. Based on our findings, we discuss practical implications regarding incentive schemes and theoretical implications as starting point for further research.

## Keywords

Software-platforms, Facebook applications, complementors, motivations, crowding-effects.

## INTRODUCTION

In recent years, online social networks (OSN) have enjoyed a formidable success. Facebook, for example, now ranges within the top 5 internet properties worldwide regarding unique visitors (comScore 2009). In order to take the next step and enhance their business models, the providers of OSN try to follow the example of traditional software providers (such as Microsoft) by establishing software-platforms for complementary applications (Cusumano and Gawer 2002).

In the beginning of 2007, Facebook, for instance, has opened its platform and enabled external developers "[...] to write and distribute applications that are based on the platform's API and its technical infrastructure. As a consequence, third-party applications can easily be installed individually by users and integrated seamlessly into their user accounts on the platform" (Ermecke, Mayrhofer and Wagner 2009, p. 3). In the case of Facebook, the usage of the API and the provision of applications in the application directory are at no charge for developers. Moreover, Facebook actively provides support to the developer community in terms of comprehensive tutorials and an editorially approved wiki (Facebook.com 2009b).

This open development environment led to low entry barriers for developers of complementary applications and promoted a strong growth in terms of registered developers and available applications (Facebook.com 2009a). Unlike in conventional software development environments, in which developers have to take care of their programming environment, the required infrastructure, and the distribution themselves, developers of applications in social software-platforms face no or only little upfront costs to develop and publish complementary applications. Compared to conventional and open source development, the associated development process is rather lean, because, due to the smaller functional range of social applications, a distribution of development efforts is not necessary. Hence, developers are able to produce social applications by themselves and outside professional organizations as well.

As a result of the simplified development process in social software-platforms, it can be supposed that the composition of complementors is more heterogeneous compared to conventional software development environments. We assume that, in addition to professional software developers with merely commercial interests, a considerable fraction of interested amateurs possibly led by personal and more self-determined motivations is involved. Hence, uncovering the developers' motivational structure entails a high degree of practical relevance, because it would allow complementors to consciously position themselves against their competitors, while it could help operators to address complementors' motives in a more specific way to further increase the overall success of the OSN.

Because our research objective aims at the optimization of platform participants' relationships, our contribution is related to the emerging literature on platform strategies (Cusumano and Gawer 2002). However, the existing contributions of this literature have focused on a solely organizational perspective and neglected personal and social aspects of developers so far. In contrast, the question of software developers' individual motivations is already intensively discussed in a related strand of literature, namely the research on Open Source Software (OSS). Therefore, the existing findings of this literature will form a helpful basis of our investigation. Even though OSS development is comparable to developing applications for social software platforms, the existing findings do not cover the requirements and particularities of social software platforms, as they neglect the special characteristics of the development process within social software platforms (see the subsequent section for details).

This research gap motivated us to address the following research questions: (1) what are the relevant motivational drivers of Facebook application developers? (2) How are these motivational drivers interrelated?

For this purpose, our paper is structured as follows. In section 2, we review the literature on platform strategies and motivational structures in software development. The theoretical model and our research hypotheses are presented in section 3, followed by our research methodology, analysis, and empirical results. The paper concludes with a discussion of findings and limitations.

## LITERATURE REVIEW

In recent years, a broad body of literature on practical and theoretical aspects of platform-strategies has emerged. Evans, Hagi and Schmalensee (2006) define software-platforms as systems “[...] that make services available to other software programs through Application Programming Interfaces (APIs)” (p. vii). Such software-platforms are inherently multi-sided because they serve at least two distinct groups (usually developers and users) that each benefit from an increased participation of the opposite group (Evans et al. 2006). Social software-platforms as a special form of platforms feature several distinctive characteristics in terms of its complementary applications and the associated development process (O'Reilly 2005). Here, applications have a smaller functional range and are less complex than traditional software components (W3C 2009), which reduces the need of distributing development efforts. Furthermore, the platform commonly provides an appropriate infrastructure like a well documented API or in some cases even the hosting environment already. Hence, social software-platforms are more likely to enable individual developers outside professional environments to participate as well.

As mentioned above, the question of developers' motives and the resulting implications should provide insights on how to strategically optimize the relationship between the platform participants (e.g. by incentive schemes). Hence, our research objective is related to the emerging body of knowledge on platform strategies (Cusumano and Gawer 2002). However, regarding the introduced aspects of developers' individual motivations, this literature has neglected important aspects so far: As developing successful strategies for achieving and retaining platform-leadership under various circumstances is at the core of the platform strategies literature (Cusumano and Gawer 2002; Gawer and Cusumano 2007; Rochet and Tirole 2003), the majority of this literature emphasizes the perspective of platform-operators; research explicitly focusing on aspects of the complementors' perspectives is, in contrast, rare (Economides and Salop 1992; Yoffie and Kwak 2006). Furthermore, to our knowledge, research on software-platforms has so far neglected to analyze social and psychological phenomena on the individual level. However, because social software platforms make it easy especially for amateurs to participate as developers, as well, a consideration of the personal and social perspective seems to be an important aspect.

Hence, in this study, we draw on findings from other areas of IS-research to analyze the motivational structure of social application developers. Besides more general aspects of motivation in software engineering (see Beecham, Baddoo, Hall, Robinson and Sharp 2008 for a review), especially the literature on motivation of open source software (OSS) developers provides helpful insights. Based on established motivation theories in psychology (i.e. self determination theory, Deci 1976), IS researchers have identified a set of individual motivations ranging from purely intrinsic to internalized and extrinsic motives as explanatory factors of the actions taken by developers in OSS projects (Hars and Qu 2002; Ke and Zhang 2009;

Lakhani and Wolf 2005). Recent contributions extend these findings by additionally taking inter-motive correlations, also known as crowding effects, into account (Roberts, Hann and Slaughter 2006).

Although the introduced research fields will provide a helpful basis for our investigation, a direct approach to address our research questions could not be found. The reviewed literature either has neglected aspects of individual motivation or does not meet the particularities of the development process in social software-platforms. Over the course of this paper, we hence address this research gap by empirically revealing the motivational structure of Facebook application developers and its influence on the individual effort intensity for developers working on the social software-platform Facebook. In doing so, we contribute to the literature on software-platforms by investigating developers' motivations to develop apps on an individual level.

## HYPOTHESES AND THEORETICAL MODEL

### Theoretical Background

For the development of our theoretical model on the motivational structure of Facebook application developers we draw on established theories from psychology. Locke, Latham and Smith (1990) define motivation as "internal factors that impel action and external factors that can act as inducements to action" (Locke et al. 1990). This definition implies that motivation can only be analyzed in the context of a certain action which is to be implied or induced by the individual motivation. In this regard, it is to be noted that motivation is generally not translated into participation outcomes directly but it can translate into outcomes by means of effort expended on the task (Locke 1968). Consequently, the individual motivation should determine effort intensity, which is defined as the amount of resources expended on a given task (Kanfer 1990).

Motivation is not a unitary concept. According to the self determination theory (SDT) motivational drivers are generally subdivided into extrinsic and intrinsic motivation (Deci and Ryan 1985). *Extrinsic motivation* refers to performing a certain action because it leads to an accordant outcome. On the contrary, *intrinsic motivation* is defined as doing something because it is inherently interesting or fun. The supplemental organismic integration theory (OIT) further differentiates extrinsic motivation by introducing the concept of internalization (Deci and Ryan 2000). In contrast to *external rewards* as a form of "pure" extrinsic motivation, internalized extrinsic motives are transformed into personally endorsed values in particular by means of introjection or identification. Under the influence of *introjection*, one performs an action in order to enhance her/his ego and feelings of worth. In comparison, *identification* is a more self-determined form of extrinsic motivation. It implies that individuals identify with an action and personally support it (Ryan and Deci 2000). Altogether, we derive extrinsic motivation, subdivided into external rewards, introjection and identification, and intrinsic motivation as our motivational spectrum.

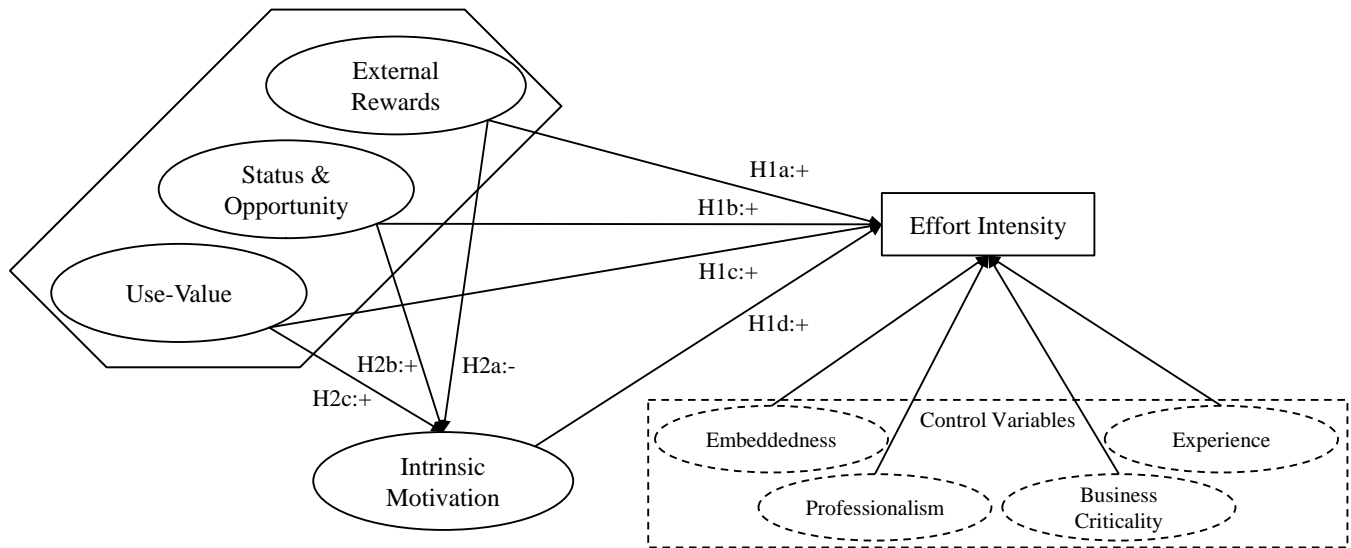
Beyond different types of motivation, inter-motive correlations are intensively discussed in literature stemming from psychology and economics (Bem 1967; Frey and Jegen 2001; Titmuss 1971). According to the crowding theory (also referred to as overjustification effect), external interventions can affect intrinsic motivation. While most contributions on inter-motive correlations agree in the existence of such correlations, the question about whether the effect of external interventions on intrinsic motivation is strengthening or undermining is a matter of controversial scientific discussion (Deci, Koestner and Ryan 1999). On the one hand, the classic economic view implies that rewards and incentives should increase the motivation and accordingly the outcome (crowding in); on the other hand, external rewards may also lead to a perceived impaired self-determination and hence undermine intrinsic motivation (crowding out)<sup>1</sup>. According to Frey and Jegen (2001), the determining factor of whether crowding-in or crowding-out occurs is the perception of the external intervention: external interventions perceived as controlling lead to crowding-out; interventions perceived as supportive strengthen intrinsic motivation (crowding-in). Accordingly, we argue that external rewards as a form of controlling intervention will undermine intrinsic motivation, while introjection and identification as more self-determined forms of extrinsic motivation are more likely to be perceived as supportive and hence strengthen intrinsic motivation.

### Hypotheses Development

We deduce our research hypotheses and the resulting theoretical model on the theoretical basis introduced above. In doing so, the development of our hypotheses and motivational factors follows existing findings and established argumentations (Ke and Zhang 2009; Roberts et al. 2006). The overall resulting theoretical model is illustrated in Figure 1.

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<sup>1</sup> The term crowding out was introduced by Titmuss (1971) who found that paying money for blood donations crowded out the supply of blood donors.



**Figure 1. Theoretical model (leaned on Roberts et al. 2006 and Ke and Zhang 2009).**

According to operant conditioning theory, an individual's behavior is more likely to be repeated in the future if it has been positively reinforced (Skinner 1953). Taking monetary rewards as the most common form of positive reinforcement, a salaried employee developing applications as part of her/his job would be an example of a Facebook developer being motivated by external rewards. Hence, we define external rewards as our first motivational construct and, according to the argumentation presented above, we hypothesize that being paid and experiencing external rewards promotes the effort intensity of application developers.

*Hypothesis H1a: External rewards promote developers' effort intensity.*

Introjection refers to performing an action in order to enhance one's ego and feelings of worth. Transferred to the context of Facebook application development, developers might strive to increase their status within the developers' community. Furthermore and in consistency with signaling theory, developers might also develop applications in order to present their specific skills and signal this to future employers (Spence 1976). Altogether, we define status and opportunity motives as second influential factor of the individual effort intensity. Accordingly we derive:

*Hypothesis H1b: Status and opportunity motivation promotes developers' effort intensity.*

Identification implies that individuals identify with an action and so personally support it. In software development, this is especially the case, if developers want to add a feature that is personally needed or solve a problem of immediate personal importance (Lerner and Tirole 2002). In terms of Facebook, the satisfaction of a specific need could for example be to add a feature that allows Facebook users to directly interact with a third-party service. Hence, the motivation of increasing the personal use-value provides our third motivational construct.

*Hypothesis H1c: Use-value motivation promotes developers' effort intensity.*

Intrinsically motivated behavior is characterized by performing an activity for the enjoyment it entails regardless of the outcome. Having fun while performing an activity is at the core of intrinsic motivation (Deci and Ryan 1985). In this regard, an important factor is that developers can choose their own difficulty level. Tasks below one's personal skill level will be perceived as boring; tasks beyond one's personal skills create feelings of anxiety. A crucial factor within the realm of intrinsic and enjoyment-based motivations is creativity: developers acting with a sense of creativity focus more on the task, are more willing to take risks and will more likely explore alternative strategies for performing the task (Amabile, Hennessey and Grossman 1986). Hence, we assume that intrinsic motivation will promote developers' effort intensity.

*Hypothesis H1d: Intrinsic motivation promotes developers' effort intensity.*

In addition to the promoting effect of motivational factors on the developers' effort intensity, we include inter-motive correlations into our theoretical model. According to the motivation crowding theory, extrinsic motives may strengthen or, depending on the individual perception of the external intervention, undermine intrinsic motivation (Frey and Jegen 2001). Transferred to our given context of Facebook application development, we assume that any kind of salary or other compensation will be linked to a job description that limits the developers' task autonomy. Because the according limitation

of self-determination will most likely be perceived as controlling, we expect external rewards to undermine Facebook application developers' intrinsic motivation. Accordingly, for our hypotheses H2a we derive:

Hypotheses H2a: *External rewards undermine developers' intrinsic motivation.*

The question whether internalized as well undermine or rather strengthen intrinsic motivation is more debatable. On the one hand, Deci et al. (1999) found that crowding-out is not limited to external regulation but applies to the undermining effect of internalized motives (including introjection and identification) on intrinsic motivation as well. In the context of developers this seems justifiable, because the necessity to produce applications that either have to include the desired features (use-value) or that are especially suitable to signal individual qualifications to the developers' community or possible future employees (status and opportunity) will limit the task autonomy in a possibly controlling manner. On the other hand, internalized extrinsic motives are already characterized as a form of more self-determined motivation which is commonly not perceived as external intervention (Ryan and Deci 2000). In the context of application developers, we therefore assume that the goals of increasing one's status or implementing personally needed features are not perceived as explicit external interventions. Accordingly, the described limitation of task autonomy resulting from internalized motives will most likely not impair the developers' self-determination and undermine intrinsic motivation. On the contrary, we expect that status and opportunity motives as well as use-value motives are perceived as supportive and therefore strengthen intrinsic motivation. Hence, we derive:

Hypotheses H2b: *Status and opportunity motives strengthen developers' intrinsic motivation.*

Hypotheses H2c: *Use-value motives strengthen developers' intrinsic motivation.*

In consistency with comparable studies on individual motivation in OSS-development, we control for other effects influencing the effort intensity, as well (Ke and Zhang 2009). In our model these control variables include task specific experience, the developers' organizational background in terms of embeddedness into a team and professionalism and the degree of how business critical the development of Facebook applications is for the respective developer or her/his company.

## **METHOD**

### **Data Collection Procedure and Sample**

To test our hypotheses, we conducted a web-based survey among Facebook developers in the summer of 2009 (Fielding, Lee and Blank 2008). Consistent with our theoretical model, our survey items were assembled on the basis of previous empirical work on developers' motivation in digital environments and especially in the field of OSS research (Hars and Qu 2002; Ke and Zhang 2009; Roberts et al. 2006). After a pretest among 15 researchers and application developers associated with our institute, a few minor changes were made to improve the comprehension for the given context. For reasons of convenience, a random sample of 4014 developers listed in the Facebook application directory was contacted and invited to the online survey (via the "contact developer" function). After dropping incomplete and inconsistent datasets, a total of 268 responses remained for the analysis. By using a method suggested by Armstrong and Overton (1977), we found no indication for a nonresponse bias, since a chi-square comparison of the first and last 25 percent of the respondents showed no significant difference.

### **Operationalization of Constructs**

The motivational constructs were measured using standardized five-point Likert scales, with the exception of the first item, which requested a binary answer. The specific motivation items are based on questions used in prior studies with minor adaptations to fit the context of Facebook application development (see Table 1).

Constructs	Indicators	Adapted from
External Rewards (reflective)	Do you receive any kind of direct or indirect compensation for developing Facebook applications? ("yes" / "no")	Roberts et al. 2006
	I develop applications because it is part of my job.	
	I develop applications because it is well paid especially compared to other programming jobs.	
Status and Opportunity (reflective)	Developing Facebook applications gives me the chance to attain a recognized qualification or skill.	Roberts et al. 2006
	Developing Facebook applications increases my opportunities for a better job.	
	I like to compete with other application developers.	
	Being a Facebook applications developer gives me status at work.	
Use-Value (reflective)	I create applications because they satisfy other users' needs.	Roberts et al. 2006
	The application I developed adds a feature that I and/or friends of mine needed.	
	I develop applications because I have not found Facebook applications that satisfy my specific needs.	
Intrinsic Motivation (reflective)	I really enjoy developing Facebook applications. It is fun.	Roberts et al. 2006
	I like to invent something new by creating a Facebook application.	
	I like developing Facebook applications because I enjoy doing things I am good at.	
	Developing Facebook applications gives me a sense of personal achievement.	
Effort Intensity (reflective)	How many hours a week do you spend on developing Facebook applications? (number of hours)	Ke and Zhang 2009, Hars and Qu 2002
	What percentage of your total working time do you spend on developing Facebook applications? (Percentage 0% - 100%)	
<b>Control Variables</b>		
Embeddedness (formative)	Do you develop applications in a team or on your own? ("team" / "alone")	Ke and Zhang 2009
Professionalism (formative)	I develop Facebook applications in a professional background. ("yes" / "no")	
Business Criticality (formative)	Developing Facebook applications is critical for my/our business. (five-point Likert scale ranging from "not critical at all" to "highly critical")	
Experience (reflective)	Since how many years do you develop Facebook applications? (number of years)	
	Since how many years do you develop software in general? (number of years)	

**Table 1. Measurement of Constructs**

**Instrument Validation**

The measurement items were assessed for content, convergent and discriminant validity and for reliability according to Anderson and Gerbing (1988). Content validity was achieved by adopting constructs that had been used in former studies and by a pretest of selected application developers and researchers. We used the standard procedures of the current literature to validate reflective measurement models (Chin 1998; Straub 1989).

Constructs	Number of indicators	Range of standardized factor loadings*	Composite Reliability	Average variance extracted (AVE)
External Rewards	3	0.674-0.773	0.781	0.544
Status and Opportunity	5	0.715-0.791	0.863	0.558
Use-Value	3	0.731-0.856	0.834	0.627
Intrinsic Motivation	4	0.736-0.838	0.860	0.607
Effort Intensity	2	0.926-0.950	0.936	0.880

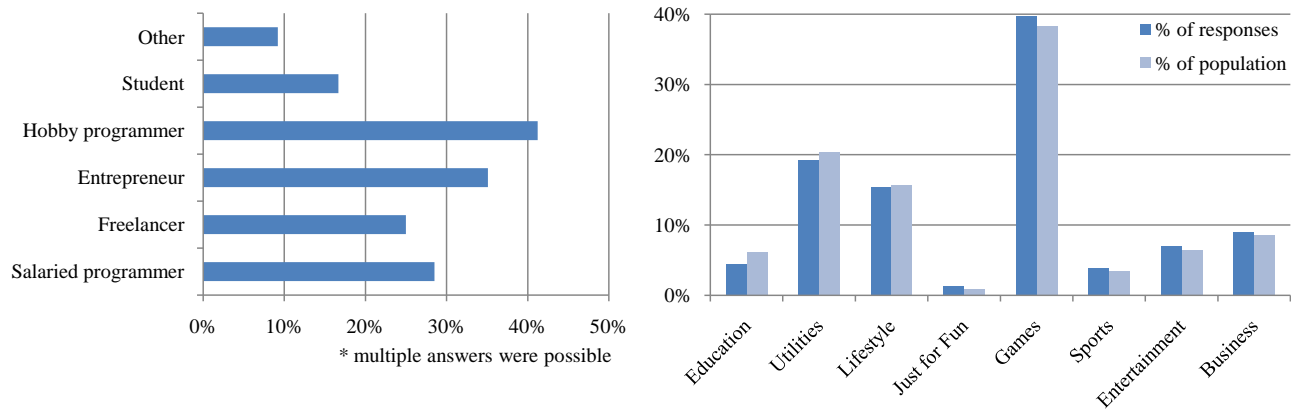
\* All factor loadings were significant at least at the  $p < 0.01$  level

**Table 2. Assessment of Measurement Model**

We were able to observe significant standardized factor loadings ( $p < 0.01$ ) for all of the reflective items; thus, convergent validity is assumed (Bagozzi, Yi and Phillips 1991). Construct reliability is suggested by composite reliability for each construct that is significant above the cut-off value of 0.70 (Hair, Anderson, Tatham and Black 1995). In addition, the average variance explained for all reflective constructs met the threshold value of 0.5. To assess the discriminant validity of the constructs, we compared the square roots of their AVEs which exceeded the inter-construct correlations in all cases. Altogether, the reliability and validity of the motivation measures used in this study received strong support from our tests.

**Sample Descriptives**

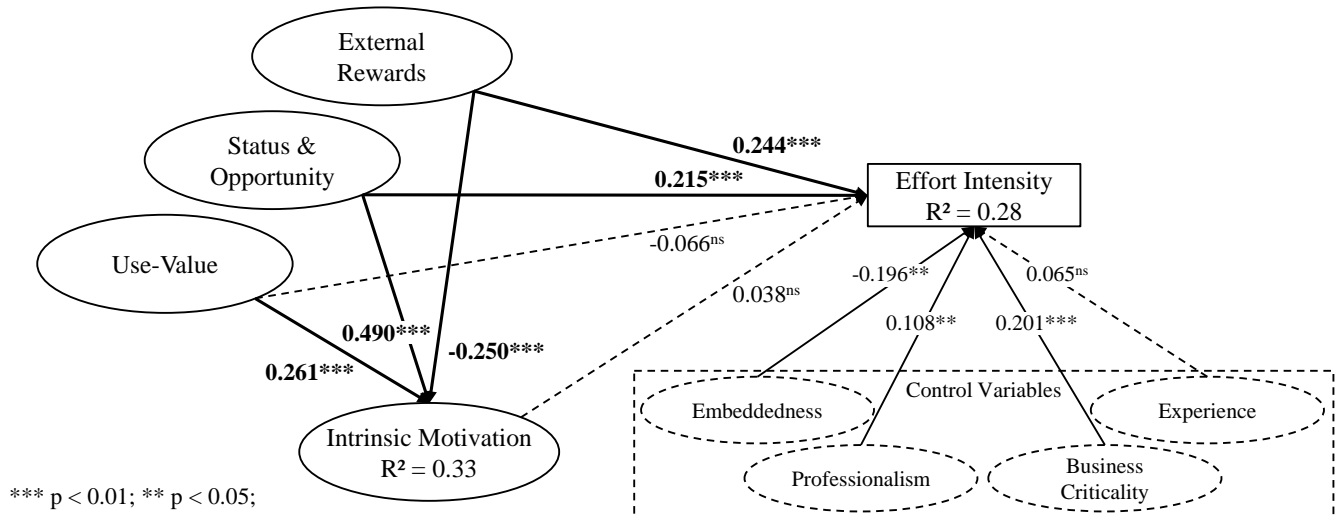
The sample consists of 268 valid responses. Regarding the organizational background influencing the development of applications, we found no concentration on a certain background (see Figure 2). Furthermore, we found that the distribution of application genres of our response sample is largely comparable to the overall distribution of genres.



**Figure 2. Descriptives: Organizational background and Genre Distribution**

**ANALYSIS AND RESULTS**

In order to test our research hypotheses we used PLS-based structural equation modeling (Chin 1998; Lohmöller 1989) based on SmartPLS (Ringle, Wende and Will 2009). In contrast to parameter-oriented and covariance-based structural equation modeling, the component-based PLS method is prediction oriented (Chin 1998, p. 352) and places minimal restrictions on sample size and residual distributions. Tests using SPSS revealed that our data set contains a number of abnormally distributed variables. Consequently, PLS was the method of choice, since it does not rely on normally distributed indicator data (Chin 1998).



**Figure 3. Model results: standardized path coefficients and explained variance**

To assess our research model, we evaluated the structural model on the basis of the explained variance ( $R^2$ ) of the dependent latent variables. The size and significance of the path coefficients were used to test the hypotheses of our model. Figure 3 shows the standardized path coefficients and  $R^2$  as the major model-fit index.

In terms of motivational factors influencing effort intensity, we achieved the following results. The path coefficients between effort intensity and external rewards (H1a) and effort intensity and status and opportunity motives (H1b) were significant and positive ( $\beta_{1a} = 0.244, p < 1\%$ ;  $\beta_{1b} = 0.215, p < 1\%$ ). Hence, both hypotheses were supported. However, H1c and H1d, which predicted a positive relationship between intrinsic motivations and use value and effort, respectively, had to be rejected, since both path coefficients were insignificant ( $\beta_{1c} = -0.066, ns$ ;  $\beta_{1d} = 0.038, ns$ ).



Regarding the inter-motive relationships, all extrinsic and internalized motives demonstrated a significant effect on intrinsic motivation. As expected, external rewards undermined intrinsic motivation (H2a), while status and opportunity as well as use-value motives strengthened intrinsic motivation. ( $\beta_{2a} = -0.250$ ,  $p < 1\%$ ,  $\beta_{2b} = 0.490$ ,  $p < 1\%$ ;  $\beta_{2c} = 0.261$ ,  $p < 1\%$ ). Hence, H2a-c could be supported.

## DISCUSSION

Summing up, our empirical results show that “external rewards” and “status and job opportunity” motives were the dominating motivational driver of Facebook application developers, while “use-value” and “intrinsic motivation” did not play a role. Moreover, we found evidence for motivation crowding effects, as external rewards undermine intrinsic motivation, while internalized motives strengthen it. Based on these findings, we will discuss practical and theoretical implications in this section.

### Major findings and implications

*Finding 1: External regulation and status and opportunity motives were the driving factors for the developers' effort intensity, while use-value and intrinsic motives did, however, not play a role.*

From the perspective of application developers, the Facebook platform seems to be a matter of professional business and job opportunities and less a playground for fun and creativity expression. As it became obvious that on the one hand, as predicted, the developer community is comprised of a considerable fraction of non-professional amateurs (see sample descriptives), and on the other hand, unexpectedly, intrinsic and use-value motives did not play a role, we assume that many amateur-developers are lead by the expectation of a “gold rush”, which was promoted by prominent success stories like Playfish or Zynga in the past.

The practical implication of this finding is, that social platform-operator should further promote possibilities to monetize complementary applications, which e.g. Facebook did by announcing the “Pay with Facebook” within-application payment service. Furthermore, our results on status and opportunity motives suggest that developers' ego-related and job-opportunity motives should be addressed more specifically. A way to realize this could be to draw more attention on the developers themselves, e.g. within the platform (“developer of the day”, etc.) or by holding specific developer events (“employees meet developers”, “freelancer contract market”, etc.).

*Finding 2: External rewards undermine intrinsic motivation, while internalized motives strengthen it.*

We found evidence for the theoretically predicted crowding effects, since external rewards undermined intrinsic motivation and both internalized motives strengthened intrinsic motivation. From a theoretical point of view, this is an interesting result, because, although the crowding theory is widely accepted in theoretical psychology, its practical impact is controversial due to its conflict with the traditional relative pricing effect on the one hand and its limited empirical foundation on the other hand (Prendergast 1999). Therefore, our findings contribute to this discussion by confirming the position of Frey and Jegen (2001), who argue that only interventions perceived as controlling reduce self-determination while supportive forms of extrinsic motivation even strengthen intrinsic motivation.

A practical implication of this finding is that social platform-operators should clearly distinguish between offering monetization possibilities and addressing intrinsic motives like enjoying creativity. Hence, an example of a counterproductive motivation would be, to announce solely monetary incentives for a competition on especially creative application ideas. On the other hand, we found that promoting job opportunities would not only be suitable to motivate an increase in developers' effort intensity but also to strengthen intrinsic motivation.

### Limitations and future research

First, our findings must be interpreted in light of the limitations of cross-sectional research. Because our data are not longitudinal, we are unable to conclusively confirm the direction of causality. While we feel that the balance of logic in our study supports the idea that effort intensity is significantly affected by external rewards and status and opportunity motivation, longitudinal research would help to better understand the temporal relationships between our constructs.

Another limitation of our study is that only a small portion of effort intensity's variance could be explained by the selected explanatory variables. Although, this result is well within the range of comparable studies on individual motivations of software developers (Ke and Zhang 2009), future studies should include additional antecedents of effort intensity (e.g. the developers' age or other socio-economic environmental factors). A possible reason for this limitation is the way we measure effort intensity. As with all self-reported data, our measures might be biased due to the illusory superiority effect, as respondents might have overestimated their own effort intensity (Hoorens 1993). A possible solution and therefore also a proposition for further research, is to complement our data with “real” indicators provided by Facebook. An instrument for

the measurement of effort would thus be to count the number of applications produced by a developer and weight them using a complexity indicator.

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