Facilitating Supplementary Innovation in the Digital Game Industry: The Role of Modding Toolkits

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Short Paper

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Abstract

Game modifications (mods) developed by users are common in the digital game industry, serving as a form of user-driven supplementary innovation that enables game developers to extend the lifespan of their core games. Companies have recognized the strategic value of such innovation and offered official modding toolkits to support users' endeavors. Nevertheless, the effects of modding toolkits on mod performance are not well understood, as extant literature is fragmented and descriptive, lacking an examination of the relationship between official modding toolkits and mod performance. This study plans to address this knowledge gap by analyzing official toolkit documents and behavioral data from platforms such as Nexus Mod and investigating the effects of modding toolkit features on mod performance. By advancing our knowledge of the supplementary innovation toolkit as a strategic approach in the digital game industry, the study is expected to provide valuable insights into extending product lifespan and utility.

Keywords: Supplementary Innovation, Modding Toolkit, Digital Game Industry, Open Innovation, Mod Creation

Introduction

The development of digital products no longer stops at the release of its core service. Especially in the digital game industry, it has become common for digital game developers to tailor and enhance its user experience by supplementing core functionality with additional features and content. Such practice noted as

supplementary innovation plays an especially salient role in the digital game industry (Bilińska-Reformat et al., 2020; Cao et al., 2022). In order to retain players' interest in the game, digital game developers often come up with additional gameplay or features such as downloadable content (DLCs) or other add-ons to enrich players' experience. Yet, official supplementary innovation can be costly and time consuming, and it can be challenging to satisfy most customers with a one-for-all offering (Prügl & Schreier, 2006). This draws game developers' attention to another representative manifestation of supplementary innovation, game modification created by users (also known as game modding).

Unlike DLCs and other official patches, game modding is a spontaneous innovation process mostly managed by the user community itself (Sotamaa, 2010). After the core game's release, many dedicated users may be motivated by their heterogenous interests to create game mods to incorporate additional game features such as new quests, new gameplay mechanics, and enhanced visuals for the game environment and avatars. Facilitated by the ongoing interest and innovativeness of the user community, the utility and lifespan of a game can be extended continuously and cost-effectively.

The merits of game mods encouraged game developers to seek how to leverage the vantage of such supplementary innovation. Since the mod development process is mostly beyond the control of the game developer, a representative strategy for game developers to benefit from such supplementary innovation is to provide official modding toolkits. One representative illustration can be CD Projekt which released its official modding tool (i.e., RedMod) to make mod creation and installation more convenient for users (Goslin, 2022). The official modding toolkit is expected to function as the 'seed' to foster users' creativity and the 'facilitation' to help users actualize their innovative ideas. Thus, it is imperative for game developers to understand what kind of official modding toolkit they need to provide to boost supplementary innovation in game mods. This leads to the question of what characteristics the mod creation toolkit should hold to effectively incubate users' creativity.

Although current research in game modding practices has validated the value of game mod and found out the role of providing a mod creation toolkit as a symbol of openness to cultivate a flourishing mod community (Poretski and Arazym, 2017), there is limited discussion on the effects of the toolkit and user involvement in game mod creation. Given the open innovation nature of mod creation, the official modding toolkit can be conceived as a user toolkit for innovation. Drawing on Hippel (2005)'s perspective of user toolkit for innovation, this study proposes to examine the effects of a mod creation toolkit characterized by three features (i.e., scope of toolkit, easiness to use, facilitation on sharing) on the overall performance of game mod (i.e., mod quality, mod quantity, and mod variety).

The prospective contribution of this study is to advance our understanding of the effects of the supplementary innovation toolkits on user innovation in the digital game industry and bear implications for game developers to provide optimized official modding toolkits to enhance user innovativeness. Also, given the strategic value and importance of the official modding toolkit as a supplementary innovation approach for game developers, we believe that the insights generated from this study can enrich our knowledge of how game developers can cultivate their supplementary innovation strategy based on external voluntary innovators.

Theoretical Background

Literature Review on Game Modding

Modding is the act of modifying a game through computer programming with software tools that are not part of the game, such as fixing bugs, modifying content to improve it, or adding content (Poor, 2014). Though equally beneficial as DLCs created by game developers, modding itself is mostly done by user communities. Specifically, mods are digital artifacts designed by avid players and fans to tinker with their favorite games (Sotamaa, 2010). Motivated by a common interest in a game, modders spontaneously form large online groups and may voluntarily collaborate with the game company (Sotamaa, 2009). Several game companies (e.g., Epic Games) also provide official modding tools and cultivate modders' forums to support modding activity.

Previous studies have pointed out the value of modding practice in the game industry. For instance, Bilińska-Reformat et al. (2020) treat game modding as a manner of customer value co-creation which benefits both companies and other game users. Postigo (2007) regards modders as fan programmers of

digital games. Arakji and Lang (2007) consider mod as a new form of producer-consumer collaboration through which game companies outsource innovation to game consumers in digital entertainment.

However, studies on game modding are mostly fragmented in describing the social, cultural, and economical aspects of mods (Lee et al., 2020). For instance, some researchers identified existing mods types and the motivations of modders to create mods and players to use mods (Bilińska-Reformat et al., 2020; Poor, 2014; Postigo, 2007; Sotamaa, 2010). Several studies explored and described the relationship and mutual benefits between a game and its mod developers (Arakji & Lang, 2007; Nieborg & Van Der Graaf, 2008; Sotamaa, 2003). In recent years, a few studies have started to investigate the performance of game mods based on objective behavioral data from mod community platforms (e.g., Nexus Mod). For example, Lee et al. (2020) conducted a large-scale study based on the metadata of 9,521 mods from the Nexus Mods distribution platform to look into game mods' release schedules and bug reports. Poretski and Arazy (2017) conducted an empirical study on 64 games from the Nexus Mods distribution platform and showed how the game company's support of the modding community encourages modders' creativity and productivity, and ultimately contributes to the sales of the original game.

Although efforts have been made to advance understanding of the role of an official modding tool, extant research has only checked whether game companies provide official modding toolkits engender positive impacts without deeply exploring the characteristics of optimized official modding toolkits to improve the performance of game mods. Whilst in this study, we believe that it is imperative to understand which kinds of official modding toolkits the game developers (i.e., producers) should provide to facilitate game users (i.e., consumers) to achieve better mod performance (i.e., supplementary innovation performance).

To mitigate the research gap, we try to identify different characteristics of official modding toolkits from the user innovation toolkits perspective and examine the effects of different characteristics of modding toolkits on game mod performance, which are elaborated in the following sections.

User Toolkit for Innovation

To meet heterogeneous market needs, companies have noticed the value of involving users in product development to achieve a high level of customization and satisfaction (Franke & Von Hippel, 2003). One representative practice for the company to leverage the wisdom of the user community is to provide a user toolkit for innovation. By issuing the toolkit, companies are able to partially 'contract out' their product development with high efficiency and effectiveness (Goduscheit & Jørgensen, 2013).

From the existing literature, the development toolkit for innovation has been discussed in the contexts of both physical product development as well as virtual product design (e.g., watch, shoes and mobile game). It is suggested that the user toolkit for innovation can be characterized by five attributes (Hippel, 2005). First, the toolkit provides users with a solution space to realize their preferences by creating designs. It, by nature, is expected to facilitate self-customization of the product in terms of appearance and functionalities (Franke & Von Hippel, 2003). Second, it is likely that the toolkit would not require too many specialists for customized design, which means it encourages novice users to contribute to product development (Goduscheit & Jørgensen, 2013; Prügl & Schreier, 2006). Third, it is suggested that the toolkit would provide a set of design modules as the foundation of user customization. Fourth, the toolkit may also provide product developers with a learning process to polish their design based on market insights (Franke & Von Hippel, 2003; Prügl & Schreier, 2006). This is also associated with the fifth characteristic that the toolkit needs to ensure the user-designed product is producible by the manufacturers.

Due to the lack of physical production, the considerations on an official modding toolkit for the digital product by nature may not follow all characteristics suggested by Hippel (2005)'s perspective of user toolkit for innovation. Yet, the similarity in user innovation also draws some researchers to discuss the role of the game modding toolkit as a form of user toolkit for innovation in the digital context. For instance, Prügl and Schreier (2006) introduced *The Sims* as the research context and described the role of the official modding toolkit in the customer-as-innovator approach in game development. Nonetheless, discussions on which features official modding tools would have on user innovation in mod creation still remain unexamined.

In this study, we believe the perspective of user toolkits for innovation can be an inspiring starting point to unpack the characteristics of official modding toolkits and their corresponding effects on the overall performance of game mods. In the next section, three features of official modding toolkits would be introduced and elaborated.

Hypothesis Development

Following the theoretical perspective on the five attributes of the user toolkits for innovation, three features are introduced in adaption to the context of the official modding toolkit: scope of toolkit, easiness to use, and facilitation in sharing (See Table 1 below). The scope of toolkit refers to the degree of design freedom. It is derived based on the first and third attributes of the user innovation toolkit. It can be conceived as the overarching feature reflecting what design possibility is allowed in the toolkit (Prügl & Schreier, 2006). Easiness to use refers to what extent the toolkit is novice friendly. This is derived from the second attribute of a user toolkit for innovation. It suggests that the toolkit developers should consider to set the knowledge level required to accomplish design tasks by user innovators. Facilitation in sharing refers to the toolkit support in sharing created mod in the user community. It is derived from the fourth attribute of the user toolkit for innovation which suggest that learning and exchanging opinions and insights can be an important quality for leveraging collective innovativeness. It reflects the user toolkits' role in facilitating the learning process to acquire market insights and polish product design.

In this section, we propose to investigate the effects of these features on the overall performance of game mods which is captured by the quality, quantity, and variety of mods created.

Features	Definition	Original Characteristics from von Hippel (2005)
Scope of Toolkit	To what extent the game content is editable and designable by the toolkit	Provides users with a solution space to create their own design
		Provide a set of design modules as the foundation of user customization
Easiness to Use	To what extent the toolkit requires extra specialist knowledge to use	Not require too many specialists for customized design
Facilitation in Sharing	To what extent does the toolkit support the sharing of a created mod in the user community	Provide product developers with a learning process to polish their design based on market insights
Table 1. Features of Official Modding Tools		

Scope of Toolkit

The scope of toolkit refers to the extent to which the toolkit facilitates users to edit the game and customize their own design. Not all official modding tools would enable users to edit all the content in the game. One representative example can be the Witcher Game series. In Witcher 1, the game developer officially released an official modding tool named D'jinni Adventure Editor which allows users to create their own game quests by putting dialogue and characters in the game world. Nevertheless, such a modding tool only allows users to create a plot in a quest structure (Official Witcher Wiki, n.d.-a). When it comes to Witcher 3, the official modding tool (i.e., Modkit) not only allows users to edit and change what is already in the game (i.e., texture and mesh) but also support editing game script to create and incorporate new functionality as a game mod (Official Witcher Wiki, n.d.-b). It can be expected that the more possibility an official modding toolkit can support, the more various designs can be created. Also, when there is no constraint over the mod design, there is more room for skilled users to leverage their creativity and make a high-quality mod. Hence, we propose that:

Hypothesis 1: The scope of toolkit is positively associated with a game's overall performance in mod quantity, quality, and variety.

Easiness to Use

Easiness to use refers to the level of extra specialist knowledge needed for a user to create a game mod. Creating a game mod is not an easy task and it usually requires users to possess a certain level of digital design knowledge such as programming and 3D visual design. Nonetheless, a more novice friendly toolkit

is likely to encourage more users to actively participate in mod creation, which in turn may lead to the cultivation of a large mod community (Goduscheit & Jørgensen, 2013). Therefore, a low level of easiness to use is expected to increase the number of mods created for a game. However, it is suggested that the 'democratization' of mod creation for novice users through low easiness to use may not attract skilled users to make contributions (Franke & Von Hippel, 2003; Prügl & Schreier, 2006). The Toolkit with low easiness to use which unnecessarily limits the design possibility usually appears to be a basic tool for mod creation. Whilst for skilled workers, their own advanced tools can be convenient for mod design suiting their own preference. A representative illustration can be the reputable game called *"The Sims."* The game developer provides official modding tools for users to customize the visual color of existing objects in the game world (e.g., skin color of avatar). When comes to the design of new animation (e.g. smokable smoke in the game world) which demands more advanced skills, users' own tools are often preferred (Prügl & Schreier, 2006). Thus, it can be expected that low easiness to use may lead to less high-quality mods and less variety in mod creation. Hence, we propose that:

Hypothesis 2 (a): Easiness to use is negatively associated with a game's overall performance in mod quantity.

Hypothesis 2 (b): Easiness to use is positively associated with a game's overall performance in mod quality and mod variety.

Facilitation in Sharing

Facilitation in sharing refers to the extent to which the official modding toolkit supports the sharing of created mods to the user community. Prior research in user toolkits for innovation suggests that product developers are able to improve their design through a collective innovation process with users facilitated by the user toolkit (Franke & Von Hippel, 2003). In the context of game modding, users are both the players and innovators of game mods. Support in sharing mods in the user community is likely to encourage users to exchange opinions regarding what mod to design, how to design, and how to refine the quality. An evident example of this can be the famous game, *Skyrim*. Its official modding tool, namely Creation Kit, not only allows users to view the game content and modify gameplay such as the new quest, new visuals, and new equipment but also integrates the Steam Workshop, which makes it convenient for users to share the created mod with fellow users on Steam (Bethesda Softworks, 2022). Hence, it can be expected that facilitation in sharing can be favorable in honing mod quality, increasing the mod quantity, and enriching mod variety. Hence, we propose that:

Hypothesis 3: Facilitation in sharing is positively associated with a game's overall performance in mod quantity, quality, and variety.

Figure 1. Proposed Research Conceptual Model
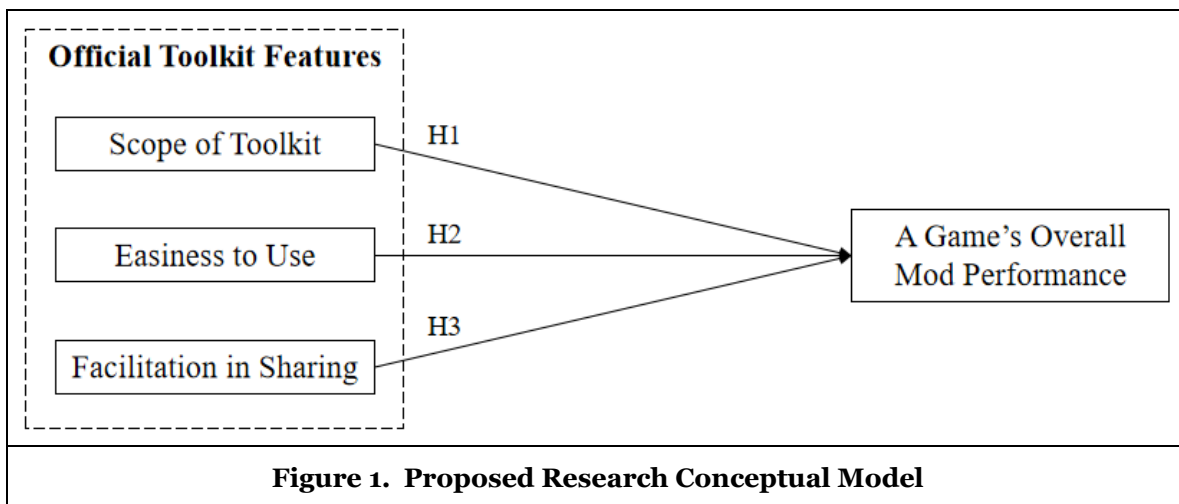
Research Design

Data Collection and Analytical Approach

Two sources of data are expected for the incoming data collection and analysis: (1) the features of official modding toolkits would be extracted from the descriptive information documented in the official guidance of selected games, (2) the information about the overall mod performance (i.e., mod quantity, quality, and variety) of each selected game will be collected from one of the most representative game modding platforms, Nexus Mod[1] (Poretski & Arazy, 2017).

To be specific, this study will first search for games that have published official tools for modding developers. MobyGames[2], one of the largest online databases of game information, will be checked to identify such games. Currently, a total of 66 single player games have been listed in the "Games with official modding tools" category from 1996 to 2021, covering 10 genres like action, strategy, shooting, and role-playing, among others. At this stage, the data is still under collection, and a sample of 90-100 games is expected to be collected for future analysis. Additionally, these games are available on various platforms, such as Windows, Linux, game consoles, and mobile platforms where any other complementary information about the game will be further collected if needed. In this case, the sample selection and data collection will be ensured to reflect and represent the real gaming industry.

After identifying the relevant sample games, the features of their official toolkits will be collected primarily from the documentation available on their official websites. In cases where games do not provide detailed documentation on their modding toolkits, other resources such as Reddit, PCgamingWiki[3], and SteamWorkshop[4] will be used to find related information.

Finally, to collect data on the overall mod performance, games with official modding toolkits will be matched with specific pages on the Nexus Mod platform. First, the number of modding items and the overall download count of each game will be collected. Then, within each game, the features of each modding item will also be collected, including the number of endorsements, unique downloads, total downloads, and total views of each item. Additionally, the description, bug reports, and forum posts will be collected to investigate topics and issues related to modding toolkits and items.

Given that the three toolkit features are seldom quantified in extent research, the approach of computer-aided text analysis (CATA) is proposed to operationalize the three variables by aligning the content features with their definitions (Short et al., 2010) (See Table 2 below). Specifically, the scope of toolkit will be measured based on how many design functions are provided by an official toolkit. Easiness to use will be measured based on how complex the toolkit can be to set up and accomplish a modding task (Xia & Lee, 2005). Facilitation in sharing is operationalized by counting the number of sharing functions provided by the toolkit. With regard to dependent variables, the mod quantity will be measured by the change in the growth rate of total mods created since the official toolkit was launched. The mod quality can be reflected by received endorsement, which is given by peer users who not only download the mod but also decide to 'recommend' the mod to the community. Thus, it will be measured by the total number of endorsements received by a game. The mod variety will be measured by the change in each game's Shannon-Weaver Diversity Index of the mods (Ortiz-Burgos, 2016). Once the variables are properly captured, the correlational analysis will be conducted to test the proposed framework.

Future Complementary Analysis

In addition to the forthcoming test of the proposed framework itself, we would also like to conduct a complementary analysis to identify the role of specific attributes of different official modding toolkits in contributing to the three core features (i.e. scope of toolkit, easiness to use and facilitation in sharing). To be specific, we would like to develop a taxonomy of official modding toolkit attributes from the functionality and user perspective. We believe that such a taxonomy would help generate insights on how the three core

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[1] https://www.nexusmods.com/
[2] https://www.mobygames.com/
[3] https://www.pcgamingwiki.com/
[4] https://steamcommunity.com/workshop/

dimensions are achieved in a toolkit with various combinations of unique attributes for the modding toolkit, which are expected to guide industrial professionals on how to develop a proper toolkit for mod creation (Nickerson et al., 2013).

Variables	Definition	Proposed Measurement
Independent Variables – Toolkit Features		
Scope of Toolkit	To what extent the game content is editable and designable by the toolkit	The number of design components or functions provided by the toolkit (Thomke and von Hippel 2003)
Easiness to Use	To what extent the toolkit requires extra specialist knowledge to use	The number of technical requirements to use the toolkit. The number of steps required to create a mod (Xia and Lee (2005)
Facilitation in Sharing	To what extent the toolkit supports the sharing of a created mod in the user community	The number of sharing functions provided by the toolkit
Dependent Variables - Mod Performance		
Quantity	How many mods are created in total since the launch of the official toolkit	The change in the growth rate of the mod amount each game has accumulated since the launch of the toolkit
Quality	The overall attractiveness of mods created since the launch of the official toolkit	The change in the growth rate of mod endorsements (i.e., download and recommend) each game has received since the launch of the toolkit
Variety	How many types of mods are created in total since the launch of the official toolkit	The change in each game's Shannon index of mod created since the launch of the toolkit. $H = -\Sigma p_i * \ln(p_i)$ p_i: the proportion of the entire mods made up of mod type i (defined by the mod platform)
Control Variables		
Moddability of Game Engine	To what extent the game engine is modding friendly	To generate a ranking list of game engine moddability through expert assessment
Game Popularity	How popular the game is regarding player base	Average number of daily active players
Release Time	The duration of the game after release	Total number of days after the release of the game
Genre	The type of game (e.g., action, role-playing, shooting, etc.)	Dummy variable for each type of game
Game size	The size of game content required on a hard disk	The value of content size in MegaBytes (MB)

Table 2. Measurement of Variables

Prospective Contribution

This study is proposed to examine the associations between the features of the official modding toolkit and a game's overall mod performance. The findings will be expected to generate insights into how modding toolkit influences user innovativeness in mod creation. We believe this study's prospective contribution is important for both academia and industry professionals. In terms of theoretical implications, this study attempts to mitigate the research gap in game mod literature about the specific effects of different features of official modding toolkits. It can also be a starting point to further investigate how the supplementary innovation toolkit affects the ongoing evolvement of digital products in general. With respect to managerial implications, we believe that the findings of this study would equip game developers with fundamental knowledge which help them to organize their thoughts and sort out what kind of official modding toolkit they shall provide to cultivate user creativity. In addition, to get a comprehensive understanding of how the mod creation toolkit affects mod creation, we would also like to extend this study in the context of the unofficial mod creation toolkit as a future possible direction to develop a fuller view of how supplementary innovation evolves spontaneously in various forms.

Acknowledgements

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