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The Management of Continuous Product Development

Empirical Research in the Online Game Industry

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Chapter 1
Introduction

1.1 Objective of This Book

The Objective of this book is to identify effective management practices in continuous product development (CPD). This book defines continuous product development as the process of continuously adapting the product to the changing external environment through multiple activities. Contrary to intermittent development activities discussed in existing research, continuous development requires product adaptation to information from external sources, such as users, not only during the planning phase, but also throughout the entire long-term development process. As a result, it is necessary to reevaluate the validity of the management methods suggested by previous studies and to explore new methods which are necessary. This book examines effective development patterns in industries and products that engage in continuous development activities. This book discusses theoretically and empirically the trade-off relationship between the frequency of product adaptation activities and the constraints on development resources, and how companies can respond to these constraints. Furthermore, user community management is also discussed from the perspective of the interaction process between multiple user groups.

The following four points summarize the differences between continuous development and traditional intermittent development.

- Adaptive activities are completed within the same product, and that same product is continuously evolving while adapting to environmental changes.
- In order to maintain a product's performance, repeated (iterative) adaptation activities are vital.
- As information is continuously flowing into the development organization from the external environment (customers, competitors), it is more difficult to manage uncertainty.
- The development activities of the same development organization must be continued for a long time to ensure product performance.

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In this book, two analytical issues are addressed regarding continuous product development: first, the relationship between adaptation activities and product performance throughout the development process. Previous studies have examined the importance of adaptation activities in the face of a changing environment. It should be noted, however, that each development project, which is the subject of adaptation activities, has distinct characteristics when it comes to the development resources, capacity building, and development policies. Accordingly, it is necessary to clarify how adaptation activities should be managed in a concrete and empirical manner, concentrating on the characteristics of the project. Secondly, it is important to consider the relationship between adaptation activities and the management within the organization that undertakes such activities. Focusing on adaptation activities, continuous development activities must take into consideration a combination of four factors: external information and products as adaptation targets, development flexibility and collaboration among departments (especially in the development and operations) as the adaptation entities. By examining these four factors, it is possible to gain insight into how organizations are managed in products and industries that are characterized by continuous product development.

For addressing these research questions, this book focuses on the online game industry. Online game industry contains various companies and projects that are consistent with continuous development activities. Therefore, this book incorporates statistical analysis and case studies to derive academic knowledge and provide practical recommendations on the management of continuous product development. By examining these topics from an integrated perspective, it is expected to become clear what conditions and factors enable an organization to achieve and maintain high product performance.

1.2 Product Development Activities Transforming into Continuous Activities

The development of new products is considered an essential component of a company's success. Since environmental changes profoundly influence this activity, such changes must be incorporated into companies' products in order to ensure sustainable competitive advantage. Changes in the external environment are one of the most significant influences on the theoretical inquiry into product development. As the environment changes, it is a common challenge for the development process to absorb external information such as market and technology and incorporate it into new products.

In recent years, the development of products has been undergoing continuous evolution as products become more service oriented. Therefore, to support continuous evolution, product development is becoming a continuous activity instead of a series of stand-alone projects (Buganza & Verganti, 2006). In continuous development activities, interactions with the external environment take place at multiple

times, not only at the planning stage, because the activities of the development process continue after the release of the product. Products like software and games, for example, are quickly and frequently adapted to changes in their external environment to stay competitive. Even after a product is launched, it can be updated anytime via the Internet to fix bugs or add new features. In the context of global competition and information technology innovation, continuous development is becoming more and more popular as an efficient way to use resources and information in industries confronted with a rapidly changing environment.

Traditional industrial products have also been affected by this trend. In the manufacturing industry, product adaptation has so far been driven by full model changes, i.e., replacing older models with new ones. Meanwhile, smaller changes are spreading, such as modifications and improvements to existing products. With product categories such as automobiles and home appliances, for example, small-scale product improvements incorporating the latest technology are now being made in a short period of time. As the competitive environment rapidly changes, minor changes are becoming more important as an effective product adaption pattern compared to full model changes, which can respond faster to changing user needs and technological advances.

With the rising cost of R&D, the cost of technological development for component parts, including core components, increase rapidly in recent years. In the case of automobiles, the cycle of full model changes is shifting from 3–4 years to 5–7 years in order to use development resources more efficiently, and the cycle tends to extend. While Toyota is a major automobile manufacturer, it is nearly impossible for the company to make a complete model change, releasing a new car every year. Consequently, the interval between full model updates is getting longer. Meanwhile, the cycle of minor model changes for existing products is becoming shorter.

Essentially, by integrating industrial product R&D into minor model changes, companies are not only able to achieve product adaptation to external environments with reduced development costs, but also maintain better product performance. These initiatives demonstrate the importance of product adaptation among industrial products. However, minor model changes that correspond to product adaptation are difficult to implement. It is supported by long-term continuous product development activities. Thus, even in the development of traditional industrial products, the development model of continuous product development has attracted the attention of many companies, and the need for implementation management has grown significantly.

1.3 Issues Related to the Continuation of Development Activities

As mentioned earlier, with the continuation of development activities, companies are required to continuously adapt their products to changes in the external environment. In the intermittent product development model presented in previous research, the

management of interaction with external environmental changes is undertaken within the intermittent development cycle, since the product is only adapted once through a planning to implementation cycle. During continuous product development, however, the product interacts with the environment multiple times, which forces it to continuously evolve via iterative adaptation processes. In contrast with the intermittent product development model, the interaction with the external environment affects not only the planning stage, but also the development process over a long period of time. Moreover, as development activities become more continuous, the project requires a steady and continuous supply of development resources. Regarding the allocation of development resources for product development, it is not a question of deciding in advance and investing those resources at one time, but rather of continuously investing them while promoting the entire project. Compared to intermittent development, allocating and utilizing development resources is expected to be more challenging.

Accordingly, development organizations face different management challenges from the intermittent development model presented in the existing literature. There are two new issues arising in the development sites: the response to external information and the allocation of resources related to product adaptation. Due to this, it is imperative to examine these two issues more closely in order to analyze effective development patterns for products and industries that engage in continuous development activities.

Firstly, there is a great deal of uncertainty involved with dealing with external information because information continually flows from the external environment into the development organization, which ultimately leads to more difficult development management as the project proceeds. As new information is obtained or previously obtained information changes during the course of a development project, it becomes increasingly important to know how to respond to this information. Additionally, companies are expected to respond to user feedback quickly by adapting their products. As a result, companies face the challenge of managing the multiple times of interaction between their products and their customers. Particularly in the case of products such as software and games, user usage data is automatically generated as a byproduct of product usage and is constantly flowing into the company through the product. A product with these characteristics is becoming a complex artifact containing the product itself as well as user usage data as a byproduct. Several studies have suggested that data-rich environments provide an opportunity to view users from multiple perspectives, which leads to a better product performance (e.g., Johnson et al., 2017; Troilo et al., 2017).

There has been speculation that companies can achieve improved product performance by proactively using big data in product development, yet there is a significant disconnect between this assertion and the reality of the situation in development. Increasingly, product development is relying on user data due to the emergence of data-enriched development environments. Consequently, development organizations will be faced with a tremendous amount of information processing work in parallel with the development work, making management of development processes and

operations extremely challenging. Even though the effective use of data suggested by existing research is beneficial, the reality is that it is not readily achievable.

Development sites are plagued by large, poorly organized data sets. Identifying and filtering out valid and accurate information from the large amount of data that changes daily requires considerable effort and time. So, regardless of how much unstructured data is available from outside, most of it is unlikely to be used in development sites. Additionally, the growing reliance on highly uncertain user data is likely to have the opposite effect, namely, an increase in the number of associated tasks such as data processing and analysis. It is difficult to determine whether all user requests should be fulfilled, as they are diverse and numerous. Therefore, although the active use of external information, including user data, has proved effective in responding to external information in many circumstances, there are also situations where this is not always the case. It is necessary to reexamine the development management at the field level. The clarification of these points is expected to contribute to the development of an excellent approach for efficiently collecting and analyzing large-scale user data, and to the solution of problems in companies and society related to the application of big data analytics.

The second issue is the allocation of development resources related to product adaptation. In the models of intermittent product development presented in previous studies, development projects do not begin their development activities in earnest until resources have been allocated and procured in advance. Also, when faced with changes in the external environment, the model of intermittent product development involves adaptation activity only once to adapt the product to it, so there is less uncertainty during the project, and the frequency of unexpected development work is considered low. As the consumption of development resources can be predicted in advance with high accuracy, if there is a shortage of resources on the development sites, this can be resolved by slight adjustments. Thus, in the allocation and procurement of development resources in the development process, dealing with the shortage of development resources has not been a particular problem.

Conversely, in continuous product development, as a result of changes in the external environment, activities are conducted multiple times to adapt to those changes, which means that resource allocation and procurement must also be conducted multiple times. As companies respond to changes in the environment through frequent development cycles, the frequency of unexpected development tasks also increases, thereby further increasing the uncertainty in the development process. These factors substantially affect the allocation of development resources and also degrade the accuracy of estimating the consumption of these resources.

As a result, it is expected that it will become increasingly important for projects to allocate development resources optimally in accordance with the progress of the project before new risks associated with insufficient development resources are apparent. Thus, there is an urgent issue in the development sites regarding the allocation of development resources related to product updates and how to use the limited resources to provide high quality, stable, continuous adaptation activities with optimal frequency.

1.4 What is the Optimal Development Model for Continuous Product Development?

Previous studies have investigated how companies adapt their products to change. Nevertheless, these discussions tend to consider adaptation activities as a static process of intermittent development activities for a single product, and there seems to be little consideration from a dynamic perspective that includes the interaction between the product and the environment.

By recognizing development activities as continuous processes consisting of multiple adaptations in response to environmental changes, development activities such as updating a product series containing multiple products or the continuous evolution of a single product can be viewed as more dynamic.

In relation to such adaptation activities, previous studies have focused on flexibility as a key concept in evaluating the economic costs and benefits of adaptation (e.g., Buganza & Verganti, 2006; Thomke & Reinertsen, 1998). In a rapidly changing environment, flexible development organizations must be capable of adapting by providing short, frequent and high-quality product adaptation activities. A number of previous studies have shown that increased flexibility allows products to better adapt to changes in the external environment, which also enhances product performance, and have provided methods and tools for increasing development flexibility. Consequently, it is suggested that there is a linear relationship between development flexibility and product performance because performance improves with time as flexibility increases, such as through increasing the frequency of adaptive activities within a particular period of time.

However, a higher degree of flexibility may not necessarily lead to better product performance. The logical development presented in previous studies is based on the assumption that sufficient and stable resources are available for development. In cases where sufficient development resources are available, a development approach based on increasing frequency while maintaining a certain degree of product completeness may be feasible by sparingly deploying development resources for product adaptation activities. It is difficult, however, for development organizations to acquire sufficient development resources when necessary, and the reality in the development sites is that the frequency of adaptation activities and the degree of product completeness cannot be reconciled, resulting in a tradeoff.

In particular, as a conceptual model for this book, adaptation activities for products within the same category with different levels of development resource sufficiency are to be assessed separately. The basic structure of a conceptual model for continuous product development, which is characterized by multiple adaptation activities, is based on the relationships between three variables: development flexibility, the degree of product completeness, and product performance. In order to maintain simplicity, other factors, such as labor cost and profit margin, are not taken into account in the conceptual model.

As mentioned earlier, existing studies have indicated that the rapid adaptation of products to changes in their external environments can enhance user satisfaction

and enhance product performance. Accordingly, it may be concluded that product performance (P) can be predicted by three factors: the number of adaptation activities to be performed (n), the degree of product completeness (C_i), and the degree of cumulative customer satisfaction (CS_i) following the implementation of product adaptation activities.

In terms of development flexibility, previous studies have defined it as the ability to adapt and redesign a product or service in the shortest possible time and at the lowest possible cost (Buganza & Verganti, 2006). It is expected that more adaptation activities can be carried out within a given time period for projects with higher development flexibility. Based on the assumption that the amount of resources required for each adaptation activity and the product quality are constant, development flexibility can be operationalized as the number of adaptation activities (n) that can be achieved in a given period of time.

Product completeness refers to the degree to which an adaptation activity was executed to meet product requirements. Accordingly, the degree of product completeness is determined by the relationship between the amount of development resources input and the amount of resources required. When the amount of input is insufficient, the degree of product completeness falls. The amount of development resources that can be invested in product development is determined largely by the development capacity of the development organization and is not expected to change in the short term. In light of this, it is assumed that the development resources available within a given period will remain the same.

Regarding the last item, cumulative customer satisfaction, it is assumed that resources required for adaptation activities and product quality will remain constant, so that variations in product content and quality are minimized. Increasing the number of product adaptation activities will lead to a greater level of cumulative customer satisfaction due to the ability to adapt more quickly to environmental changes. Nonetheless, it is reasonable to assume that the first adaptation activity will result in a sudden increase in customers' satisfaction, but the slope will gradually decrease. The assumption here is that cumulative customer satisfaction increases in a diminishing manner as a result of increasing product adaptation activities in accordance with the law of diminishing marginal utility.

The conceptual model shown in Fig. 1.1 is developed under the conditions described above.

This section assumes two basic conceptual models for development resource constraints, based on the actual situation of the development sites.

Model A: No overtime, no additional staffing in the short term

It is easy to think that the increased demand for development resources as a result of the increased frequency of adaptation activities can be managed by adding additional development resources, but it is difficult to implement such resources in practice. To begin with, as for the development staff, the most important development resource, it may seem straightforward to recruit people within as well as outside the organization to boost manpower, but it takes extensive time and resources for the new members to become effective immediately. In this regard, it is considered almost impossible to

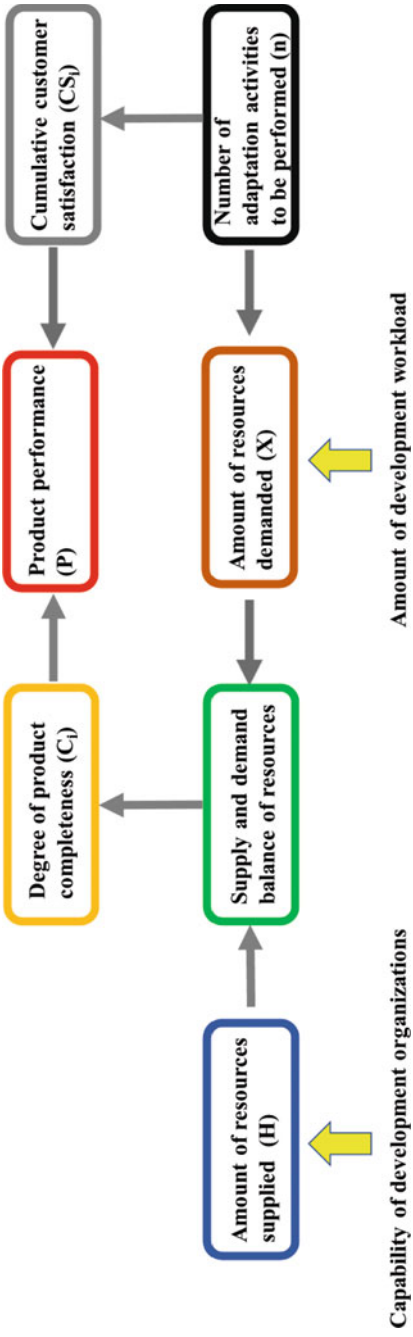

Fig. 1.1 Conceptual model of continuous product development

Table 1.1 Basic settings for Model A

Number of adaptation activities to be performed (Development flexibility)	n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Number of project developers	m	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Annual regular working hours per developer	h^*	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Annual overtime working hours per developer	o	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Annual working hours per developer	$h=h^*+o$	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Annual amount of resources supplied	H=mh	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000
Resources(Man-hours) required per project	x	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Annual amount of resources demanded	X	2000	4000	6000	8000	10000	12000	14000	16000	18000	20000	22000	24000	26000	28000	30000	32000
increment of customer satisfaction (Increasing in a diminishing manner)	s_i^*	10	9.5	9	8.5	8	7.5	7	6.5	6	5.5	5	4.5	4	3.5	3	2.5
Cumulative customer satisfaction	CS_i	10	19.5	28.5	37	45	52.5	59.5	66	72	77.5	82.5	87	91	94.5	97.5	100
Degree of product completeness	C_i	1	1	1	1	1	1	1	1	1	1	0.9	0.83	0.76	0.71	0.66	0.62
Product performance	$P_i=C_i \times CS_i$	10	19.5	28.5	37	45	52.5	59.5	66	72	77.5	74.25	72.21	69.16	67.1	64.35	62.62
Ideal product performance	$p_i=C_i \times CS_i \quad (C_i=1)$	10	19.5	28.5	37	45	52.5	59.5	66	72	77.5	82.5	87	91	94.5	97.5	100

increase the development resources available in the short term. The assumption that overtime is prohibited against the background of the promotion of work style reforms in the private sector would also imply that if the amount of workload increased due to an increase in the frequency of adaptive activities is greater than the project's capacity, the project would be at risk. In this case, the degree of product completeness will have to be reduced.

Based on these actual conditions at the development sites, Model A is constructed as shown in Table 1.1.

First, in terms of the supply of development resources, in a 10-person project (no additional staff may be added), the number of hours per person per year is set at 2000 h. In addition, since overtime is prohibited, the number of annual overtime hours is zero. Therefore, the annual development capacity of the project can be determined to be 20,000 man-hours. Alternatively, from the perspective of the demand for development resources, if the number of man-hours required for one adaptation activity is defined as 2000 h, the annual development workload may be calculated as the product of 2000 h and the number of adaptation activities per year.

As shown in Table 1.1, when the annual frequency of adaptation activities exceeds 10 times, the required resources significantly exceed those that the development organization can provide, and the degree of completeness must be reduced in order to promote the activities as planned. When the frequency of adaptation activities is increased excessively, the degree of completeness begins to decline.

Model B: Overtime, no additional staffing in the short term

Various companies and development projects face varying degrees of development resource constraints. A small or medium development company, for example, which has very limited development resources, may find it necessary to compensate for the shortage by increasing the overtime of its existing development team since it is difficult to add development budget or personnel. This could be covered in the short-term through overtime work, but over the long term, if the organization becomes overburdened, some employees may begin to quit. This situation may also lead to the project reducing the degree of completeness, just as in Model A.

Based on this situation, Model B is constructed as shown in Table 1.2.

First, in terms of the supply of development resources, in a 10-person project (no additional staff may be added), the number of hours per person per year is set at 2000 h. Thus, the annual development capacity of the project can be estimated as 20,000 man-hours. Additionally, since overtime work is possible, additional development resources may be invested in the form of overtime hours. The demand for

Table 1.2 Basic settings for Model B

Number of adaptation activities to be performed (Development flexibility)	x_i	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Number of initial project developers	m	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Number of developers turnover	d	0	0	0	0	0	0	0	0	0	0	0	2	4	6	8	10
Number of developers remaining in the project	m'	10	10	10	10	10	10	10	10	10	10	10	8	6	4	2	0
Annual regular working hours per developer	h^a	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Annual overtime working hours per developer	o	0	0	0	0	0	0	0	0	0	0	200	400	600	800	1000	0
Annual working hours per developer	$h= h^a+o$	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	3000	2600	2800	3000	0
Annual amount of resources supplied	H=m*h	20000	20000	20000	20000	20000	20000	20000	20000	20000	20000	22000	19200	15600	11200	6000	0
Resources(Man-hours) required per project	x_i	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Annual amount of resources demanded	$X_i=x_i$	2000	4000	6000	8000	10000	12000	14000	16000	18000	20000	22000	24000	26000	28000	30000	32000
Increment of customer satisfaction (Increasing in a diminishing manner)	s_i^a (i=1,2,...,n)	10	9.5	9	8.5	8	7.5	7	6.5	6	5.5	5	4.5	4	3.5	3	2.5
Cumulative customer satisfaction	$CS_i=\sum_{i=1}^{n} s_i^a$	10	19.5	28.5	37	45	52.5	59.5	66	72	77.5	82.5	87	91	94.5	97.5	100
Degree of product completeness	C_i	1	1	1	1	1	1	1	1	1	1	1	0.8	0.6	0.4	0.2	0
Product performance	$P=C_i \cdot CS_i$	10	19.5	28.5	37	45	52.5	59.5	66	72	77.5	82.5	69.6	54.6	37.8	19.5	0
Ideal product performance	$p=C_i \cdot CS_i \quad (C_i=1)$	10	19.5	28.5	37	45	52.5	59.5	66	72	77.5	82.5	87	91	94.5	97.5	100

development resources is the same as in Model A as well. If the man-hours required for one adaptation activity are set at 2000 h, the annual development load can be calculated as the product of 2000 h and the number of adaptation activities per year.

Table 1.2 illustrates that whenever the number of adaptation activities per year exceeds 11, overtime work for the current development organization becomes necessary due to the fact that the required development resources greatly exceed the development resources the development organization can supply. The problem with this approach is that overtime becomes the norm as the development workload increases, resulting in exhaustion of the development organization and employee dropout. Excessively increasing the number of adaptation activities per year will not only impair product performance but may also exhaust the organization and reduce development capacity. In a similar way to Model A, the mechanism indicates that when the frequency of adaptation activities is excessively elevated, the degree of completeness begins to decline.

Furthermore, using the data in Tables 1.1 and 1.2 the author draws a relationship diagram, as shown in Fig. 1.1, for the transition of the relationship between the three factors: product completeness, development flexibility, and product performance.

In order to examine how adding the condition of development resource constraints influences the relationship between the three factors, the author compares models A and B based on the actual situation at the development sites. As shown in Fig. 1.2, as the frequency of adaptation activities increases within a given time period, it becomes difficult to obtain adequate development resources at the required time. The mechanism behind it can be assumed to influence product completeness and performance. With limited development resources, firstly, in the short term, excessive adaptation activities will be forced to reduce the degree of completeness of product adaptation and product performance. Moreover, in the long run, it is likely that the current development organization will have to work longer hours to compensate for chronic shortages in development resources. Ultimately, this could result in an exhausted development organization, which could lead to a downward spiral of reduced development capability for the entire project.

Accordingly, if companies are unable to provide sufficient and stable development resources, excessive product adaptation activities will have a negative impact on product performance. A U-shaped relationship may exist between development flexibility and product performance rather than being linear.

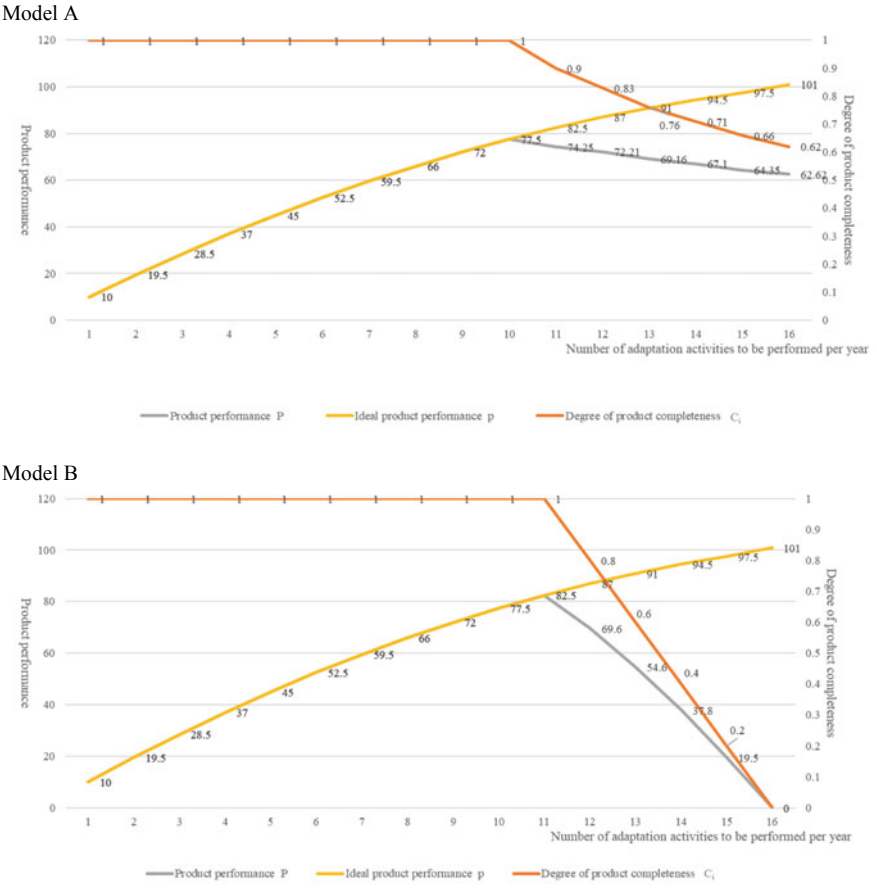

Fig. 1.2 Trends in the relationship between product completeness, development flexibility and product performance (Models A and B)

1.5 Structure of This Book

Based on the above understanding of the problems, Chap. 2 summarizes the previous studies and provides the analytical issues for this book. Chapter 3 introduces the basic concepts and explains the analytical perspectives and methods. Chapter 4 analyzes the history of the development of the online game industry in China with a particular focus on its development. Additionally, the characteristics and issues of online game development are analyzed qualitatively. In Chap. 5, the author derives hypotheses based on previous studies and preliminary research, and then tests them using a quantitative approach for the online game industry.

Chapter 6 examines the development process from the perspective of the supply side for development resources, taking a qualitative approach to the analytical issues.

In Chap. 7, the author examines the analytical issues from the perspective of the demand side for development resources, with a qualitative approach that focuses on the product's functional configuration and structure. In Chap. 8, the author examines the issue of how changes in the external environment, including user trends, affect product performance, and further discusses the interaction between the product and its external environment. Chapter 9 summarizes the results derived from the analysis so far, outlines the contribution of this book, and discusses future research topics regarding the management of continuous product development.

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Chapter 2
Literature Review

2.1 Introduction

In the previous chapter, the author notes that development organizations must continuously adapt their products in response to changes in the external environment as development activities become more continuous.

Analytic issues for this book are developed in this chapter by reviewing previous studies and examining research in related fields. The structure of this chapter is as follows.

First, the literature on new product development is examined to determine what type of management is needed for successful product development. By organizing the representative review papers in the previous studies (e.g., Brown & Eisenhardt, 1995; Fujimoto, 2002a; Kuwashima, 2013), the author explores how the discussion of success factors in product development has shifted from seeking universal patterns across industries to examining the relationship between the characteristics of an industry and its products and effective product development. In this context, the author points out that the external environment of a company is a particularly important factor that affects the theoretical inquiry into effective product development.

Additionally, based on the research background of searching for a compatible relationship between the development organization and the external environment, the author reviews the literature regarding adaptation activities in product development and weigh the implications for adaptation activities in a rapidly changing environment. Research has been conducted on the development of hardware and software products in the IT industry that highlights the importance of flexibility in products and development processes and recommends measures to facilitate rapid adaptation to change (e.g., Boehm, 1988; Eisenhardt & Tabrizi, 1995; Iansiti, 1997).

Nevertheless, since the effective development patterns presented in previous studies typically focus on modular products and view their development activities as intermittent processes, it may not be possible to determine effective development patterns for integral products discussed in this study.

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Furthermore, the author examines the economic costs and benefits of adaptation activities in the development process, focusing on flexibility as the key concept. In many previous studies, there has been an implicit assumption that improving flexibility will allow a product to adapt to external environmental changes, as well as leading to improved product performance. However, increased flexibility may not necessarily result in better performance. It is important to note if it is difficult to provide sufficient and stable development resources, the concern is that excessive product adaptation activities may result in lower product performance.

Finally, with regard to the game industry, which is characterized by continuous product development, the author clarifies how development activities that support the growth of this industry have been viewed from an administrative perspective. According to prior studies on the video game industry, game software development requires a different approach from conventional commercial software due to its highly uncertain development activities and polysemous and ambiguous requirements (e.g., Baba, 1998; Tachimoto, 2002; Ikuta, 2012). On the other hand, existing studies on the online game industry have highlighted that the continuous updating of content is necessary for the success of online games, and that the influence of user trends, such as user communities and user interaction, is significant to the success of online games (Nojima, 2002; Wi, 2006). However, since most of these studies were conducted at an industry-level, the author points out that there is insufficient attention given to project-level management of development activities.

After reviewing existing studies, the author derives the analytical issues of this study.

2.2 Literature Review on New Product Development

Identifying the conditions in which companies can achieve a sustainable competitive advantage is one of the core issues in management, and the area of product development has attracted considerable attention for empirical analysis (Kuwashima, 2012). Specifically, new product development (NPD) research has been discussed from various perspectives as one of the important research fields of innovation.

Brown and Eisenhardt (1995) conducted a literature survey of studies on product development published in major academic journals in Europe and the United States from 1969 to the first half of 1990, and classified the previous studies into three streams as follows.

Product Development as Rational Plan

The stream of research on rational planning can be traced back to the SAPPHO project by Myers and Marquis (1969) and Rothwell et al. (1974). The approach emphasizes that the success of product development is directly attributable to three factors, including elaborate planning, execution by a collaborative team, and management support. The focus is on an exploration of independent variables related to the financial success of new product development. The theoretical model of product development as rational planning establishes eight independent variables, such as

team composition and management layers, and examines their impact on product performance.

Product Development as Communication Web

In the research stream of networks of communication, major studies include Allen (1977), Katz and Allen (1985), and Katz and Tushman (1981). This approach is based on the premise that communication between project members and with external parties facilitates team performance. A unique aspect of this study is that it attempts to categorize communication patterns both within and outside the organization, by using corporate R&D activities as the primary research objective, and examines the impact of these patterns on the performance of development projects. This approach is a framework that separates communication from three independent variables such as composition, internal communication, and external communication of the team, and examines its impact on product performance. It has particularly clarified the importance of gatekeepers in mediating communication between internal and external teams.

Product Development as Disciplined Problem Solving

A series of studies on product development practices in Japanese companies in the mid-1980s (e.g., Imai et al., 1985; Takeuchi & Nonaka, 1986; Clark & Fujimoto, 1991) triggered the research trend of disciplined problem solving.

This approach is based on the principle that successful product development can be achieved through a combination of methods. This approach identifies successful product development as the result of a balance between four factors: autonomous problem-solving abilities of the development team, the discipline of a heavyweight leader, strong top management, and a clear and comprehensive product vision. Based on the theoretical model of this approach, the product development process is examined, and the performance of product development is evaluated by examining indicators such as development lead time, productivity, and product integration, and examining interaction between the various factors during the process. Additionally, this approach presents the concept of the heavyweight leader as a key concept and emphasizes the importance of project leaders in intra-organizational problem solving and product integrity.

Fujimoto (2002a) reviewed the research on technology management and organization that analyze the relationship between product development organizations and competitiveness, and discussed the evolutionary path of theories on product development. As Fujimoto (2002a) pointed out, up until the late 1980s, research on technology management was primarily devoted to measuring success, but in the 1990s, a major trend in research became a move toward competitiveness analysis and product development analysis, and research about the measurement of project performance began to flourish. In particular, this approach is based on a more broadly defined contingency theory and had been influenced by developments related to the measurement of product development performance. According to Fujimoto (2002a), the research of product development has evolved from early studies of the causal relationship between the product development process and new product success, to

industry-specific studies with a clear focus on competitiveness, and then to comparative studies among products that emphasize the fact that effective development processes differ from product to product.

Kuwashima (2002) and Kuwashima (2012, 2013) conducted studies on the transition of major research approaches in the product development management research process. Kuwashima (2002) and Kuwashima (2012) pointed out that the process approach was developed in the mid-1980s, which examines the relationship between management, organizational patterns, and performance in the product development process to discover effective product development patterns. Additionally, Kuwashima (2002) and Kuwashima (2013) organized the major studies conducted after Clark and Fujimoto (1991) as an important foundation for the process approach into four streams based on their problem concern and analysis approach: product-industry based approach, multi-project approach, dynamic approach and organizational capability approach.

According to previous research on product development, there has been a transition away from seeking universal patterns of development across industries to exploring the relationship between product-industry characteristics and effective pattens of development.

The development of new products is therefore an important activity for companies to succeed, and this activity is strongly influenced by changes in the environment. Since the 1990s, numerous empirical analyses have utilized a contingency analysis framework to suggest that effective development activities differ according to product-industry characteristics (e.g., Clark & Fujimoto, 1991; Cooper, 1995; Cusumano & Nobeoka, 1992; Eisenhardt & Tabrizi, 1995; Iansiti, 1997). According to them, successful development management differs depending on the external environment, and development activities must be adapted in response to the external environment changes as well.

It is noteworthy that the so-called "product-industry based approach" has emerged since the mid-1990s, following the lineage of the above studies (Kuwashima, 2002). The "product-industry based approach" focuses on the product development process, while considering product-industry characteristics, and developing research centering on the search for effective product development patterns specific to each industry. Accordingly, the external environment surrounding the company is an important factor that affects the theoretical exploration of effective product development in this context.

2.3 Literature Review on Adaptation Activities to Rapidly Changing Environments

Within the context of the search for a compatible relationship between the environment and the organization, there has been extensive research on effective development patterns within rapidly changing environments. It is imperative that companies adapt

their products to the changes in order to maintain a competitive advantage. Among the topics which have received particular attention is the management of adaptation activities to rapidly changing environments. Changing markets and technologies are causing great uncertainty in the development activities of companies. Therefore, there is a need to identify effective development patterns that can be quickly adapted to changes in the external environment.

The adaptation activities have been analyzed based on two perspectives: the product adaptation and the development process adaptation. Two fundamental research questions have been identified, namely, how to design flexible products or how to design products flexibly in order to adapt to change have been emphasized.

2.3.1 Product Adaptation

The focus of research in product adaptation has been on product architecture and platforms (e.g., Baldwin & Clark, 1997; Ulrich, 1995). There have been many discussions regarding the construction of common platforms as well as the design and development of modular products which can be flexibly adapted to changes in the environment.

In relation to common platforms, Iansiti (1997) examined the factors that contributed to development performance within the mainframe computer industry, which is characterized by discontinuous technological evolution. Iansiti (1997) subdivided product development routines into project specification routines and project execution routines, emphasizing the importance of project specification routines in an environment that is rapidly evolving. Moreover, Iansiti (1997) proposed the concept of "technology integration" based upon project specification routines and showed that integrating previous development experience with subsequent development experience has significant impacts on a company's development performance.

As for the design and development of modular products, the theoretical basis of modularization is closely related to product architecture. The product architecture is a fundamental design concept pertaining to "how to divide a product into its parts, how to distribute product functions among them, and how to design and coordinate the interfaces between those components and the product functions they support" (Fujimoto, 2002b; Ulrich, 1995). It is also a concept regarding the interdependency between the functions of a product and its structures (Fujimoto, 2002b; Ulrich, 1995). In accordance with the complexity of the correspondence between product functions and structures, product architectures can be classified into two groups: integral and modular.

Baldwin and Clark (2000) used the case study of IBM System/360 to clarify the basic design rules of modularization and develop the theoretical foundation for product architecture. Based on Baldwin and Clark (2000), design rules are derived from architecture (which modules are part of the system and what their roles are),

interfaces (how different modules interact) and integration protocols and test standards (whether a particular module adheres to the design rules). In addition, Baldwin and Clark (2000) suggested a compatibility between product architecture and development organizational structure, since the design structure of the product heavily influences the development tasks and organizational structure. According to Baldwin and Clark (2000), the modularization of products has led to the division of labor among companies, which has evolved into clusters of companies specializing in specific components.

Subsequently, research has increased on the alignment of product architectures and development organizational structures in product development. Although previous studies have shown the compatibility between product architecture and organizational architecture, there have been few systematic empirical studies linking the two concepts. MacCormack et al. (2012) proposed the mirroring hypothesis, which predicts that these various organizational architectures will produce products with distinctive architectures, and examined the duality between product and organizational architectures. According to MacCormack et al. (2012), the mirroring hypothesis is tested using a design structure matrix for a set of products that implement the same functionality but are developed by different organizational structures. The results demonstrate that modularity is higher for products developed by loosely coupled organizations. Also, the results indicate that the diffusion costs of open source software development are higher for tightly coupled organizations than for loosely coupled organizations. In terms of practical implications, MacCormack et al. (2012) suggested that R&D alliances and open innovation require an integrated approach to project, product, and procurement management, with an emphasis on the fit between organizational structure and product design.

Based on a dynamic perspective, MacCormack and Sturtevant (2016) incorporated time horizons into their discussion and focus on the impact of decisions regarding the architecture of system software products on subsequent maintenance costs. MacCormack and Sturtevant (2016) focused on the concept of technical debt, which refers to design decisions that are expedient in the short-term can lead to increased system costs in futures. In other words, developers bear the consequences of all previous designs. In this regard, MacCormack and Sturtevant (2016) were concerned with the question of when and how to reduce technical debt related to system architecture. On the basis of this awareness of the problem, they analyzed system software products and demonstrated the relationship between architecture and maintenance costs. MacCormack and Sturtevant (2016) used a design structure matrix to quantify the level of system coupling between two types of architectures: hierarchical design and core-periphery design. Based on the results, refactoring was discussed along the time axis. MacCormack and Sturtevant (2016) conclude that the measures of coupling are an important predictor of maintenance costs. According to MacCormack and Sturtevant (2016), components with high levels of coupling are correlated with high maintenance costs in both architectures.

2.3.2 Adaptation of the Development Process

With the expansion of the IT industry at the end of the 1980s, products became increasingly complex and large, and the need to develop products in a systematic manner arose. In light of this context, much of the research on the activities needed to adapt to a rapidly changing environment has been conducted in the IT industry, which consists of both hardware and software.

Eisenhardt and Tabrizi (1995) extended their research to the entire computer industry, including PCs, minicomputers, mainframes, and peripherals, and examined effective development patterns, emphasizing adaptive processes as a response to environmental changes. Eisenhardt and Tabrizi (1995) examined the relationship between "experiential strategy" and "compression strategy", taking development lead time as a dependent variable. Eisenhardt and Tabrizi (1995) investgated 72 product development projects from computer firms in Europe, Asia, and the United States. The findings suggested that in a rapid changing environment, experiential strategies characterized by immediacy, iterativeness, and flexibility accelerate the adaption process and contribute to shortening product development periods.

Due to rapid changes in the environment, best practices in development methods have also evolved with respect to software development activities. Boehm (1988) and Cusumano and Selby (1995) examined this issue while focusing on development sites.

Boehm (1988) provided a detailed discussion of software development methods. According to Boehm (1988), in the early stages of the IT industry, the development of large systems for general-purpose machines, which was the mainstream at the time, was compatible with the waterfall model since the requirements could be defined in detail in advance, and development progress could easily be monitored. Thus, the waterfall model was adopted in many large-scale development projects. With the development of commercial software, requirements became less predictable, resulting in frequent changes in development processes. In response to these circumstances, the spiral model had been proposed based on the improvements to the existing waterfall model (Boehm, 1988). According to Boehm (1988), the spiral model emphasizes the importance of iteration among development processes, which enables quick response to changes in development projects by repeating the development loop multiple times instead of just once. Since the main development focus shifted from large-scale systems to commercial software, the spiral model, which can be more adaptive to change, became more prevalent.

Cusumano and Selby (1995) researched Microsoft's software development projects and found a new development methodology called the "synch-and-stabilize" model, which differs from the waterfall model and spiral model. By building products functional requirements in a modular manner, and testing them both upstream and downstream, this model allows the company to quickly respond to changing customer requirements in the rapidly changing field of commercial software. According to Cusumano and Selby (1995), it integrates and stabilizes product functionality by

performing frequent periodic builds of the product and sharing and synchronizing the results within the project.

Hence, in the management of activities related to adaptation to a rapidly changing environment, it is essential to seek proactive measures to accommodate that change, and emphasis is placed on providing flexibility in products and development processes.

First, in terms of product adaptation, it is proposed that modular products such as commercial software should be adapted to rapid technological changes by modularizing the structure of the product and platforming the core technology. It is important to note, however, that there are also a number of integral products with complex product structures that are subject to the same rapidly changing environment as modular products.

Considering the issue of how to adjust the architecture of integral-type products in order to adapt quickly to changing environments, it will not be as straightforward to apply the measures on modularization presented in the existing research. The need for a more comprehensive perspective on integra-type products is perceived as necessary.

In addition, the existing research clearly indicates the nature of hardware and software development activities within the IT industry. However, effective development patterns presented in the existing studies treat development activities as an intermittent process, which does not take into account the effects of interacting with the external environment after the release of the product. In continuous product development, which is the subject of this study, an interaction with the environment occurs multiple times even after a product has been released, and the product needs to constantly evolve through adaptive activities which are iterative in nature. Therefore, previous studies are considered to have aspects that make it difficult to interpret development activities with such continuity.

2.4 Literature Review on Operationalization of Adaptive Activities (Development Flexibility)

On the basis of the above line of research, consideration has been given to the economic costs and benefits of adaptation activities in the development process. In the context of this discussion, flexibility has been emphasized to understand how to deal with uncertainty associated with the ongoing process of development. By offering comparable measures of adaptation activities (economic costs and benefits of adaptation), flexibility allows adaptation activities to be disaggregated from company-level discussions to an inter-company analysis framework.

First attempts to introduce flexibility into new product development research were made by Thomke (1997) and Thomke and Reinertsen (1998). Thomke (1997) examined the influences of flexibility in the context of design technology. To examine the relationship between flexibility and development performance, Thomke (1997)

proposed the concept of design flexibility, which he described as the the incremental cost and time associated with modifying a design to accommodate exogenous changes. Thomke (1997) conducted a case study comparing integrated circuit design techniques (ASICs and EPLDs). According to Thomke (1997), projects that utilized flexible design techniques achieved 2.2 times more productivity (man-months) than projects that employed inflexible design techniques. Moreover, Thomke (1997) noted that more than 23% of the difference in development productivity can be attributed to differences in the management of design change risk.

However, since flexibility is often defined qualitatively, there is an aspect that makes it difficult to utilize it for the purpose of developing products when it is introduced into the development process. To address this issue, Thomke and Reinertsen (1998) attempted to operationalize flexibility, based on the same recognition of the issue as Thomke (1997). Thomke and Reinertsen (1998) presented a clear explanation of the concept of development flexibility, which includes the cost of additional product modifications in response to changes in both external and internal circumstances. Thomke and Reinertsen (1998) clearly defined the concept of development flexibility as a function of the incremental economic cost of additional product modifications to accommodate external or internal changes.

Further, Thomke and Reinertsen (1998) developed the construct of flexibility index, a ratio between the change in a perturbing variable and the change in projected profits over the lifecycle. By presenting the flexibility index, development flexibility is broken down into variables that can be measured quantitatively and operationalized. According to Thomke and Reinertsen (1998), there is a linear relationship between change and the flexibility index (FI), indicating that the higher the cost of modifying a product, the smaller the development flexibility. In order to promote flexibility, Thomke and Reinertsen (1998) suggested three approaches: adoption of flexible technologies, modification of process management, and leveraging of design architecture.

These studies, however, have been largely focused on the concept of flexibility and little attention has been paid to the mechanisms that behind flexibility. MacCormack et al. (2001) examine the requirements for achieving flexibility, utilizing a dynamic and uncertain environment as the basis of the analysis. MacCormack et al. (2001) investigated the interaction of information with products, customers and development teams. According to MacCormack et al. (2001), three constructs are proposed which would ensure a more flexible development process: greater investments in architectural design, earlier feedback on a product's system-level performance, and a development team with greater amounts of "generational" experience. Based on an analysis of 29 software projects, MacCormack et al. (2001) emphasized that investments in architectural design play a dual role in a flexible process. Their role is not only to evaluate and select various architectural options, but also to facilitate the flexibility of the development process itself.

Due to the servitization of business, the process of product development has become a continuous activity instead of a series of stand-alone projects (Buganza & Verganti, 2006). In a sustained project, how to respond to externally obtained information becomes more important, as new information is obtained or existing information

is changed as the project proceeds. Companies are expected to adapt their products quickly in response to user feedback. Thus, if the scope of the development process extends to after the product has been released, the interaction with external information in the development process is likely to occur not only during the planning stage, but also at multiple times during the development process. Many companies are confronted with the challenge of managing interactions between products and users at multiple times. The effective development patterns outlined in existing studies are unlikely to interpret development activities with such continuity.

Based on MacCormack et al. (2001), Buganza and Verganti (2006) further developed the concept of development process flexibility into the concept of product life cycle flexibility. According to Buganza and Verganti (2006), managing innovation is necessary in the whole product life cycle, based on the assumption that innovation is becoming a continuous process of activities. Specifically, Buganza and Verganti (2006) defined life-cycle flexibility (LCF) as the ability to adapt and redesign a product or service in response to changes in the environment as quickly as possible and at the lowest cost. Buganza and Verganti (2006) also attempted to operationalize LCF by combining flexibility metrics from existing research in the operations domain with the development flexibility in the product development domain. According to Buganza and Verganti (2006), LCF consists of three dimensions: frequency of adaptation, rapidity of adaptation, and quality of adaptation.

Subsequently, Buganza et al. (2009) refined the flexible theory model by subdividing environmental changes, which has rarely been discussed in the past. With respect to environmental turbulence, Buganza et al. (2009) attempted to structure it according to the sources (markets, technologies) and dimensions (rapidity and unpredictability). Moreover, Buganza et al. (2009) summarized the development methods for increasing flexibility proposed in previous studies and examined the relationship between the development methods and the environmental turbulence using case studies. In the results of case studies, it appears that for technological turbulence, companies normally emphasize rapid project iterations, whereas for market turbulence, companies normally leverage on (1) early experiments involving customers, (2) formal and cross-functional project team, and (3) flat organizational structure.

On the other hand, Cusumano et al. (2003) and Cusumano et al. (2009) conducted empirical studies with data obtained from software development sites to investigate the effectiveness of development methods.

Cusumano et al. (2003) conducted an international study covering 104 software development projects in India, Japan, Europe, and the United States to better understand the realities of software development sites as well as the relationship between methodological methods and the performance of the product. In particular, four types of software development projects were analyzed at the time, including system software, application software, custom or semicustom software, and embedded software, with international comparisons focusing on development processes. According to Cusumano et al. (2003), there is a significant difference between product performance and development methods among countries and regions. In terms of development methodologies, Cusumano et al. (2003) observed that 64% of projects divided work into sub-cycles, and found that a more flexible and iterative development

approach was widespread across countries. In terms of specific differences in development methods, Cusumano et al. (2003) estimated that many Japanese projects in the upstream design phase follow a waterfall structure, whereas the United States has a more flexible approach.

Cusumano et al. (2009) revisited the empirical results of Cusumano et al. (2003) and incorporated the findings of subsequent studies to provide suggestions for software development. The suggestions were focused on selecting a development process, structuring global design chains, managing the interaction between project structure and software design, and balancing innovation with efficiency.

Regarding effective development methods, Cusumano et al. (2009) stated that there is no "best practice" that applies to all projects and situations, both waterfall and iterative methods have their place and can be effective depending upon the specific project context. Cusumano et al. (2009) emphasized that managers must choose a combination of practices and integrate them into a coherent process that's aligned to their business context.

In accordance with research on product development processes, the operationalization of the concept of flexibility has evolved from the initial flexibility index to life-cycle flexibility. As a key concept, flexibility allows adaptation to be broken down from a company level discussion to an inter-company analysis framework by providing comparable measures of adaptation (economic costs and benefits). Various factors, including increased flexibility in development, increased investment in architectural design, and the use of standard technologies, have been considered as contributing factors to the development performance (Buganza & Verganti, 2006; MacCormack et al., 2001). However, these studies are premised upon an assumption of a stable and sufficient supply of development resources, which can result in a large disparity between the management of development sites under conditions where development resources are constrained. In this regard, it is necessary to reconsider the effects of development flexibility and the effectiveness of related development methods.

2.5 Literature Review on Game Industry

Next, the author examines the research of the game industry. Initially, the author introduces literature on the video game industry, which is the origin of the modern game industry. Additionally, the author discusses the online game industry in more detail.

A series of Kohashi's studies (Kohashi, 1993; Kohashi & Kagono, 1995) highlighted the video game industry for the first time in business administration. Based on survey data from Nintendo and other companies, Kohashi and Kagono (1995) provided two important implications related to the success of the Japanese home video game industry. First of all, ambiguous and implicit images play an important role in product design. Kohashi and Kagono (1995) argued that the sharing of images within the team is an important aspect of the development of game software. Another

implication is the relationship between software development and Japanese management styles. According to Kohashi and Kagono (1995), compatibility between the characteristics of Japanese management and those of game software development has a positive effect on development.

Baba (1998) attempted to clarify the characteristics of game software development in relation to traditional software development. Based on the case study, he proposed that game software development is an emerging activity that requires a different approach than conventional software development.

Shintaku et al. (2003) conducted a comprehensive and multifaceted study of the video game industry in the 1990s, including an analysis of the software industry as well. They proposed a new classification framework after clarifying the actual situation of corporate activities in the game industry. With data from more than 20 companies, they suggested a classification axis that focuses on the activities of software development and publishing in addition to the conventionally used framework based on platform types. Moreover, Shintaku et al. (2003) focused on the internal and external game development, suggesting that there is a certain correlation between factors such as the choice between internal or external game development and the product development performance. In particular, they pointed out that the accumulation and utilization of development know-how within a company can be a strong positive factor in the development of game products.

Tatsumoto (2002) focused on the software development and examined the compatibility between the product and the development process. Tatsumoto (2002) discussed the waterfall model and synch-and-stabilize model, both of which are suitable for business-oriented PC software development. He then compared them with video game development, where Japan has a competitive advantage, and identified the differences between the development processes involved. Since in the case of game software development, especially in the case of new type game software development, there are no specified functional goals, he suggested that the development process may be distinct from the above models and proposed the "exploratory model". According to Tatsumoto (2002), the typical exploratory model involves exploratory outline design, concurrent detailed design and coding, as well as frequent coupling tests.

Ikuine (2012) clarified which types of innovation patterns are generated when product innovation is not constrained by process innovation, and what causes these innovation patterns to emerge. In the case of game software development in the video game industry, he demonstrated the chronological change of innovation and revealed the phenomenon of the tendency of creative innovation to decrease. Ikuine (2012) presented the key concept of the "development productivity dilemma" in which it is difficult for companies to combine the expansion of product functions with improved development productivity. As a result, companies will maintain expansion of product functions at a certain level and aim to increase development productivity in order to maintain their competitive edge. In relation to the factors responsible for the innovative pattern found in the game software industry, Ikuine (2012) focused on the endogenous factors within the industry and explained that it results from the

synergistic effects of the behavior of game software development companies, product recognition and purchasing behavior of users, and the distribution process.

Among the studies of online games as research subjects, Nojima (2002), Wi (2006, 2009) are discussed.

Taking into account the relationships between community and companies activities, Nojima (2002) recognized the online games industry as a kind of "place business" and analyzed the case studies of Korean online game development companies. Using case studies of Korean online game companies, Nojima (2002) discussed strategies for constructing corporate strategies in places of business to increase profitability, such as increasing the attractiveness of products and services, and increasing the attractiveness of communities.

The study by Wi (2006, 2009) analyzed the Korean online game industry from an industrial level perspective, as well as its development path and success factors. Wi (2006) identified four factors that have contributed to the rapid development of Korea's online game industry: independent development by developers with advanced server and network technologies, an immature video game market, complementary infrastructure such as ADSL, PC bang (Internet cafes in South Korea), mobile small-amount payment systems, and government support for industry promotion. Furthermore, after explaining the business model of online games, Wi (2009) stressed the importance of interaction with users in the development process of games.

There is a substantial body of research on the game industry. Among them are studies that examine the management of game software development. However, the effective development patterns and organizational capabilities of game software have not been fully clarified. Furthermore, since most previous studies have been conducted in the video game industry, which has intermittent development projects, the findings may not be applicable to online game development, where continuous development is predominant. The majority of game studies to date have limited their scope to Japanese game developers. The reason for this can be explained by the competitive advantage that Japanese companies possess in the video game market. With the rapid growth of online game industry, game development companies from Korea, China, and other countries are emerging. Thus, it is essential to consider the online game industry, which has a high level of international comparability, as a research subject from the perspective of product development at both the industry and company levels.

2.6 Organizing Prior Research and Identifying Research Gaps

In this section, the author discusses three research gaps after verifying the reach of research in related fields by reviewing the studies described above.

The first research gap is the intermittent nature of product development activities. With the shift from products to services, the process of product development

has evolved into an ongoing activity rather than a series of stand-alone projects (Buganza & Verganti, 2006). If the development process is extended to cover post-product release, it can be assumed that the interaction with external information in the development process occurs not only during planning, but also at multiple times throughout the development process. The challenge facing companies is how to manage the multiple times interactions between products and environments. Effective development patterns presented in existing studies consider development activities to be intermittent in nature, which may make it difficult to interpret continuous development activities. In addition, the theoretical and empirical approaches to the management of continuous product development are not sufficiently advanced.

The second research gap is the complexity of adaptation activities for integral products. With regard to the continuity of development activities, from the perspective of product structure, modular products such as commercial software are often taken up as research targets, without a comprehensive examination of integral products. The development of integral products, which have a complex product structure, is considered to be more complex when it comes to adapting to rapid changes. Hence, it may be difficult to apply the measures on modularization presented in previous research.

The third research gap is the effects and objectives of adaptation activities. According to previous studies, it was assumed that by improving flexibility, it was possible to adapt products to external environmental changes, resulting in higher product performance. However, the logical development presented in the previous studies is premised on a sufficient and stable supply of development resources. Organizations engaged in development often face difficulties in procuring sufficient development resources when needed, and how to effectively use limited development resources to provide high-quality adaptation activities at an optimal frequency is a pressing concern in the development sites. Under the condition that development resources are limited, excessive product adaptation activities by companies are likely to deteriorate the product's performance. Additionally, when faced with a large amount of external information as a target of adaptation activities, there is little research on the criteria that should be used to select information from the external environment, and how this information should be incorporated in the product.

2.7 Analytical Issues of This Book

Based on the above research gaps, this book sets two analytical issues.

2.7.1 Analytical Issue 1

What impact does the multiple adaptation activities that take place during the product life cycle have on the product's performance as development activities become more continuous?

Analytical issue 1 discusses the relationship between product performance and adaptation activities during product development. Previous studies have discussed the importance of adaptation activities in the face of rapidly changing external environments. Yet there is heterogeneity among development resources, capacity building, and development policies pertaining to development projects which are the subject of adaptation activities. Because of this heterogeneity, it will be more difficult to manage adaptation activities in the development sites. Therefore, this study explores the impact of adaptation activities on product performance based on the attributes of development projects.

2.7.2 Analytical Issue 2

What are the most effective development patterns for products and industries characterized by continuous development activities?

Throughout this book, the author examines effective development patterns in products and industries characterized by continuous development activities from four perspectives: external information and products as adaptation targets, development flexibility and collaboration among departments (especially in the development and operation) as the adaptation entities.

In terms of the two issues discussed above, it can be expected that they will academically complement related areas of product development research by specifically identifying continuous product development, a topic that has not been sufficiently explored in existing research, as well as by examining the nature of its effective management. Additionally, introducing the concept of development resource constraints into the existing product development model based on the actual situation in the development sites is thought to have practical implications for development companies.

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Chapter 3
Research Design and Analysis Methods

In the preceding chapter, an analysis of previous studies is conducted, and the analytical issues is summarized. The purpose of this chapter is to provide a conceptual framework for analyzing and answering the questions.

3.1 What is the Concept of Continuous Product Development Defined in This Book?

In this book, continuous product development is defined as a process of adapting products to changes in the external environment multiple times during their development. There are four fundamental differences between continuous development activities and traditional intermittent development.

- Adaptive activities are completed within the same product, and that same product is continuously evolving while adapting to environmental changes.
- In order to maintain a product's performance, repeated (iterative) adaptation activities are vital.
- As information is continuously flowing into the development organization from the external environment, it is more difficult to manage uncertainty.
- The development activities of the same development organization must be continued for a long time to ensure product performance.

Thus, in order to effectively manage continuous development activities, the ability to adapt products to changes in the development process is essential (Fig. 3.1).

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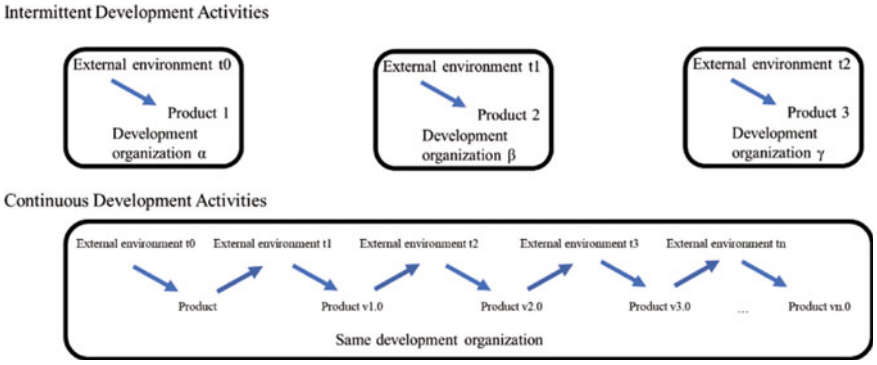

Fig. 3.1 Comparison of intermittent development activities and continuous development activities

3.2 Analytical Perspectives and Methods

Figure 3.2 illustrates the framework for analyzing the two analytical issues raised in this book. In Chap. 1, the author proposes a model that incorporates the fact that development resources are constrained in order to reflect the real development sites better. In order to optimize the supply and demand balance of development resources, the author examines continuous development activities from two perspectives: supply and demand for development resources.

Figure 3.2 also shows how the chapters are positioned within the framework. Chapter 4 provides a historical overview of the development of the Chinese game industry, which is characterized by the majority of its products being online games. It focuses specifically upon online game development activities. Chapter 5 provides a comprehensive analysis of the factors affecting the supply and demand for development resources, based on survey data collected in the online game industry. Chapter 6 takes a qualitative approach to examine the relationship between development flexibility and product performance in more detail, focusing on projects from both groups (small and medium development companies vs large development companies). Chapter 7 discusses a case study which illustrates how a company was able to reduce its development load by adjusting its product architecture and feature configuration. Chapter 8 discusses the impact of user interaction on product performance through case study analysis and computer simulation of game operation activities. In Chap. 9, the results of the previous analysis are summarized, the contribution of this research is explained, and future issues are discussed.

In order to properly investigate the development activities of actual companies by using the analytical framework presented in this chapter, it is necessary to promote detailed research regarding the actual situation of the development sites, the project status, and the development organizations. Hence, the goal of this book is to derive a hypothesis from previous research and preliminary investigations, and then verify the validity of the hypothesis based on quantitative empirical analysis. Qualitative analysis, such as case studies, is also used to clarify the specific mechanisms involved.

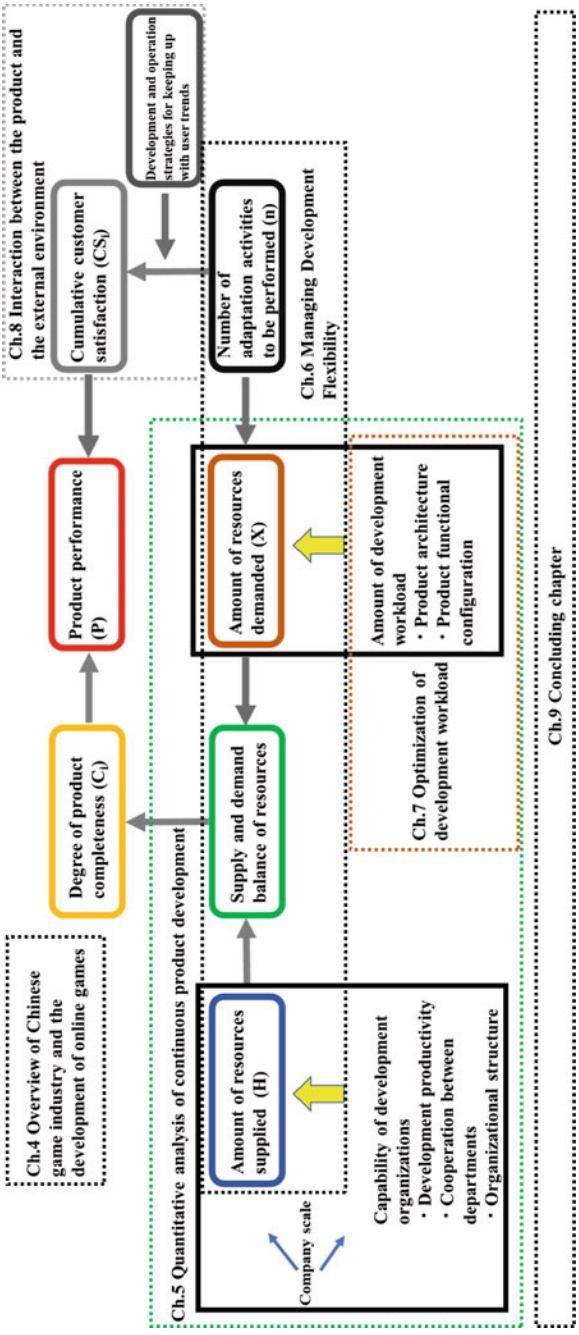

Fig. 3.2 Analytical framework of this book

Additionally, the interaction between the external environment and the product is examined using a simulation approach.

To gather the data for this study, the author utilizes primary sources such as interviews, field studies, and survey data from development companies in the industry, as well as published materials such as white papers, reports, and news-paper articles published by industry associations.

3.3 Selection of the Research Target

In this book, the author focuses on online game industry in China as the subject of investigation.[1] The four main reasons for this include product complexity, rapid environmental change, continuity of development activities, and the limited development resources available to companies in emerging economies.

In the first place, game software is a product with a relatively low technical difficulty, but the development of the product is extremely challenging. This type of software is designed to provide entertainment for users. The process of reflecting the added value of enjoyment in each component and attribute of the product is extremely complex and difficult to accomplish. The evaluation criteria for game software can vary from user to user, and are rarely made explicit by the users themselves. Developers of game software are constantly faced with ambiguous and multifaceted requirements (Ikuine, 2012). Accordingly, the success or failure of the upstream process associated with the implementation of the ambiguous and multifaceted requirements into each of the attributes and components of the product has a considerable impact on the overall product development. It is especially difficult, when it comes to online games, to elicit the latent needs of users via marketing surveys in the same way as it is with console games. Post-production exploratory activities, such as data-driven analysis after the release of the product, are more critical than preliminary exploratory activities. The primary reason for choosing online games is to be able to examine the management of this type of exploratory product development.

Secondly, changes in the external environment can be viewed in two different ways: from the viewpoint of the market and technology. In the context of the market, changes in user needs across the entire game industry, including online games, are extremely uncertain and also extremely rapid. This necessitates the ability to adapt quickly. As for technology, technological advances in the game development environments and the development tools are also occurring at an accelerated rate. Additionally, the spread of smartphones has led to the emergence of a new market category, mobile games, which is further speeding up changes in the industry. As

[1] The Chinese game industry has so far developed an industry structure based pre-dominantly on online games, and has built a robust freemium business model to support the industry's sustained growth. The majority of its products are online games (PC-based online games, browser games, mobile games). Thus, from a product perspective, the Chinese game industry is more appropriately referred to as the Chinese online game industry.

hardware specifications improve, technological developments related to integrated development environments are continually updated.

The third reason is the continuity of online game development activities. Unlike console games, online games require constant development of new content in order for users to stay engaged, since a single title needs to run for a long time. Frequently updated content is critical. The game development team collaborates with the operation team to evolve the game through a series of small and large updates. It is therefore considered to be a suitable research subject in answering the research questions of the study.

The fourth reason is the limited development resources available to companies in emerging countries. In the context of development, since most of the research targets discussed in existing studies are companies in developed countries with sufficient development resources, limited development resources will not be an issue. As a result, the logical development of the existence of a linear relationship between development flexibility and product performance is premised on the assumption of an adequate and stable supply of development resources. It has been suggested that an approach that increases development frequency while maintaining a certain degree of development completion by generously investing resources into product adaptation would be effective in such a scenario. Nevertheless, to examine the impact of the additional condition of limited development resources presented in this study on the nature of effective management, it is necessary to consider companies with varied development histories and development resource sufficiency as compared to companies in developed countries. The study therefore focuses on the online game industry in China, a developing country. Unlike the United States, Japan, and South Korea, Chinese game industry has successfully made the transition from developing PC-based stand-alone games to developing online games without going through the development phase of console games. In this regard, it is possible to reexamine the nature of effective management based on the heterogeneity of the development process and capacity-building of companies in developing countries. During the past few years, the mobile games market, which has low entry barriers, has grown rapidly, encouraging many small and medium development companies to enter the market. Since small and medium development companies have been entering the market recently, it can be assumed that the diversity of company behavior resulting from differences in company size will increase, as well as the risk of facing resource limitations. The online game industry in China is considered suitable for examining the actual condition of development activities within the constraints of limited development resources.

For a comprehensive understanding of the online game industry in China, which is the subject of this study, the following chapter introduces the history of its development, highlighting the evolution of product groups and business models. After an analysis of the historical development of the industry, the characteristics and issues of the current online game development is discussed.

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Chapter 4
Overview of the Chinese Game Industry and Characteristics of Online Game Development

4.1 Introduction

The previous chapter provides a conceptual model and a framework for answering the analytical issues mentioned. Further, the reasons for selecting Chinese game industry as a research target are outlined. It emphasizes the heterogeneity in companies' development histories and capacities as well as the high risk of facing limited development resources. The question remains, however, as to how Chinese game industry has developed, as well as why many small and medium development companies lacking sufficient development resources were able to enter the industry.

In this chapter, the history of Chinese game industry is reviewed by focusing on the evolution of product groups and business models. After examining the development history of the industry, the characteristics and issues related to the current online game development are described qualitatively.

4.2 Development of Chinese Game Industry

4.2.1 Pre-2000 Period: Coexistence of Pirated and Official Versions of PC-Based Stand-Alone Games

Industry Overview

Chinese game industry has developed in a distinctively different way than that of Japan, South Korea or the United States due to the fact that it has made a dramatic shift from PC-based stand-alone game development to online game development without going through the traditional console game development phase. Since the 1990s, as console games have become increasingly popular in nations around the world, a similar market had also emerged in China. However, this market was illegal (Nakamura & Wirman, 2021).

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Because the intellectual property system was not adequately enforced at that time, domestic manufacturers produced and sold imitations of console hardware and corresponding software, and so-called pirated hardware and software were available in the domestic market. On the other hand, since 2000, the sale of console game machines and game software in China has been prohibited, making the sale of legitimate products illegal. As a consequence, in the early stages of Chinese game industry, the console game hardware and software market existed as a gray zone, which had not reached a large scale, remaining small and illegal. Despite the fact that most game consoles from the late 1990s to the present were made in Chinese factories, production and sales for the domestic market were prohibited until the lifting of the relevant market ban in 2014.

Amidst the strong restrictions on foreign console games at the time, Chinese self-developed PC-based stand-alone games had gradually gained market acceptance since 1995 and had developed a legitimate game market. It is a computer game that runs independently on a single computer without being connected to the Internet. The implementation of regulations concerning foreign products contributed to some degree to establishing the initial conditions for the development of independent PC-based stand-alone games.

During that period, most of the development companies were small companies with fewer than ten employees. Also, many of the development companies had switched from commercial or educational software development to game development. Since Chinese game developers had not experienced the console game period, their development base was weak, with an insufficient amount of technological accumulation and a lack of understanding of the entertainment aspects of games. A large technological gap existed between them and Japanese and Western developers. Domestic development companies were actively seeking to incorporate traditional Chinese culture by referring to the systems and character designs of games popular in Japan and Western countries. Small and medium development companies had been set up throughout China to take advantage of this blank market, and these companies were pursuing independent development through trial and error. As a consequence, a variety of PC-based stand-alone games, such as RPGs and simulations, were developed in the late 1990s, leading to the formation of the game market. CGPA and IDC estimated that the related market for PC-based stand-alone games reached 150 million yuan in 1999. In the early stages of Chinese game industry, the independent development of PC-based stand-alone games contributed greatly to the development of human resources and the accumulation of technical know-how (CGPA & IDC, 2005). Yet, self-developed PC-based stand-alone games also encountered the same challenges of piracy as console games overseas, and many game development companies were severely affected by piracy. In addition, because of the low level of home PC ownership in the 1990s, game-related markets remained limited.

Business Model

PC-based stand-alone games followed a similar business model to those for console games during the same period, with companies selling software as a product and

users buying and installing the software on their PCs to play games. Developers derive most of their revenue from the sale of game software, with nearly no revenue from advertising or hardware sales. A certain number of game software had to be sold in order for development costs to be recovered. Since the number of game software sold was dependent upon uncertain factors such as the quality of the game itself, advertising, and distribution, this was a business model with low revenue stability and high risk.

Additionally, as part of the external market environment effects, the negative impact of copyright infringement did not just extend to game software, but also extended to many development companies. In many areas, piracy laws were not completely enforced, which allowed pirated game software to be sold at 10–30% of the price of legitimate products on the market. It was fatal to the sales of legitimate game software. Due to the small profits that were being returned to the development companies, there was limited room for growth. It had become extremely difficult to recover development funds and to develop PC-based stand-alone games continuously. Many developers were thus forced to withdraw from the game market, and some of them began to develop educational and business software by utilizing their accumulated development expertise, which was significantly less vulnerable to piracy.

During this period, independent development was accompanied by the business model of selling overseas PC-based stand-alone game products as domestic distributors. Because of regulatory policies, foreign developers were not allowed to sell games directly in China at the time. Foreign PC-based stand-alone game products were introduced to the Chinese market by signing a distribution agreement with the domestic distributors and by exercising exclusive agency and sales rights to the related game products in the Chinese market.

4.2.2 2000–2010: Formation and Growth of the Game Industry

Industry Overview

The decade between 2000 and 2010 is considered to be the formative and growth period of Chinese game industry. With the popularization of the key product, online games, new users and development companies entered the industry around 2000, and the industry as a whole experienced rapid growth. In the late 1990s, online games became popular in South Korea, leading to a new business model of monthly charges, which attracted the attention of Chinese IT companies.

As mentioned earlier, the growth of the Chinese game industry was limited due to the business model of PC-based stand-alone games not being able to compete effectively with pirated copies. Several major IT companies recognized online games as a great business opportunity because monthly charges could effectively combat piracy, and were actively involved in introducing Korean online games to China. Specifically,

these companies established subsidiary operating companies to handle the localization and operation of online games for the Chinese market under an exclusive operating license with Korean developers. In the course of implementing the service, the Chinese operator had little knowledge or experience regarding the installation, maintenance, and servicing of servers required for online games. Due to this, the principal method of obtaining information was through the Korean development companies with which they had contracts.

In July 2001, Shengda Network, based in Shanghai, took over the Chinese operation of the Korean online game "The Legend of Mir 2" (translated as "Chuanqi" in Chinese). Localization and operation of the game content by Shengda Network were highly praised by Chinese users at the time, and the goal of 100,000 maximum simultaneous connections was achieved within six months. At that time, China's three largest portal sites, SINA.com, SOHU.com, and NetEase, were all involved in Chinese game industry. During 2002, Sina launched the Korean online game "Lineage" (called "Tiantang" in Chinese) in the Chinese market. In 2002, Sohu signed a business cooperation agreement with Korean developer WIZGATE for the localization and operation of "Knight Online" for the Chinese market. In the same year, NetEase independently developed "The Mythical Journey to the West II", an RPG game based on the story of the novel "Journey to the West". With the entry of three major portal sites with stable sources of revenue, high-quality games as well as improvements in the operating environment have been produced, which is thought to have encouraged the development of Chinese game industry.

As for the PC utilization environment, which is imperative for playing online games on PCs, Internet cafes (called "Wangba" in Chinese) was becoming increasingly popular in major cities in China as legal entertainment facilities, and the environment for using PCs had improved.

In 2001–2005, the overall market for online games grew from 310 million yuan in 2001 to 910 million yuan in 2002, an increase of approximately 300% over the previous year, as numerous development companies have entered the field since 2000. The market has shown a rapid growth rate of about 300% year on year. Furthermore, the online game market in China generated revenues of RMB 3.777 billion in 2005, an increase of 52.6% from 2004. Additionally, there were 26.34 million online game users at the end of 2005, an increase of 30.1% over 2004 (CGPA & IDC, 2005). The PC-based stand-alone games market, on the other hand, stagnated in 2005, with a total of 71 games launching on the Chinese market in 2005, a decline of 32.8% from 116 in 2004 (CGPA & IDC, 2005). Only one game was developed independently by a Chinese developer, and the remaining 70 games were sold by domestic distributors from overseas developers (CGPA & IDC, 2005). Therefore, it can be noted that the development resources of domestic developers have shifted from PC-based stand-alone games to online games, and the proportion of PC-based stand-alone games in the overall market had gradually declined.

With the entry of Korean online games in the Chinese market, lawsuits with Korean development companies are also on the rise over disputes over licensing and revenue sharing arrangements. When online games developed by overseas companies are operated on the Chinese market, the Chinese side has little or no influence over game

content and must give high priority to the wishes of overseas companies with regard to the frequency and content of updates. Chinese game operation companies realized that simply focusing on management of game operations, such as maintenance, would make it easier for them to be controlled by Korean development companies with which they contracted, and would do little to increase their competitiveness. This led them to reconsider the possibility of developing their own intellectual property. Some of the game operation companies had gradually increased their investment in development resources while transforming themselves into development companies with integrated development and operations similar to those in Korea.

Various games were created and released which incorporated elements of traditional Chinese culture to meet the needs of domestic users. During the formative years of the industry, the emergence of this group of self-developing companies has contributed to the rise of the overall market by driving the industry as a whole with their technical skills and excellent management systems.

Regarding the development of the online game market between 2006 and 2010, China's online game market's revenue reached 32.37 billion yuan in 2010, up 26.3% from 2009 (GPC & IDC, 2010). Compared to the market size of 3.77 billion yuan in 2005, the market has grown tenfold in five years. By the end of 2010, the total number of users had reached 75.98 million, with 43.06 million paying users. Moreover, according to the content of the product category, the sales of Chinese-made online games in 2010 were 19.3 billion yuan, making up 59.6% of the total market size in the same year (GPC & IDC, 2010). Consequently, the percentage of self-developed games was increasing, which indicated that many developers are shifting away from the business of operating Korean-made online games and instead focusing on developing their own games to develop a fully integrated development and operations business.

In particular, the widespread use of new products such as browser games is thought to contribute significantly to the growth of independent development and market expansion. Browser games are games which can be played through a web browser. These games have the advantage of being accessible from anywhere without the need to download and install game software. Users can play them immediately by registering with a web browser as long as they have Internet access. With the advancement of web technologies (Web 2.0), web browser-related technology has become much more advanced since 2005, and many major developers have begun to monetize their games on the new web browser platform.

Business Model

During the period 2001–2005, the main revenue model for online games was based on playing time, with users paying a monthly or hourly fee to purchase the duration of the game. The flat-rate, pay-per-play model for online games provides developers with a continuous and stable source of income. By charging users a fixed amount every month, developers and operators can expect a certain amount of monthly revenue, which will reduce long-term development risks. For anti-piracy measures, unlike conventional PC-based stand-alone games business models, when a game is installed on a PC and launched, the user needs to authenticate and connect to the server. These

measures effectively eliminated the opportunities for pirate companies to destroy the market with illegal copies of legitimate software.

There were few professional game development companies in China at that time, and many games relied on the content provided by Korean companies. It is necessary to note that the cost of operating a company in China is divided into two parts: the cost of the license and the actual costs of operating in China. Furthermore, the ratio of the operating license cost to the total cost was high.

The Chinese operator offered a highly convenient payment method to users by establishing a prepaid card distribution network, which was mostly distributed through Internet cafés. To facilitate the purchase of prepaid cards, the company had signed agreements with Internet cafes in major cities for the sale of prepaid cards. At an Internet café, users could purchase a prepaid card and charge it to their account, and the usage period would be updated in real time.

There has been a constant search for better revenue models for online game developers, and since the beginning of 2005, the revenue model appears to have shifted to the freemium business model, mainly to attract new users (CGPA & IDC, 2005). In a typical freemium business model, the game is essentially free, and monetization comes from special items sold for a fee. There are various types of convenience items that can be charged for, including reducing the time required for certain requests, powerful items, and rare items. As a feature of the freemium business model, users can determine how much they wish to spend on the game. Prior to the application of the freemium business model, all user groups were composed of paying users. The widespread use of freemium business model has, however, promoted diversification of the user group, created a group of non-paying users, and contributed greatly to the growth of the user base.

Furthermore, advertising revenue was being generated by integrating in-game advertising and collaborative items as joint projects with other industries. With the growth of the online game market, innovations in business models were being innovated, and the profit structure was becoming more diverse.

4.2.3 2010–2015: Multi-platform Development of Online Games

Industry Overview

Since 2000, Chinese game industry has been experiencing rapid growth and, since 2010, it has entered a period of industrial structural adjustment (GPC & IDC, 2010). Annual growth rates for game users and industry scale have slowed down, the market share has gradually begun to concentrate in the hands of the largest developers. The rapid growth of major game developers such as Tencent, Shanda, NetEase, Perfect World, Sohu Chang you, etc. have contributed to the development of the game market. Furthermore, as leading companies, they have also contributed to

the enhancement of the development technology for the entire industry, including independent development and operational know-how for the Chinese market.

The game market in China grew to 500 million users in 2014. Nevertheless, the growth rate in 2014 was 4.6%, and it is expected to continue to decline. Increasing the average revenue per user (ARPU) became increasingly important for game development companies. On the other hand, the overall size of the game market continues to grow steadily, exceeding 30%. Looking at the overall market, the Chinese games industry has maintained an impressive growth rate since FY2013, and in FY2014 it increased by 37.7% compared to the previous year, reaching 114.48 billion yuan (Fig. 4.1).

The domestic market share is as follows: PC-based online games ranked first with sales of 60.89 billion yuan, accounting for 53.19% of the total; mobile games ranked second with sales of 27.49 billion yuan, accounting for 24% of the total; and browser games ranked third with sales of 20.27 billion yuan, accounting for 17.7%. It is notable that the mobile game market has a high growth rate. Since 2012, this sector has maintained a high growth rate with 90.6% in 2012, 246.9% in 2013, and 144.6% in 2014. In 2014, the number of mobile game users increased by 15.1%, reaching 358 million (Fig. 4.2).

Note: According to GPC, IDC and CNG (2014), each product category is defined as follows.

PC-based online games are one of the forms of online games, they require that game client software be installed on the computer for them to work. Majority

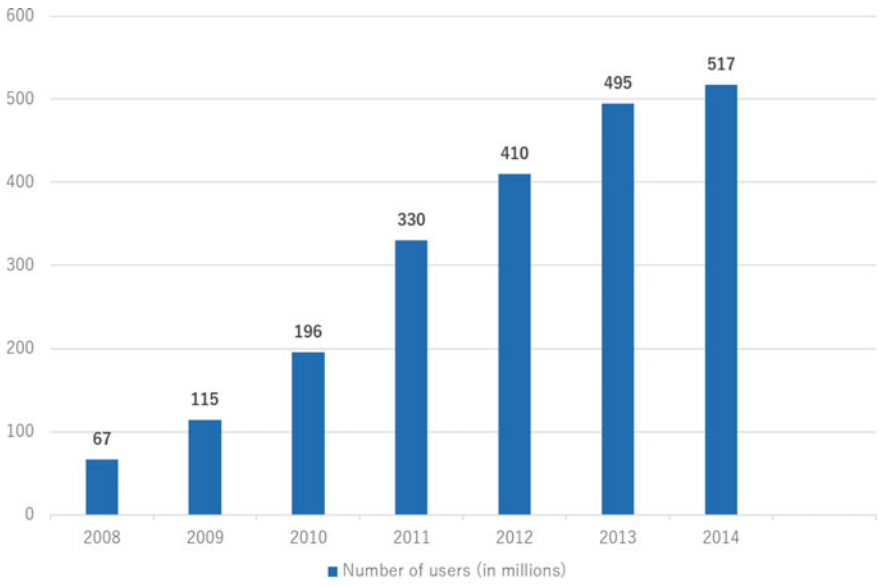

Fig. 4.1 Number of game users in the Chinese game industry (2008–2014). *Source* Prepared by the author based on GPC, IDC and CNG (2014)

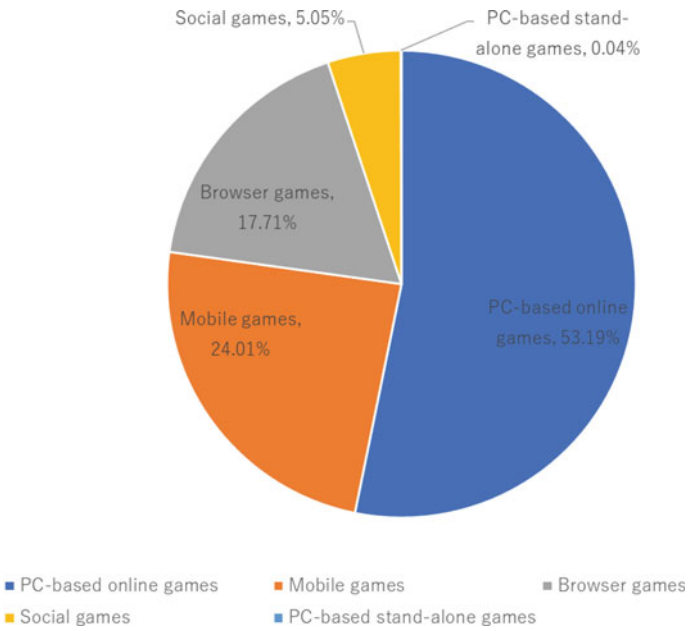

Fig. 4.2 China's domestic market share by game genre (FY2014). *Source* Prepared by the author based on GPC, IDC and CNG (2014)

of PC-based online games refer to massively multiplayer online role-playing games and casual online games.

Browser games are online games that can be played directly through browsers, without requiring users to install any software.

Social games refer to online games played within a social network service community. These games help to enhance communication between individuals through interactive entertainment. The key characteristics of social games are high interactivity, easy to play, mainly fun and casual content and high participation by users.

PC-based stand-alone games are based on independent PCs and softwares, and are primarily played by a single player or a limited number of users in a network environment using IPX/SPX protocols.

Mobile games refer to online games that run on mobile devices, which are generally multiplayer online games utilizing the mobile Internet as the transmission medium, the game operator's server, and the player's handheld device as the processing terminal, mobile payments as the payment channel, and game client software as the information interface.

Increasing development and operational costs associated with the transition to richer content in games has reduced the industry's average profitability and raised

entry barriers. Also, as competition in the industry intensifies, online game developers was placing greater emphasis on building internal human resources development systems. Game developers used various methods to ensure the stability of their workforce and are utilizing internal and external resources to implement talent development programs.

Since 2010, the capital markets for the online game industry have settled into a steady state, with investors shifting from outside venture capital firms and major companies in associated industries to major developers in the industry. The expansion of financing channels and the increase in retained earnings provided developers with the resources they required for product innovation and diversification. Investment funds are set up by some companies for the purpose of promoting investments in small and medium development companies with development potential. Additionally, some major developers diversified their content business by actively entering related sectors such as film, television, animation, and literature. For example, in 2010, Perfect World announced its strategic investment in the entertainment industry, including film and television, in order to explore user resources and promote the two-way flow of users between gaming and other related industries.

Business Model

In addition to MMORPGs, other genres of games have also adopted this model. There are two significant trends that have evolved from the pre-2010 business model, namely the platformization of game content and the subdivision of the chargeable items.

Platformization of Game Content

Major game development companies typically develop and operate multiple game titles simultaneously. Previously, user management was divided by game title. As product portfolios grow, the use of dedicated platforms that integrate products has become increasingly common in order to maximize synergies between products. All of the company's games are integrated into a single platform and centrally managed by dedicated software. Dedicated platforms serve as a one-stop shop that integrates the three functions of publishing games, attracting users, and paying. Once the user has installed the platform software on their PCs, they will be able to access all of company's game titles in one place. Additionally, it is expected to increase the exposure of titles by linking multiple titles through collaboration items, special events, and other activities. The platform also includes dedicated payment functions, greatly improving the convenience and security of the payment process. It is anticipated that these efforts will broaden the number of opportunities for users to be exposed to a company's product series, and promotions for new titles will be delivered directly to the target user base. As the system is managed by a common server system, a considerable amount of operating costs could be saved, as well.

Subdivision of the Charged Items

Charged items has become increasingly focused on the user's identity in the game community since 2010. Besides the pursuit of convenience, users are also creating

their own in-game characters, and customized gameplay is increasingly integral to the gaming experience. Accordingly, the segmentation of charged items around a user's status in the virtual world has increased. In addition to character appearances and ornaments, rare items that indicate status have become popular.

4.2.4 2015–Present: Shrinkage of the PC-Based Online Game Market and Rapid Growth of Mobile Game Market

Industry Overview

Since 2015, the game industry has experienced a platform transition, and development resources are shifting from PC-based online games to mobile games. The overall market revenue for 2019 was 230.88 billion yuan (+7.7% YoY), and the user scale was 640 million people (+2.5% YoY). Although the market is growing, the rate has slowed dramatically over the last few years (GPC & IDC, 2019). In terms of market share by product, mobile games accounted for 68.5% of the market with sales of 1.581 billion yuan, while sales of PC-based online games made up 26.6% of the market with 61.65 billion yuan. The mobile game sector is considered to be the most dynamic segment of the entire game industry. Due to the limited growth in users in the game industry, the mobile game market is expanding rapidly, eroding the existing PC-based online game market. The business model of mobile games is primarily based on charged items, which is similar to that of PC-based online games. On the other hand, from the perspective of usage environments, it is important that mobile games can be played quickly and be accessible to a wide range of light users, while securing a certain amount of core users. It is therefore not surprising that the mobile game market has grown rapidly since it has been able to develop new game content and user segments.

The domestic mobile game market continues to be dominated by Tencent and NetEase. The existing industrial structure presents a situation where large development companies lead the industry, with many small and medium development companies entering the market (GPC & IDC, 2019). At the end of 2018, there were 199 companies listed on Chinese and overseas stock exchanges, of which 44 were in Guangdong, 39 in Beijing, 22 in Zhejiang, and 21 in Shanghai (GPC & IDC, 2019).

Over the past few years, the Chinese game industry has not only increased its market size but also made a good start in expanding on an international scale, with several Chinese game development companies acquiring overseas game development companies and entering overseas markets. Overseas markets are becoming increasingly important sources of revenue. Chinese game development companies have developed long-term and stable cooperative relationships with several overseas publishers, including Facebook and Google Play. Furthermore, as game development companies expand overseas, it is becoming increasingly common for them to promote the hiring of foreign developers overseas or to invite foreign developers

to China, and there is an increasing number of developers who have returned from studying abroad or who have work experience working for overseas development companies. The hiring of these overseas personnel is facilitating the introduction of advanced development methods and tools popular in other countries. The future tendency of overseas development is expected to be that the Chinese game development companies will continue to strengthen their position in Southeast Asia while challenging Japan, the United States, and Europe.

Within the context of inter-company relations, a greater degree of competition and collaboration is observed between various companies. Small and medium development companies are being eliminated in the mobile game sector, but this segment is expected to grow significantly in the coming years. Large development companies are actively investing in the small and medium development companies by providing them with their own game platforms, thus creating a win-win situation by increasing their own profits while giving small and medium development companies a chance to succeed at the same time. To maintain their competitiveness, large development companies are also diversifying their business operations to enter markets other than the game sector, create new profitable businesses, and extend their corporate scale.

Figure 4.3 illustrates the rapid expansion of the mobile game market. The rapid growth of the market is attributed to four factors.

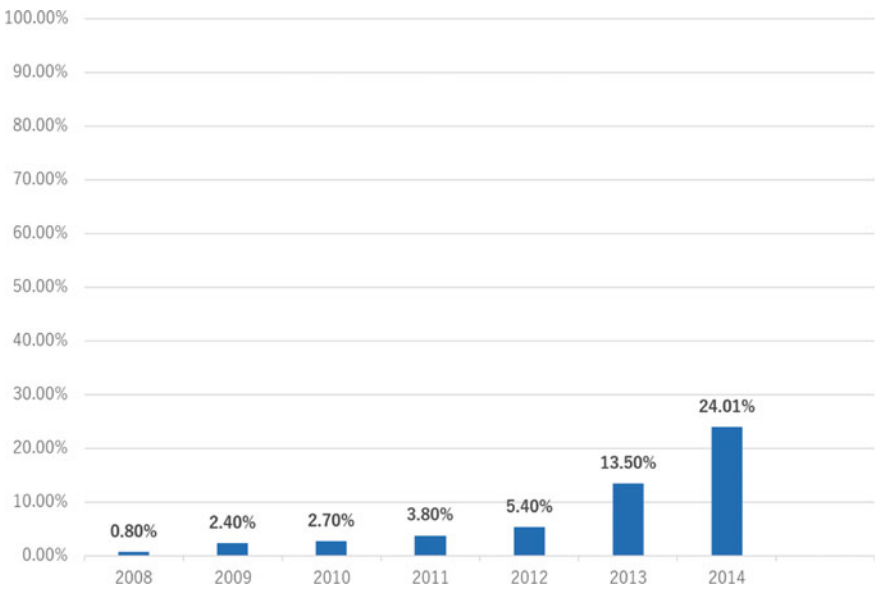

Fig. 4.3 Chinese mobile game market share trends (2008–2014). *Source* Prepared by the author based on GPC, IDC and CNG (2014)

Development of Communication Infrastructure

In accordance with the technological advancements of the 4th generation mobile communication network (hereinafter referred to as 4G), which allows for ultra-high-speed and high-density communication, the major telecom operators, such as China Mobile, China Unicom, and China Telecom, have been steadily improving their communication infrastructure. Since 2013, China Mobile has provided 4G network services in major cities including Beijing, Shanghai, and Guangzhou, and has expanded its coverage area and moved rapidly from 3 to 4G networks. As a consequence, the monthly usage fees for mobile games are becoming cheaper, while the speeds of communication are increasing, which further encourages the expansion of the user base for mobile games. Many mobile game applications are also massively multiuser online games, which require a good communication environment between the users and the servers. 4G network infrastructure can enable a better gaming experience by accelerating the loading of games, providing a more comfortable gaming environment.

The Rapid Expansion of Smartphones

A new generation of multifunctional communication devices known as smartphones has had a significant impact on the global mobile communication industry. The race for smartphones in the Chinese market began with the launch of the iPhone 3G by China Unicom on October 30, 2009. In recent years, the market has continued to expand with manufacturers such as Samsung, HTC, and Sony, as well as domestic manufacturers such as Xiaomi, Huawei, and ZTE, offering smartphones priced below 1000 yuan (20,000 yen). Total smartphone shipments in China for the full year of 2014 totaled 389 million units, a decrease of 8% from the previous year. However, total shipments have returned to a recovery trend since the beginning of 2015, and have increased 7.5% over the first half of the previous year to 210 million units. There is a wide variety of handsets available at varying prices that has contributed to the rapid expansion of smartphone users. Furthermore, smartphones offer greater functionality than feature phones and can be used to play games requiring high processing power, such as 3D graphics. Even though hardware performance is not necessarily proportional to game quality, higher processing power is expected to result in a more pleasant gaming experience in terms of game operability and graphic quality.

The Emergence of New User Groups

The light user group includes individuals who are not heavily dependent on devices such as PCs and smartphones, and spend less time using them. Unlike core users, who play games on a regular basis, light users play games “if it’s free” or “if they have some spare time”. Since smartphones have become widely available, not only young people in their teens and twenties, but also people in their forties and fifties who have had little opportunity to play mobile games, are now able to play such games. Increases in the number of light users are contributing to the total number of user base. Also, although light users tend to spend less money on games than

core users, the overall population is large, so the market size is expected to be large. Moreover, the growing proportion of light users has emphasized the need for games that can be launched quickly and played easily, and game developers have shifted their focus to mobile gaming one after another.

The Building of App Distribution Platforms and the Potential for Growth Through the Entry of Small and Medium Development Companies

In China's domestic market, there are two major platforms for distribution of digital content for communication terminals based on operating systems: iOS and Android, with Android still maintaining its dominant position. The mobile game market is characterized by two different distribution models: the iOS distribution model and the Android distribution model. With the launch of the iPhone 3G by China Unicom on October 30, 2009, it became possible to purchase applications from the App Store. Regarding the Android distribution model, the situation in the Chinese market is different from that in overseas markets, as the most influential platform—Google Play—has not yet entered the Chinese market. Consequently, Chinese companies have created a unique ecosystem of distribution platforms and application stores. In particular, independent platforms such as "Wandoujia" and "HiMarket" (referred to as Third Party Channel Platform in Chinese) are used by many Android smartphone users. The building of app distribution platforms has enabled these platforms to offer more and higher quality games to their users, while at the same time creating a favorable business environment.

In addition, mobile games have a lower development load and technical difficulty than PC-based online games, allowing small and medium development companies with limited technical capabilities to enter the market. Companies with limited resources to invest in marketing are able to use app distribution platforms to concentrate more on development and expand their markets independently.

4.2.5 Summary

As mentioned above, based on the main products and business models, the development of the Chinese game industry can be divided into the following four stages (Fig. 4.4).

1. **Pre-2000 period: Coexistence of pirated and official versions of games**
   Main product: PC-based stand-alone games
   Business model: package model
   The business model is that companies sell game software as a product, and users purchase it and install it on their PCs to play games.
2. **2000–2010: Formation and growth of the game industry**
   Main Products: PC-based online games and browser games
   Business model: shifting from fixed charge and pay-as-you-go charge to freemium business model

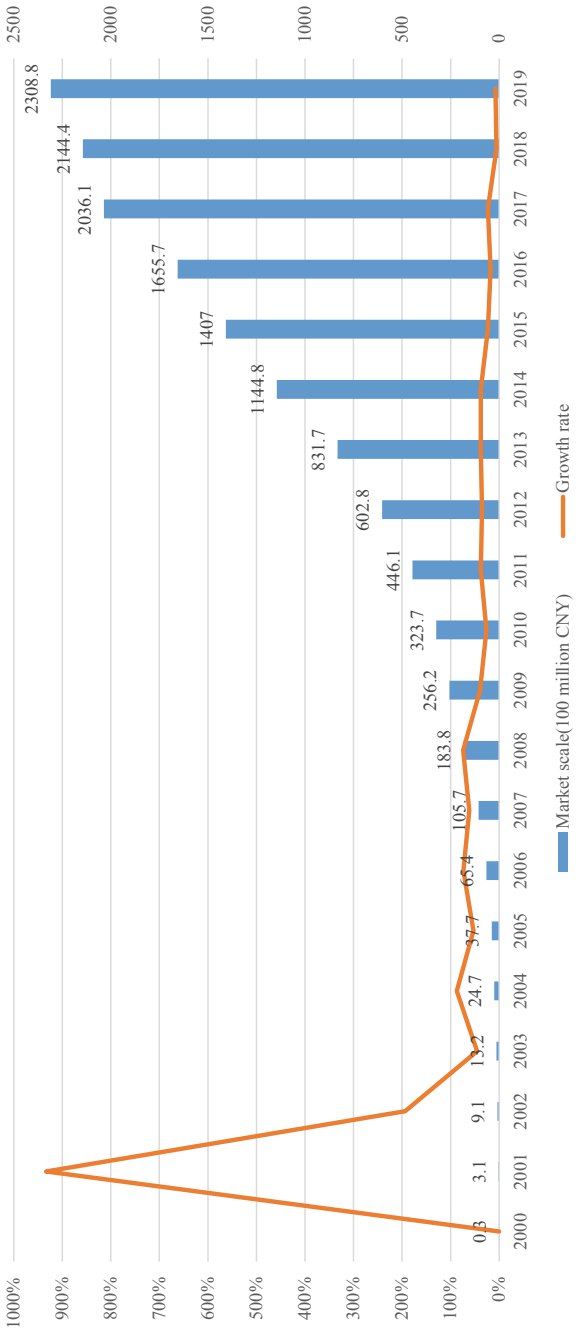

Fig. 4.4 Chinese game industry market size trends (2000–2019). *Source* Prepared by the author based on GPC, IDC and CNG (2014) and GPC and IDC (2019)

In the period 2001–2005, the primary revenue models for online games were fixed charge and pay-as-you-go charge, where users paid a monthly fee or a fee based on the amount of time they spent playing the game. As the number of new users has increased, the revenue model seems to have evolved from fixed charge and pay-as-you-go charge to freemium business model since the beginning of 2005. Basically, it is a business model in which the use of the game is free of charge, and revenue is derived from the sale of items with special conveniences. The widespread adoption of the freemium business model contributed significantly to the growth in the number of new users in the online game market at that time.

3. **2010–2015: Multi-platform development of online games**

   Main products: PC-based online games, browser games and mobile games (for feature phones)

   Business model: freemium business model-subdivision of charged items

   Until then, the primary reason that players purchased items was to enjoy improved in-game convenience such as powerful equipment and faster request fulfillment. Since 2010, the focus of charged items has gradually shifted to the identification of users within the gaming community.

4. **2015–Present: Shrinking of PC-based online games market and rapid growth of mobile games market**

   Main Products: mobile games (for smartphones)

   Business model: freemium business model-optimization of revenue mix

   In the current revenue model, the majority of revenue is derived from a small number of paying users, so the key to monetization is finding a way to convert a certain percentage of non-paying users into paying users. In a relatively early stage, this model may bring in a substantial amount of revenue, but it may ultimately result in an unbalanced game structure. There is a trend in the near future to gradually shift the focus of monetization from high paying users to a larger number of low paying users, and the revenue model of game products will be optimized to cover the entire user base.

During the initial stages of the Chinese game industry, the illegal market of piracy was a serious obstacle to the development of the early industry, as it adversely affected revenue models of foreign console games and independently developed PC-based stand-alone games for a long period of time. Due to this, the growth of game-related markets remained limited in the 1990–2000 period, and since 2000, a new business model of fixed charges and pay as you go charges has emerged via operating Korean-made online games. This model has been effective in reducing the illegal market and has enabled stable revenues to be generated. This contributed greatly to the foundation of the Chinese game industry.

Since then, many companies have developed their capacity by learning the knowledge and experience necessary for the development and operation of online games from the Korean online game development companies with which they have contract agreements. Some of the leading companies have subsequently shifted their focus from operating Korean online games to self-development and integrated their own

business on development and operation. The rise of the group of self-development companies stimulated the further growth of the entire market and led the entire industry by making use of the technological capabilities and excellent management system cultivated during the formation of the industry.

The game industry is classified within the cultural industry sector in accordance with China's industry classification standards. It has been widely discussed that China should shift from "Made in China" to "Created in China" in recent years. The government has therefore recognized the cultural industry, where creativity is most strongly emphasized, as a priority industry. Since the game industry is a significant component of the cultural industry, it has become an important issue in the national policy to foster it and encourage private sector participation in it. Various supportive measures have been taken by the government in the area of industrial policy. For example, several financial incentives, such as low-interest short-term loans and exemptions from corporate income tax, have supported and facilitated the growth of many small and medium development companies with limited financial and managerial capabilities. Moreover, game development companies have benefitted from subsidies related to the content industry and the construction of cultural industrial parks that have been offered by local governments, and the concentration of industries has enabled the exchange of information among companies, which is expected to produce synergistic effects. Despite the limitations of these support policies, these macro factors contribute to the growth of game development companies to some extent.

A platform transition is currently underway in the Chinese game industry, and the development resources are shifting from PC online games to mobile games. Mobile gaming is considered to be the most dynamic segment within the game industry. As well as the domestic market in China, many Chinese game development companies have acquired overseas companies to enter overseas markets, and this indicates that the global expansion of this industry is on track. The trend in overseas expansion will be to expand into Southeast Asia, while simultaneously challenging the developed markets in Japan, the U.S., and Europe.

In summary, the Chinese game industry did not establish a profit model similar to the Japanese and American console games during the formation and rapid development of the industry, but established a profit model based on the freemium business model. Thus, the majority of products in this industry are online games with this profit model. These games are developed on a variety of platforms, including the PC, browsers, and mobile phones, and have contributed to the growth of the entire industry since the early 2000s.

In light of this, when discussing the product development activities of companies in the Chinese game industry, it is reasonable to focus on the development of online games.

4.3 Characteristics of Online Game Development

The purpose of this section is to explain what an online game is, what the characteristics of the development environment and the development organization of online games are, and how it is developed.

Firstly, regarding the definition of online games, the term "online game" is used in this book to refer to game software that allows users to connect their client terminals to a server via the Internet, and share game progress between them.

Online games are typically played through a combination of three physical components: client-side devices, networks, and servers. In order to play an online game, the user first downloads the software for the online game to the client-side device, sets it up, and then connects to the server with a unique registration ID.

4.3.1 Online Game Development Environment and Development Organization

Game software is actually a collection of diverse contents such as art, music, and software, so its development requires a team of developers with highly specialized skills. The entity that executes such collaborative efforts is the development project.

A project is a set of coordinated activities organized to achieve a specific objective. Project management is the management of the process of achieving the goals of a project (Munns & Bjeirmi, 1996). Companies execute projects using tools and techniques, investing management resources in projects based on existing organizational structures. In project management, the goal is to allocate resources efficiently in order to achieve set objectives (Morris, 1994). The use of project management is common in areas such as planning, cost control, and quality control. Project management includes planning, resource procurement, organizational management, and progress management (Kerzner, 2017). Generally, game development launches projects for each product. (Keith, 2010). According to the size of the company's development, there may be a case in which only one development project is pursued, or multiple development projects may be pursued simultaneously.

The development organization is essentially composed of dedicated teams for each project. A professional development team is assigned to each development task, including game planning, character design, graphics, user interface design, and programming, and they perform their duties under the supervision of the project leader. A project leader is tasked with managing the entire project, including budget, development schedule, personnel allocation, and product quality. Furthermore, since collaboration among the members of the project is essential during the development of a product, the departments involved are usually grouped together on a single floor.

As far as the typical development environment for online games is concerned, many online game development companies rely on general-purpose game engines for their development activities. There are also some leading companies that develop

their own proprietary game engines. Additionally, for the development of graphics and other components, some divisions use middleware that combines general-purpose functions and specializes in specific functions. The development environment may also include plug-ins developed by in-house engineers to increase development efficiency.

During the early days of mobile game development, small development teams (4–10 people) and multi-skilled development styles (one developer handling multiple functions) were common. While the competition intensifies, mobile games have become richer in content and operate for longer periods of time. Due to the above circumstances, the aforementioned development methods are becoming increasingly difficult to implement and are being eliminated. Rather, as in the case of PC online game development organizations, medium-sized development organizations of 40–50 people, or larger development organizations of 100 people or more, as well as specialized professional organizations, have begun to spread among mobile game development companies.

Figure 4.5 illustrates the structure of the development organization. In order to facilitate the understanding of the organizational structure of game development projects, some specific positions have been simplified. It is common for game development projects to establish corresponding positions in a flexible manner to meet the specific requirements of their product, and the organizational structure is in general more complex. For MMORPG development, due to the complexities of the requirements for the design of the game system, the role of the game systems director is more subdivided into several responsibilities.

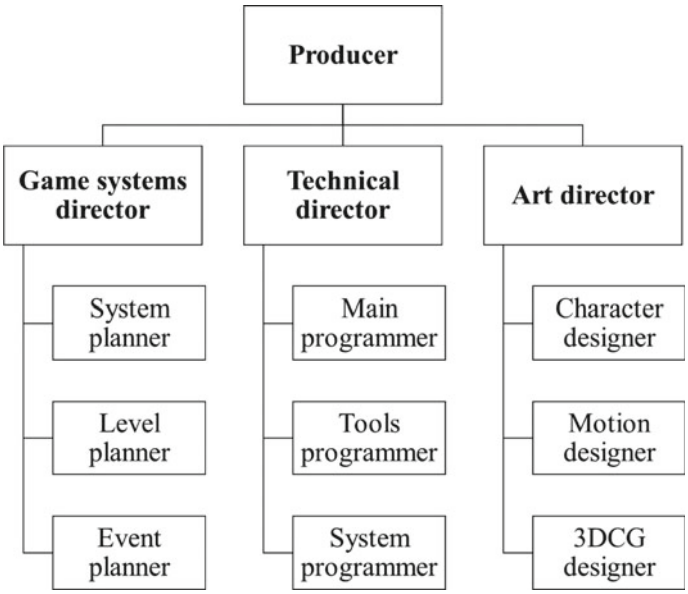

Fig. 4.5 Online game development organization

The specific duties of each position are as follows.

Producer:
Lead the game development process and provide oversight to the entire project.

Game systems director:
Design and visualize the core of the game—the game systems.
System planner, level planner and event planner:
Perform detailed design and optimize the game systems in accordance with the instructions of the game systems director.

Technical director:
Establish the development environment and provide technical support to the project.
Main programmer, tools programmer and system programmer:
Design and develop programs that serve as the game's foundation.

Art director:
Responsible for maintaining conceptual consistency and integrity in the graphic design process as well as planning, quality control, and quality assurance. Organize, supervise, and coordinate the means of visual expression in the game.
Character designer, motion designer and 3DCG designer:
Design and embody the main component parts.

4.3.2 Online Game Development Process

A typical online game development process consists of several stages: creation of the product concept (development of the planning outline), specification development, implementation, alpha testing, closed beta testing, open beta testing, and launch (Fig. 4.6).

Creating Product Concept

Development of an online game begins with the preparation of a planning outline. Based on information provided by the marketing department, the game planners first analyze and predict the needs of the target audience, and then develop a planning outline. Generally, the content of the planning outline consists of three main parts: target user settings, product concepts, and basic system requirements. At this stage, it is required to submit more than one planning outline. Considering that the content is still conceptual, it is produced in conjunction with the ideas of the game planner. Plan proposals undergo multiple rounds of review by team leaders, including the producer. According to the review opinions, the game planners also improve and enhance the content. As many of the plans are abstract in nature, including the user experience and the game system, detailed knowledge of the game and a clear understanding of

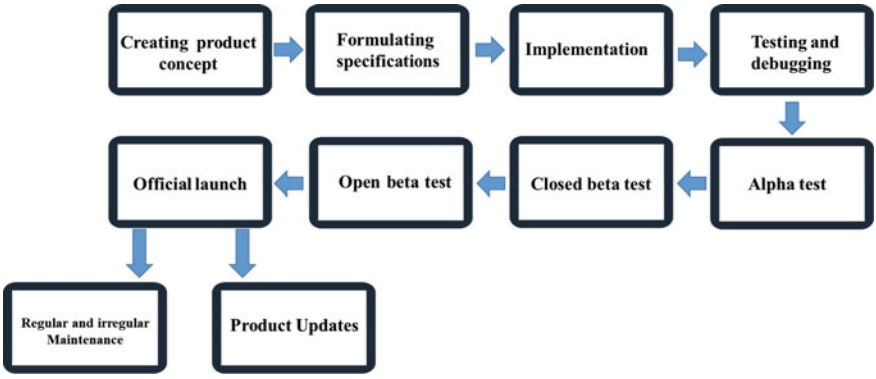

Fig. 4.6 Online game development process

the user's enjoyment are required. Following this screening stage, the content of the proposal is narrowed down to a single outline, and the content is enhanced to include more detailed information, such as the basic rules of the game, the world view, and the elements that appear within the game.

Formulating Specifications

Normally, a core team of approximately 10–15 people is assembled with lead members from each of the professions involved in game development, including programming and design. The role of this team is to examine the feasibility of the technology presented in the previous planning outline, and then to organize and refine the content accordingly in order to develop specifications. The game planner facilitates meetings by explaining the game to other departments and incorporating their feedback into the specifications. Additionally, the other departments subdivide the game content according to their respective perspectives and estimate and quantify the number of man hours needed for implementation. As an example, they estimate that 300 lines of source code are required to implement function A. The specifications describe the development platform, the relationship between each element, and the functions to be implemented. The discussion process also contributes to the development of an internal consensus regarding the product.

Implementation

Following approval of the specifications, the development work will begin with the aim of officially launching the game. Each department is responsible for creating the main program, graphics, audio, and other components in parallel, following the instructions of the leader of each category. A development team consisting of 60 to 100 individuals meets on a weekly and monthly basis to review deliverables and progress with development. The addition of new components by the game planner or unavoidable technical difficulties can cause confusion in the management of development progress. Ensuring frequent communication between departments helps to build product consensus within the project, which is an essential element for the

smooth progress of the project. After each department in charge has completed their development work, all data is harmonized on the development platform for the alpha version of the game.

Testing and Debugging

This stage involves verifying that the alpha version of the game complies with the specifications and adjusting the game balance, including the game system. The vast number of game settings in online games necessitates a variety of activities to verify the interactions among variables. In some cases, the testing process is outsourced to an external company specializing in debugging, but it is most often carried out internally by developers. This process is similar to that of other software and consists of five steps.

- Recognize the presence of bugs.
- Identify and isolate the source of the bugs.
- Identify the source of the error.
- Determine the method for fixing bugs.
- Fix the bugs and retest.

Since the alpha version of the game is the product of this phase, it contains the basic functions that are expected to be achieved, and the developer can intuitively convey a concrete image of the game. During the testing period, if the intended way of playing or enjoyment is not obtained, detailed adjustments and minor modifications should be made to the game system. Therefore, after a certain period of testing and debugging, the gameplay and stability can be further examined. A beta version of the product will be created after these modifications have been reflected and harmonized.

Closed Beta Test

Closed beta tests are conducted for the purpose of gathering data from potential users. The nature of online gaming means that it is played by many people at once over a prolonged period of time. Even if in-house testing is conducted, there are certain aspects that cannot be verified without data pertaining to multiplayer play. Since online users are sharing the progress of the game with each other, the impact of any bag or glitch is amplified compared to console games played by just one individual. Furthermore, online games have a more complex structure than console games, and the game worlds are dozens of times larger. It is possible, for instance, that a particular ability of a character in a game will perform well in location A, but will not work in location B. Therefore, it is necessary to give users early access to the game in order to obtain play data early and detect these basic problems within the game system. As with the previous stage, the emphasis is on fixing bugs and improving the balance of the game at this stage. The close beta test is limited to lead users who are closely related to the developer's product line. The number of users ranges from 1000 to 5000. Leader users possess a vast amount of knowledge about the company's product line, possess an in-depth understanding of the game, and communicate to the public as opinion leaders. It is very important to actively

monitor their in-game activities and to reflect their viewpoints in game development to make the necessary corrections.

Open Beta Test

The test is literally open to the general public, and the number of participants is not limited. In view of the fact that the basic bugs were already resolved in the closed beta test, the game system during the open beta test is in an extremely high state of completion. During this phase, the development of the game will shift from improving the game system and balance to improving the network part, such as server load. With the number of users increasing rapidly, reducing network traffic becomes increasingly critical. A few of the problems can be resolved by adding more servers, however the issue of traffic caused by the structure of the system due to the large number of concurrent users must be resolved by the coordination between the game system and the network program. These days, the open beta test is viewed as a strong promotional tool by many development companies. Following the release of an open beta test, it is common for online and offline campaigns to be conducted. Moreover, in order to attract more users, some games ensure that users' data will not be deleted during the open beta testing period. The data would also be transferred after the official launch. As soon as the major issues that occurred during the open beta testing period are resolved, the game system will be incorporated into the final version of the product for the official launch.

Official Launch

As soon as the official product is launched, the development team will proceed with further development work in collaboration with the operation team. There are two major types of development work: maintenance and product updates.

Maintenance can be categorized into two categories: scheduled maintenance and unscheduled maintenance. Scheduled maintenance is carried out at regular intervals since the launch of the service, primarily once per week. Connection testing, server equipment maintenance and user data backup are the main tasks of the operation team. As opposed to PCs, servers run continuously 24 h a day under high loads, so regular equipment inspections contribute to ensuring the stability of the gaming environment. In the case of irregular maintenance, it is performed irregularly in order to be able to cope with unexpected situations such as bugs in new versions or excessive server loads led by the rapid increase of users. In light of the possibility of problems associated with updating to a new version, the operation and maintenance of the servers are very important, and the operation team must monitor the servers 24 h a day following the release.

Product Updates

Unlike console games, online games must continually produce new content to ensure that users are not bored. After the launch of the product, the development team will continue to monitor and analyze user data as well as work on new developments such as additional content (maps, items, etc.) and refinement of graphic elements in order to support further evolution of the product. A significant amount of development

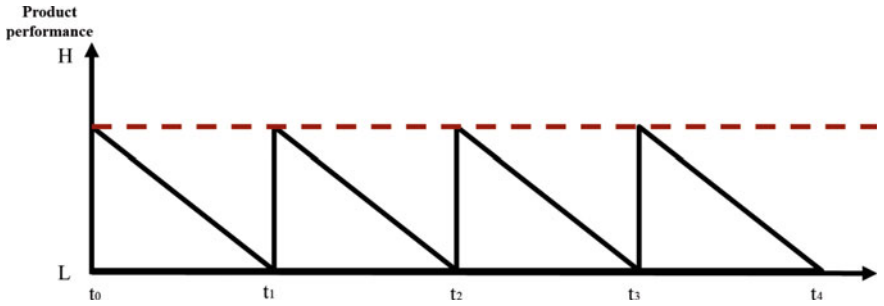

Fig. 4.7 Product performance over the online game lifecycle

resources will also be invested in refactoring (optimizing) existing content in addition to developing new content. Through a series of small and large updates, the game quality will evolve to the point where it can be recognized as a different game.

An online game's lifespan is influenced not only by its pre-release development status, but also by subsequent updates to its content. As with any other product, online games have a life cycle consisting of four phases: introduction, growth, maturity, and decline. It is possible to de-mature a declining product by encouraging continuous product updates. There are several games on the Chinese game market today that have been in operation for more than ten years since their release. In contrast, if problems such as inadequate management or difficulties with updating occur, the product may suffer a decline in performance, fail to attract new users, and become obsolete.

In Fig. 4.7, it is demonstrated that product performance fluctuates constantly in interaction with the environment, and maintaining a constant level of product performance over a long period of time by means of adaptive activity is considered to be an important issue in the development of online games.

4.4 Summary

Thus, unlike the development history of the game industry in Japan, Korea, and the U.S., Chinese game industry has achieved rapid development while seeking its own path of self-development of online games by turning from the operation of Korean online games. The Chinese game industry has so far developed an industry structure based predominantly on online games, and has built a robust freemium business model to support the industry's sustained growth. Furthermore, the rapid growth of the mobile game market, which is the most important growth area for online games in recent years, has made the market more accessible to small and medium development companies. It would be beneficial for the Chinese game industry to have a variety of companies, both large and small. The highly developed technology and accumulated knowledge acquired through independent development will serve as the basis for

competitiveness for China's online game development companies and will support the future growth and internationalization of the game industry.

Since the Chinese game industry is quite different from that of developed countries and Japan, which have been discussed in previous studies, in terms of development history, heterogeneity in capacity building, and the high risk of facing development resource restrictions, it is necessary to question the nature of effective development patterns. As such, Chinese game industry is appropriate for examining the actual development activities under the constraints of development resources.

Based on the discussion in this chapter, the following Chap. 5 utilizes a quantitative approach to examine the current state of development projects in the industry.

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Chapter 5
Quantitative Analysis of Continuous Product Development

5.1 Introduction

In the previous chapter, the author presents a brief history of development of the Chinese game industry, and briefly summarized the characteristics and issues related to present-day online game development. Chinese game industry is quite different from that of developed countries when it comes to self-development of online games and the entry of small and medium development companies in the market as the mobile game market has grown rapidly in recent years. Hence, it is imperative to re-examine the nature of effective development patterns. In the previous chapter, it is pointed out that an important issue in online game development is maintaining a certain level of performance over a long period of time through multiple adaptation activities. Nevertheless, there are several aspects of how adaptation activities should be conducted at the development sites that are unclear.

This chapter is therefore concerned with understanding the reality of continuous product development by acquiring data from development projects in the online game industry, and analyzing it quantitatively for effective development patterns.

According to the research design presented in Chap. 3, an analytical model was developed to fill the research gap. Continuous product development is defined as a process of adapting products to changes in the external environment multiple times during their development. As opposed to the intermittent model of product development, the interaction with the external environment influences not only the planning stage, but also the whole development process over a long period of time. As development activities become more continuous, a steady and continuous resource input is required during project implementation. Development organizations are therefore dealing with a different development environment from that described by the intermittent development model in previous research. As a result, there are two new issues expected to emerge in the field of development: the response to external information and the allocation of resources to product adaption.

For the purpose of breaking down the above-mentioned issues, this research focuses on adaptation activities and examines models of effective development in

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industries and products characterized by continuous development activities from four perspectives: external information and products as adaptation targets, development flexibility and collaboration among departments (especially in the development and operations) as the adaptation entities.

First of all, the constant flow of information from the external environment (customers, competitors) into the development organization makes managing the uncertainty of development processes more challenging. It is especially important to note that the information on user usage is automatically generated as a by-product of product usage, and is continuously flowing into the company through the product. As important as the effective use of such data is, it is imperative to examine the relationship between such data and independent development by development organizations.

In relation to product, product architecture is strongly correlated with the amount of development workload. Within the same product category, since integral products have a more complex structure than modular products, it can be expected that the amount of workload, including the interface between component parts and parameter adjustment, will increase. Implementation of long-term development activities by the same development organization may result in an accumulation of development workload, leading to organizational exhaustion and rigidity. For integral products that require extensive integration, adjusting the product-level architecture is necessary in accordance with the organization's own development capabilities. While product integration contributes to the improvement of product performance, pursuing only a high level of integration without understanding the actual situation in the development sites may result in an excessive development workload, accelerated the use of development resources, and consequently a decrease in product performance. It is therefore necessary to examine the management of architectural coordination at the product level in more detail.

The third issue is the flexibility of the development process. In order to maintain product performance over the long term, it is essential to adapt to changes in the external environment. Organizations engaged in product development are confronted with the challenge of how to allocate development resources and how often to adapt products. It is believed that flexible product adaptation can improve product performance by allowing them to respond to changes in the external environment. Nevertheless, it is challenging for development organizations to acquire sufficient development resources when needed, and the truth is that the degree of product completeness and the frequency of adaptation activities are incompatible, thus creating a trade-off. Increasing the frequency of adaptive activities steadily without degrading the degree of product completeness would be a very ideal situation. However, this situation has a significant gap with the management of the development sites. Consequently, it is essential to re-examine the question of how to maximize the use of limited development resources in order to provide stable and continuous high-quality adaptation activities at an optimal frequency.

Lastly, there is the issue of collaboration between the development and operation department. The operation department, in addition to the development department, which is responsible for the existing development work in a product development

project, is also crucial as products become more service oriented. The operation department is responsible for monitoring and maintaining product performance over the long term. In particular, since the operation department is directly responsible for the interaction between the product and the user, the collaborative relationship between development and operation is becoming increasingly important. However, the perceptions of the product between development and operation are not always the same. The operation department, for example, tends to promote product adaptation activities from a short-term perspective, since it is more likely to be obsessed with user trends at any particular point in time, while the development department tends to promote product adaptation activities from a long-term perspective because it more emphasizes the integration of the entire product. Because information and goals are shared more smoothly within collaborative organizations, they are more likely to successfully resolve these contradictions and produce better products. Thus, the degree of collaboration between development and operation is also expected to influence product performance. It is imperative to consider the relationship between collaboration and product performance in continuous development projects.

Following the derivation of a hypothesis based on previous research and initial investigations, this study tests the validity of the hypothesis using quantitative data analysis.

5.2 Previous Research and Hypothesis Derivation

5.2.1 Usage of User Data

There is a growing awareness that successful product development depends not only on a company's internal resources, but also on the use of external resources (Chesbrough, 2003). In addition to these external resources, the information generated by the interaction between the company and the consumers contributes to marketing and development activities and helps the company to provide high product value while satisfying customers needs. For products such as software and games, user usage information is automatically generated as a byproduct of product usage and is continuously flowing into the enterprise. This sort of data-rich environment provides an opportunity to perceive customers from multiple perspectives, and research indicates that data-driven decisions lead to better product performance (e.g.,Johnson et al., 2017; Troilo et al., 2017). However, in situations where users' demands are diverse, it becomes very difficult to determine whether they should be met to what extent. The majority of the previous research has focused on opinion leaders, influencers, or pioneer users, and most of the research has been limited to specific groups (e.g., Jeppesen & Laursen, 2009; Jensen et al., 2014). There are concerns that the interaction between the product and the entire user population, including general users, has not been sufficiently considered. It is reasonable to expect that the use of user data in development will become more complex, especially when several

different user groups interact within the same product. While it is important to make effective use of user data, if the content of development planning is heavily dependent on user trends that change daily, this may, in turn, undermine the overall performance of the product. In light of the above, the author proposes the following hypothesis.

Hypothesis 1

A higher degree of usage of user data has a negative effect on product performance.

5.2.2 Integrity of Product Architecture

In terms of the complexity of the correspondence between product functions and structures, product architectures can be divided into integral and modular types. In this regard, the construction of a common platform and the design and development of modular products are often mentioned as approaches to product design that are more flexible in adapting to environmental changes. Modularization of product structures and platformization of core technologies have been suggested to allow products to adapt to rapid technological change (e.g., Ulrich, 1995; Baldwin & Clark, 1997).

Recently, many product areas, including automobiles, software, and industrial equipment, have become increasingly multifunctional and integrated, resulting in increasingly complex product structures. In order for such an integrated product to function properly as a whole, each component must be designed optimally. Additionally, in the development of an integrated product, measures to improve the degree of integration, such as optimizing the design of each part by coordinating them jointly, may enhance product performance by increasing product integration.

Nevertheless, there are a number of integral products that have complex structure and face the same rapidly changing environment as modular products. The demands for greater flexibility and adaptability are increasing for these products. The architecture of the product is closely related to the amount of development workload involved. Considering integral products have a more complex structure than modular products within the same product category, a greater workload can be anticipated, including interfaces between components and parameter adjustments. A vast amount of verification work will be required by development organizations of integral products, which will further complicate the management of development processes and operations, as well as increase the possibility of organizational exhaustion. Especially in an environment where development resources are severely constrained, the implementation of adaptation activities for products with a higher degree of integration will result in a corresponding increase in resource consumption, which will negatively impact resource allocation for subsequent adaptation activities and product performance. Accordingly, the author proposes the following hypothesis.

Hypothesis 2

A higher degree of integrity of product architecture has a negative effect on product performance.

5.2.3 Development Flexibility

The rapidly changing external environment has created a significant amount of uncertainty in technology and markets. Companies have to adjust to the external environment and reflect changes in user needs and technological advancements in the development of new products in order to achieve a sustainable competitive advantage. In light of the need for ways to actively adapt to changes in the environment, adaptive activities in the development process, e.g., how to design products flexibly, are now being discussed. Specifically, flexibility has been emphasized as a key concept when considering the economic costs and benefits of adaptation activities in the development process. Flexibility enables adaptation to be broken down from a firm-level discussion to a multi-firm analytical framework in which the economic costs and benefits of adaptation are comparable (e.g., Thomke & Reinertsen, 1998). According to most previous studies, increased flexibility allows products to adapt to changes in the external environment, leading to higher product performance (e.g., Buganza & Verganti, 2006; Cusumano et al., 2003; MacCormack et al., 2001).

Yet, development flexibility and product performance are not necessarily linearly related. Companies that fail to provide sufficient and stable development resources may experience a decline in product performance as a result of excessive product adaptation activities. According to the actual situation in the development sites, and taking into account the factor of the development resource limited, if the project adapts excessively and engage in frequent product adaptation activities, the number of man-hours required will exceed the number of man-hours available within the project, so the project will be forced to reduce the degree of completeness of the product. This results in a process in which the more you adapt, the lower the performance of the product becomes. Thus, high development flexibility is not necessarily associated with high performance. It is therefore necessary to examine in greater detail the relationship between product performance and development flexibility, using the flexibility metrics presented in the previous research. Therefore, the author proposes the following hypothesis.

Hypothesis 3

A higher degree of development flexibility has a negative effect on product performance.

5.2.4 Collaboration Between the Development and Operation

As products become increasingly complex and large in scale, the amount of information required for development projects increases dramatically. Collaboration among functional divisions is becoming increasingly important to ensure information flow within a project and the efficiency of information management in this context. Research suggests that promoting cooperation among departments can enhance the

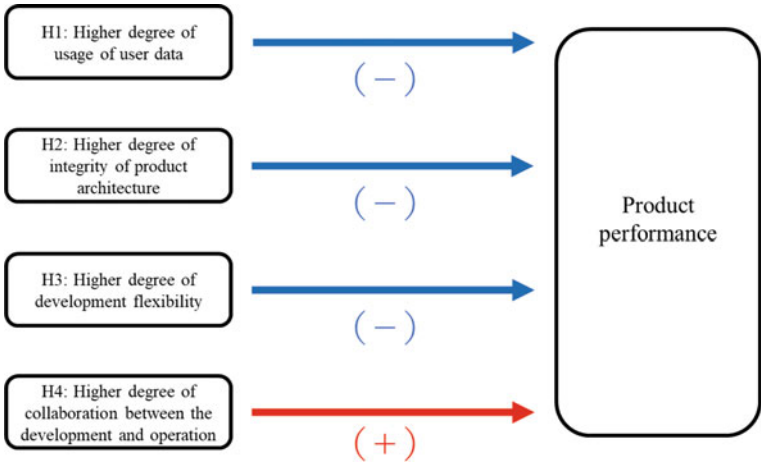

Fig. 5.1 Verification model

efficiency of information sharing and communication, and stimulate innovation (e.g., Ernst, 2002; Hoegl & Gemuenden, 2001; Nakata & Im, 2010). Also, from the perspective of the product structure, it has been noted that the development process of integral products is more likely to require greater mutual cooperation and communication than that of modular products, and that interdepartmental coordination is more important (Fujimoto, 2002). Organizations that have strong interdepartmental coordination tend to produce better products since information and goals are shared more efficiently. The following hypothesis is therefore formulated based on the assumption that these arguments also apply to continuous product development.

Hypothesis 4

A higher degree of collaboration between the development and operation has a positive effect on product performance.

The verification model in Fig. 5.1 summarizes the relationship between the above four hypotheses.

5.3 Survey Design and Data Collection

5.3.1 Outline of Survey Implementation

To test the above hypotheses, a survey was conducted among Chinese online game development companies.

For the content of questionnaire, the questionnaire is developed in two stages. First, characteristics of game development are derived from case studies of development

projects and preliminary surveys of game developers. Additionally, the indicators presented in the previous studies are adapted to reflect the characteristics of the game development process, and the wording is adjusted accordingly. A pre-test of the questionnaire was conducted for practitioners in the second stage in order to verify the consistency of the items (see Appendix for more information on the questionnaire).

The questionnaire data was gathered through snowball sampling. Snowball sampling is a non-probability sampling method that collects a sample of research subjects who meet certain criteria by using a network of informants. This method is named after the fact that a snowball increases in size as it rolls downhill, which in turn means that the survey sample size will be increasing in a snowball fashion. Survey was conducted over a period of four months, from November 2019 through March 2020. Respondents are also designated as those who supervise development projects (project leaders, producers or equivalents). Sample consisted of 17 projects from 4 large development companies, and 25 projects from 14 small and medium development companies, for a total of 42 projects from 18 companies.

In snowball sampling, the importance of sample diversity has been highlighted in order to reflect the characteristics of the population (e.g., Given, 2008; Noy, 2008; Patton, 2014). Accordingly, to compensate for the sample bias, the author refers to the sales data of self-developed game genres in the Chinese mobile game market in 2019 and adjusts the sample size according to the proportion of each game genre (Fig. 5.2).

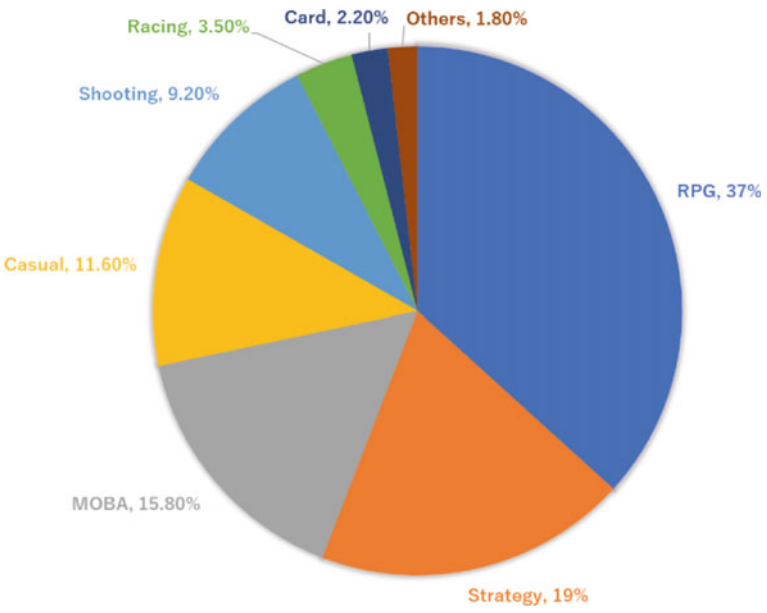

Fig. 5.2 China's self-developed mobile game sales by genre in FY2019. *Source* Prepared by the author based on GPC and IDC (2019)

5.3.2 Manipulation and Measurement of Variables

The variables in the analytical model are manipulated as follows. First, for the explanatory variables, four indicators are employed in the quantitative analysis of this study: "degree of usage of user data", "degree of integrity of the product architecture", "degree of development flexibility" and "degree of collaboration between the development and operation". Each indicator consists of multiple questions. The questionnaire items are summarized in Table 5.1. To measure each of the indicators, respondents are asked to answer the subordinate questionnaire items on a five-point scale, based on the project status, and the scores are then summed and calculated using an arithmetic mean.

As the dependent variable, the user's evaluation score in the app stores for the specified period is used to measure the product performance. Users download apps from app stores such as Apple's App Store or Google's Play Store. Because the app stores visualize the overall rating score for each app, the score is considered to be one of the most important aspects when deciding whether to use a product. Additionally, it is common for mobile games development companies to consider future development policies based on changes in evaluation scores following a product update. User's evaluation score is therefore considered an appropriate metric by which to evaluate a product's performance.

Table 5.1 Detailed questionnaire items

Indicator	Average	SD	Cronbach's alpha	Questionnaire
Degree of usage of user data	2.79	0.25	0.714	Q1 How important is user-generated content (UGC) in your game titles? Q2 During the creation of new content, what is more important, the opinions of users or the independent planning of the development team? Q3 How often do you analyze user data? Q4 How important are the results of the analysis of user data? Q5 In analyzing user data, which is more important: trends among paying users or trends among non-paying users? Q6 Up until now, how much of the game content has been modified to reflect the user data?

(continued)

Table 5.1 (continued)

Indicator	Average	SD	Cronbach's alpha	Questionnaire
Degree of integrity of product architecture	3.49	0.74	0.752	Q7 The interfaces (connections) that link the components of the game are specific to it Q8 In order to achieve the required functions of the game, the design parameters of the component parts need to be finely tuned to each other Q9 In order to realize the required functions of the game, each development process and operation needs to be finely coordinated with each other Q10 When developing an online game, which is more important: using general-purpose technologies (development platforms and middleware) or developing your original technologies (plug-ins and other customized development tools)? Q11 In developing the current game title, what is the usage ratio of your original technologies and general-purpose technologies?
Degree of development flexibility	3.20	0.51	0.739	Q12 What percentage of the total project do you think is proceeding according to schedule? Q13 The development of online games seems to involve different ways of thinking, such as A and B below. Which way of thinking is closest to your project? Q14 What is the average length of time it takes to update (adapt) the content of a game to meet changing user demands and the trends of competitors? Q15 From planning to implementation, how long does it take to make one of the simplest changes to game content (features) after its official release? Q16 How long does it take on average for a bug to be fixed after the official release, from the time a cause has been identified to the time the fix is implemented?

(continued)

Table 5.1 (continued)

Indicator	Average	SD	Cronbach's alpha	Questionnaire
Degree of collaboration between the development and operation	3.58	0.27	0.718	Q17 How often do the development team and the operation team meet regularly? Q18 In addition to regular meetings, how often do the development team and the operation team communicate with each other? Q19 How do you evaluate the current collaboration between the development team and the operation team? Q20 Following the official release, what is the importance of the operation team's suggestions in the development process? Q21 What percentage of the suggestions made by the operation team will be incorporated into the game?

In the analysis, a dummy variable corresponding to the size of the company is used as a control variable (large development companies = 0, small and medium development companies = 1). It is assumed that larger development companies would have an advantage over smaller and medium development companies in terms of accumulating development capabilities, including technical knowledge and development know-how, and therefore the performance of games developed and operated by these companies may be enhanced (Ikuine, 2012).

5.4 Analysis and Results

Table 5.2 presents statistical descriptions and correlation coefficients for the collected data. Results of the multiple regression are presented in Table 5.3. These results support H1 (degree of user data use) and H4 (degree of collaboration between development and operations). As for H3, the hypothesis that "a higher degree of development flexibility has a negative effect on product performance" is not supported, and the significant positive correlation presented in the existing study is retained. Alternatively, for H2, the hypothesis that "a higher degree of integrity of product architecture has a negative effect on product performance" is rejected.

Table 5.2 Summary statistics and correlations

Variable	Min	Max	Average	SD	1	2	3	4	5	6
1. Product performance	3.10	4.73	3.8983	0.48752	1					
2. Scale dummy	0	1	0.6	0.497	-0.817^{**}	1				
3. Usage of user data	2.33	3.50	2.7936	0.25453	-0.793^{**}	0.544^{**}	1			
4. Integrity of product architecture	2.4	4.6	3.4857	0.73802	−0.047	0.017	0.096	1		
5. Development flexibility	2.4	4.4	3.1952	0.50844	0.711^{**}	-0.742^{**}	-0.430^{**}	−0.025	1	
6. Collaboration between the development and operation	3.0	4.2	3.5762	0.27302	0.769^{**}	-0.576^{**}	-0.740^{**}	−0.006	0.484^{**}	1

n = 42
$^{**}p < 0.01$

Table 5.3 Estimation results of the regression model

	Coefficient	SE	t-value	*p*-value	VIF
Constant	4.297	1.002	4.287	0.021	
Scale Dummy	−0.357	0.095	−3.769	0.000	2.661
Usage of user data	−0.712	0.175	−4.075	0.033	2.370
Integrity of product architecture	−0.001	0.040	0.270	0.768	1.023
Development flexibility	0.179	0.085	2.107	0.017	2.249
Collaboration between the development and operation	0.345	0.167	2.064	0.035	2.493

$R^2 = 0.874$
Adjusted $R^2 = 0.856$
F-value = 49.796
n = 42

5.5 Discussion on Development Flexibility

The results indicate a significant positive correlation for H3, contrary to the hypothesis that high development flexibility would be detrimental to product performance. In order to understand why the opposite result was found for H3, a stratified analysis (the group of small and medium development companies vs the group of large development companies) were conducted.

Regarding the results of the stratified analysis, as shown in Fig. 5.3, the data group of large development companies displays a significant positive correlation, but such a correlation cannot be confirmed in the data group of small and medium development companies. All four of the top performing products (the group of small and medium development companies) in the data set exhibit relatively low degree of development flexibility. Therefore, it is reasonable to infer from the contrary result to H3 that flexibility's effects on product performance are overestimated due to the mixture of large development companies with high development resource sufficiency and small and medium development companies with low development resource sufficiency.

Based on the theoretical model presented in Chap. 1, Fig. 5.4 illustrates the inverted U-shaped curves for each group. In Fig. 5.4, it can be seen that the timing of reaching the peak product performance depends on the difference in the development resource sufficiency. For projects in small and medium development companies with low development resource sufficiency, the optimal development model is X adaptation activities, and if these companies follow the large development companies and implement more adaptation activities (X+p), product performance would reach its peak and then gradually decline. For projects in large development companies with high development resource sufficiency, it is unlikely that they will be able to reach peak performance in a short period of time. It is therefore necessary to examine the trends of large development companies over a longer period of time. The reason for this is that certain projects of small and medium development companies seem to

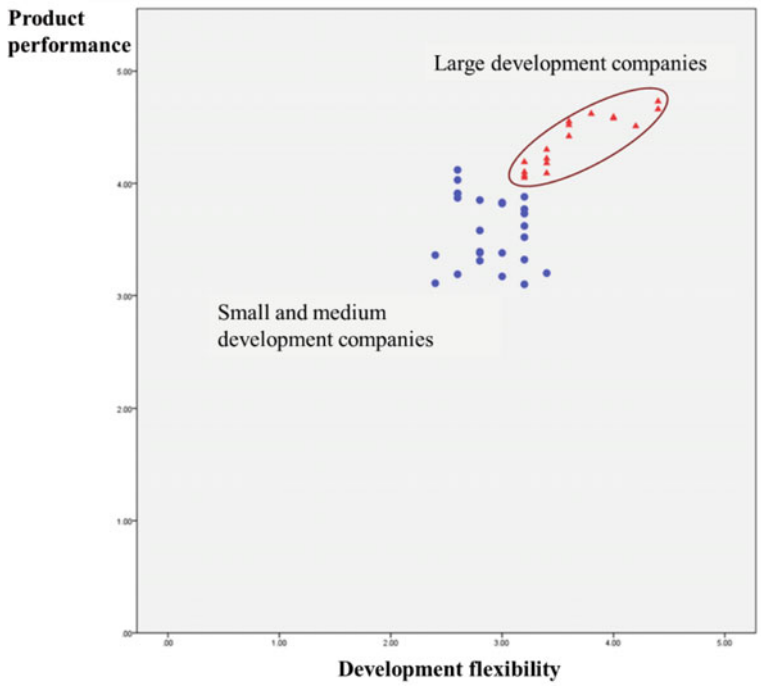

Fig. 5.3 Correlation between the degree of development flexibility and product performance by scale

have already reached their peak product performance and then slowly decreased. Furthermore, some projects of small and medium development companies seem to have already been removed from the market due to excessive adaptation activities. Accordingly, it is highly likely that such projects are not reflected in the results of the analysis.

Therefore, the group of small and medium development companies which did not display a significant positive correlation in the stratified analysis would be assumed to be in the middle of the inverted U-shaped curve (the blue circle in Fig. 5.4). Conversely, the group of large development companies that exhibited a significant positive correlation in the stratified analysis would be placed to the left of the inverted U-shaped curve (the yellow circle in Fig. 5.4).

Through incorporating the influencing factor of development resource sufficiency, the author suggests that there could be a negative correlation between development flexibility and product performance after the peak is reached. Furthermore, the discussion here supports the hypothesis that high development flexibility has a negative impact on product performance. Thus, it can be said that there is a certain consistency between the results of the analysis and H3.

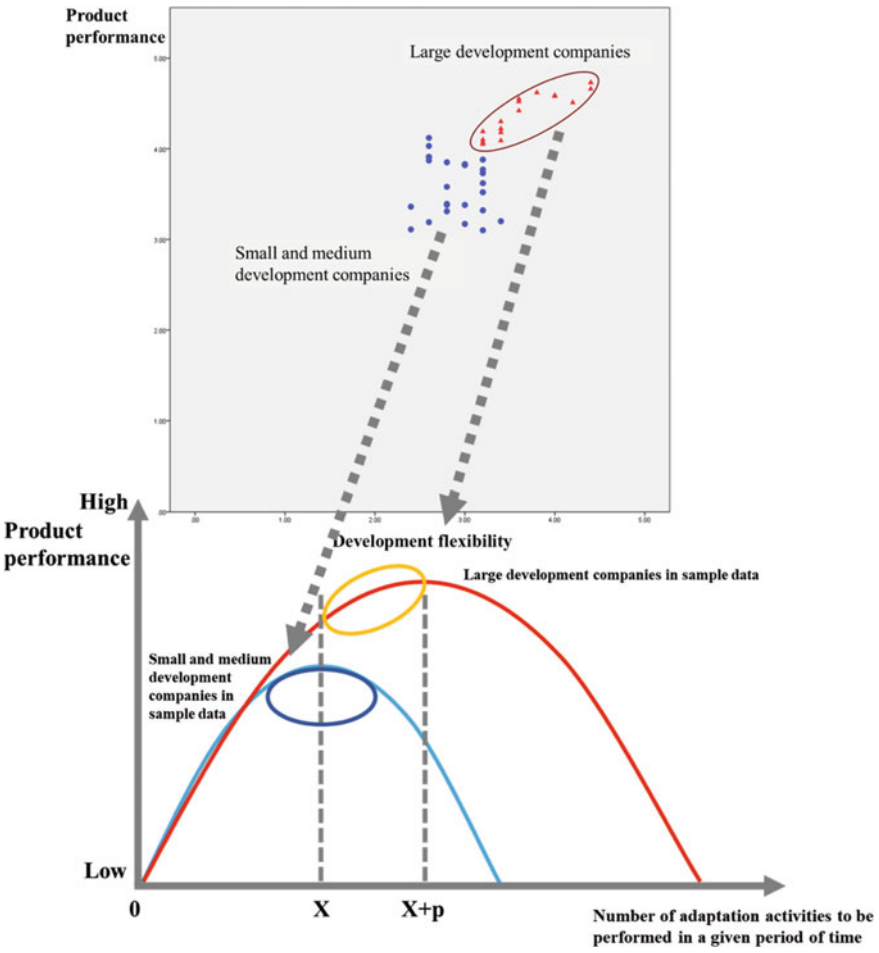

Fig. 5.4 Data positions in the inverted U-shaped curve by scale

5.6 Conclusion

This chapter deals with a quantitative analysis of effective management in continuous product development based on data collected from mobile game development projects.

In terms of the degree of usage of user data, this study shows that a higher dependency on user data leads to poor product performance. It has been demonstrated that in user data-rich environments, effective use of data leads to improved product performance (e.g., Johnson et al., 2017; Troilo et al., 2017). As development sites are confronted with an enormous amount of information and diverse users' needs, it becomes extremely difficult to decide how far they should go to satisfy these needs.

Especially in the case of game products requiring a high degree of product integration, it is imperative to plan content development in the long-term and to conduct long-term verification. A development process that heavily relies on user data, which fluctuates on a daily basis, is likely to affect the aforementioned tasks, and product integrity may not be adequately maintained. Consequently, excessive reliance on user data can negatively impact product performance.

In terms of the degree of collaboration between the development and operations, this study indicates that close interactions between development and operations result in enhanced product performance. Prior research suggests that promoting interdepartmental collaboration may lead to increased efficiency in sharing of information, communication, and innovation creation (e.g., Ernst, 2002; Hoegl & Gemuenden, 2001; Nakata & Im, 2010). This study extends the discussion of previous research and confirms the importance of cross-functional collaboration in continuous product development, demonstrating that maintaining close collaborative relationships even after product release improves product performance. In order to maintain an ongoing evolution of the product, it is important that the operation and development continue to cooperate on activities such as the analysis of user data, the addition of new content, and the refinement of graphics.

In terms of the degree of integrity of the product architecture, no significant result is found. The hypothesis regarding the negative effect of a high degree of integration on product performance is rejected. In a similar product category, a product with a high degree of integration has a more complex structure than a product with a low degree of integration. This will result in an increase in workload involving interfaces between components and parameter adjustments. At the project level, adjusting the degree of integrity of product architecture may be an effective means to reduce the development workload. This implies that the adjustment of the degree of integrity of product architecture is related to the amount of workload that is involved in development, although it does not necessarily result in an enhanced product performance. According to the analysis, the mean value (3.48) of the degree of integrity is relatively high as an indicator, although it does not show statistical significance. Clearly, the developers place great importance on the integrity of the product architecture. It is therefore necessary to perform an in-depth analysis of the relationship between the product's structure and development workload.

In contrast with the hypothesis that a higher degree of development flexibility has a negative effect on product performance, a significant positive correlation is found for the degree of development flexibility. To further investigate why this is so, a stratified analysis was conducted (small and medium development companies vs large development companies). According to the stratified analysis, the effect of development flexibility on product performance may be overestimated due to a mixture of large development companies with high development resource sufficiency and small and medium development companies with low development resource sufficiency. Based on the results of stratified analysis, it appears that there is a negative correlation in the group of small and medium development companies, as indicated by the H3. Additionally, by incorporating the influencing factor of the development resources

sufficiency, the author proposes that the relationship between development flexibility and product performance is not necessarily linear, but that an inverse U-shaped relationship may exist.

The question remains, however, how small and medium development companies with low development resource sufficiency coordinate development projects on development sites. Furthermore, the data of large development companies demonstrates a significant positive correlation, however, it is not yet clear how the resources are allocated at the development sites and how the frequency of updates is optimized. To address these questions, the author uses a qualitative approach in Chap. 6 to examine development activities in both groups.

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Chapter 6
Management of Flexibility in Continuous Product Development

6.1 Introduction

In Chap. 5, the author quantitatively examines the effective development patterns from four perspectives: external information and products as adaptation targets, development flexibility and collaboration among departments (especially in the development and operation) as the adaptation entities. Based on the data set obtained from the survey, the relationship between product performance and development flexibility is again confirmed. However, a stratified analysis reveals that the data set of large development companies with high development resource sufficiency displays a significant positive correlation, but such a correlation cannot be confirmed in the data group of small and medium development companies with low development resource sufficiency. By considering the influential factor of development resource sufficiency, it is concluded that the relationship between development flexibility and product performance is not necessarily linear, but could be an inverse U-shaped relationship.

The previous studies have shown that increased development flexibility will enable the product to be more easily adapted to environmental changes, thus improving the product's performance. However, this can only be achieved if development resources are sufficient and if the increase in development flexibility does not damage product's completeness. During the short term, development resources, including skilled developers, could not continue to be invested indefinitely. Due to increased development flexibility, resource consumption will increase to a critical point when the supply of development resources cannot be sustained. When this critical point is reached, an increase in development flexibility can only be achieved at the expense of the completeness of the product. It can therefore be expected that when the increase in development flexibility reaches a certain point (when product's completeness begins to suffer due to a shortage of development resources), it will negatively impact product performance. This is the logic behind the inverse U-shaped relationship.

Following the stratified analysis in Chap. 5, this Chapter takes a qualitative approach to examine the relationship between development flexibility and product

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Table 6.1 Information about selected projects

Project name	Company name	Company scale	Project scale
Project No. 1	Company A	Small and medium development companies	40–50 developers
Project No. 2	Company B	Small and medium development companies	50–60 developers
Project No. 3	Company D	Large development companies	90–100 developers
Project No. 4	Company D	Large development companies	80–90 developers

performance in more detail, focusing on projects from both groups (small and medium development companies vs large development companies).

6.2 Case Selection

Considering the main objective of this study is to clarify the relationship between development flexibility and product performance from the perspective of the development field, case study research is considered to be an appropriate research method. Furthermore, in order to examine the reality of development activities while also incorporating the factor of development resource constraints into the development model presented in previous studies, the author utilizes a theory-building approach to facilitate theoretical generalization (Eisenhardt, 1989; Yin, 2003).

The research has been executed as a multiple-case study. The case studies were selected from the data set in Chap. 5. The data set consists of 17 projects from 4 large development companies, and 25 projects from 14 small and medium development companies.

In general, the level of difficulty and the amount of work involved in game development is strongly influenced by the game genre. RPGs and action games, for example, have very strict requirements for graphics and motion, and therefore, in terms of the amount of resources required for development and the complexity of development techniques, they are considered considerably more challenging than puzzle games, which are generally 2D games. Therefore, it is rather difficult to compare the development activities of projects developing games within different genres. In consultation with researchers and managers from the game industry, the author selects 4 projects from both groups that were also developing games within the same genre (Table 6.1).[1]

The products of all four projects are officially launched for the domestic market and overseas market during 2018–2019, and the operation time is within 2–3 years. In both cases, the revenue is derived from the sale of chargeable items. Due to the fact that game development technology and operation management methods are unlikely

[1] The same game genre means that games are categorized within the same game category in the app store (Google Play).

to have a significant impact on the development activities within the industry in the short term, these four projects can be considered appropriate objects for investigating the development activities within the game industry during the same period.

The author conducted interviews using Zoom and WeChat with 4 project leaders from both groups between June and November 2020. In sum, 11 interviews were conducted, which lasted between about 60 and 120 min.

6.3 Case Analysis

To examine the actual conditions of mobile game development sites in more depth, semi-structured interviews were conducted regarding three aspects: development tools and methods, management of development resources and development flexibility. Focusing on these three questions, the author summarizes and compares the responses from the project leaders from both groups based on the interview data.

6.3.1 Development Tools and Methods

Currently, the vast majority of mobile games are developed using general-purpose game engines. Several game engines such as Cocos2D-x, Unreal Engine and Unity are publicly available for developers to use with full functionality for a fee. When compared to the cost of developing a custom game engine, these general-purpose engines can be extremely cost-effective. These game engines provide a high level of workflow modularity, allowing project teams to handle multiple development tasks in parallel and progress iterations more rapidly. Also, mainstream development engines are now able to adapt to multiple platforms for smartphones, thereby significantly reducing the burden of development and testing. Due to the popularity of general-purpose game engines in mobile game development, differentiation between development tools is difficult. This is in contrast to the development of more complex console games. Even so, there are some differences in the efficiency of development tool usage between small and medium development companies and large development companies.

Large development companies generally have an advantage when it comes to the efficiency of utilizing development tools. Compared to small and medium development companies, they have more development experience and more highly skilled developers, enabling them to develop a greater number of plug-ins based on general-purpose game engines that are appropriate for their workflows or products. These plug-ins can dramatically enhance development efficiency and save development resources. Due to their own technologies and skilled developers being relatively weak, small and medium development companies still stay on the stage of proficiently using general-purpose game engines. Their ability to optimize and adjust the game engines according to the project characteristics is limited. The number

of self-developed plug-ins is therefore less than that of the large development companies.

Given the recent increase in game development costs and longer development cycles, many game development companies are turning to agile development methodologies, which are already common in the software industry. Agile development methodologies emphasize short development cycles and involve users actively in the development process, enabling faster and more predictable development activities. There are three characteristics of these methodologies: (i) iterativeness: completion via multiple stages; (ii) incremental progress: the product is released more than once from simple implementation to final product; and (iii) self-organization: the team autonomously decides the best approach to get the job done effectively (Boehm & Turner, 2005).

As agile development is highly responsive to rapid changes in the environment, it is compatible with mobile game development, which has a small and flexible development organization structure. Accordingly, it has been adopted in many mobile game development projects. Additionally, agile development does not adhere to any rigid guidelines or manuals. Many game development projects pick and choose agile development methods according to the circumstances of their projects.

In addition, common libraries have become popular in small and medium development companies and large development companies. Common libraries are being built across multiple projects so that developed artifacts and tools can be used more efficiently. For example, most character designs are not designed using tools developed independently by the project, but rather based on internal common development tools, with the project-specific character control plug-ins. Moreover, the construction of integrated data systems is widespread, enabling rapid interpretation and analysis of data pertaining to multiple projects.

Overseas markets are becoming increasingly important sources of revenue for Chinese game companies. Recently, with the assistance of overseas platforms and publishers, small and medium development companies have gradually been able to launch their products overseas, just as large development companies do. For localization of mobile games, it is more economical to unify and manage the same version or content in terms of development and operations costs. Most companies tend to minimize content adaptation for international markets. Rather than creating separate content for the overseas market, the international version is simply a translation of the display language of the domestic version and does not contain any new content.

6.3.2 Management of Development Resources

Difficulties in Acquiring Development Resources in the Short Term

For a game development project, the development staff is the most important resource. For the long-term operation of the product, ensuring a stable and sufficient amount of development man-hours is essential. In recent years, the rapid growth of the mobile

game market has given small and medium development companies the opportunity to take part in it, but the business environment surrounding them is still more challenging than that for large development companies. With the fierce competition for programmers and game planners, securing sufficient development staff at the outset of a project has become increasingly difficult. Furthermore, even if the issue of insufficient development resources does emerge after the release of the product, it is unlikely that the issue can be resolved in the short term by adding additional development resources. This is due to the sticky nature of development information, such as specific understanding and knowledge of the whole project.

The acquisition of development personnel may be achieved through the recruitment of new recruits or mid-career hires; however, it can take a considerable amount of time and money to train them to a point where they can be effectively utilized in the development sites. Understanding and learning about a project is not just the result of individual efforts such as planning and coding, but also the experience of working with others through participation in numerous meetings and discussions after actually embarking on the project. In addition, a portion of the existing development staff's work hours must be invested in training newcomers. Thus, the shortage of development resources is further aggravated when new development personnel are added.

Disparities in Development Resources (Small and Medium Development Companies vs Large Development Companies)

In terms of the constraints placed on development resources, there is a substantial disparity between the resources available to small and medium development companies versus large development companies for the development of the same genre of game. As a matter of fact, the development capacity of a development project is largely determined by the number of development personnel. The development projects of large development companies are estimated to be 20–40% larger than those of small and medium development companies. For example, a small development company may be able to hire only 8 development staff for programming, whereas a large company may be able to hire 12 or more. Furthermore, since large development companies develop and operate many projects, they have already built common libraries and operating platforms within their organization. This type of development and operations expertise can be applied to a wide range of projects, resulting in significant cost savings and generating synergistic benefits. Nevertheless, since there are only a limited number of projects that can be conducted simultaneously by small and medium development companies, the effects of technological investments are limited, and synergy effects are unlikely to be achieved.

Among large development companies, specific problems such as a decline in product quality or disruptions of development schedules are far less likely to occur than in small and medium development companies. Based on the interview information, at the present time (November 2020), Projects No. 3 and Project No. 4 in Company D are experiencing no constraints with respect to the development resources. Nevertheless, large development companies still have issues such as a chronic lack of manpower. If a major update coincides with training for new

employees, skilled developers' work time will be taken up to train the new employees, which may result in confusion in the development sites.

6.3.3 Development Flexibility

Large Development Companies

Among large development companies, specific problems such as a decline in product quality or disruptions of development schedules are far less likely to occur than in small and medium development companies. Based on the interview information, at the present time (November 2020), Projects No. 3 and Project No. 4 in Company D are experiencing no constraints with respect to the development resources. Nevertheless, their resources are not unlimited. Large development companies usually advance multiple projects simultaneously. Projects are normally in competition for developer staffing and budgets. Large development companies, especially those that have gone public, are particularly sensitive to project performance data. Although some projects' performances may appear positive from the outside, they may not meet the company's internal standards, and thus will be rejected.

Moreover, large development companies still have issues such as a chronic lack of manpower. If a major update coincides with training for new employees, skilled developers' work time will be taken up to train the new employees, which may result in confusion in the development sites.

Considering the above, the increase in development flexibility has not led to a shortage of development resources, as there is an adequate supply of development resources for projects in large development companies. As a result, in this situation, increased development flexibility does not affect the product completeness, even when the resource consumption is accelerated (Fig. 6.1).

Thus, it is reasonable to assume that the position of large development companies is still on the left side of the inverse U-shaped curve, which is consistent with the results of the stratified analysis in Chap. 5. As the peak has not been reached, there is still room for the product performance to rise due to the increase of development flexibility. Nevertheless, as the frequency of updates increases, the resource consumption also increases, and even large development companies' projects will eventually encounter development resource constraints. Consequently, it can be expected that at some point in the future, large development companies will experience the same performance impact that small and medium development companies do.

Small and Medium Development Companies

As compared to large development companies, there is a considerable difference in terms of technological accumulation and development resources. It is therefore natural that there is a disparity in the amount of development resources that can be allocated. While competing with large development companies in the same genre, small and medium development companies are usually receiving feedback from a

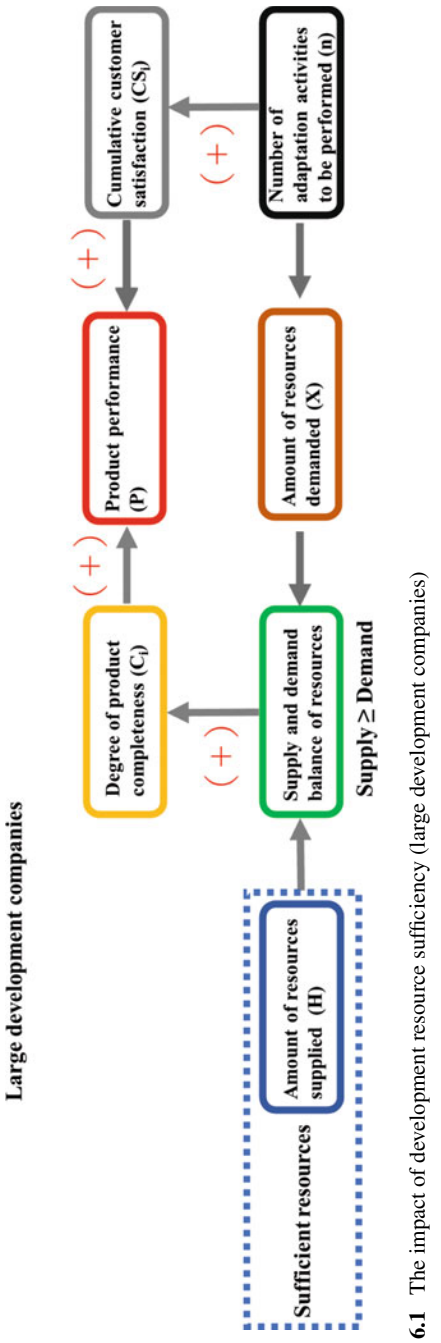

Fig. 6.1 The impact of development resource sufficiency (large development companies)

portion of heavy users, which are requests for more updates like games from large development companies. Unconsciously, they would follow the update frequency of large development companies. It may be possible for projects with low development resource sufficiency to temporarily increase their flexibility by working overtime, and in the short-term they may be able to keep up. However, in the long run, the project will not be able to maintain the schedule update frequency, which will ultimately result in a significant shortage of development resources. As previously mentioned, it will be extremely difficult to bring in additional development personnel who can work immediately in a short period of time, so that a temporary increase in development resources will be highly unlikely. An update frequency that is too high will inevitably lead to resource shortages. In the short term, this can be met by overtime, but in the long run, the development organization will be forced to reduce the completeness of the development of product updates due to exhaustion (Fig. 6.2).

One of the interviewees, as the project leader, had experienced the same issue. The project for which he was responsible decided to make major updates twice a month at the same pace as large development companies of the same genre of games. However, after four months, the number of development man-hours required increased and surpassed the capabilities of the development system at the time. According to the planned update schedule, due to the accumulation of unprocessed development tasks, the estimated required workload is far exceeding what the existing project staff may be able to handle even with overtime.

Following a series of meetings within the project, project members were realized that the planned development policy of following the updates pace of games from large development companies could no longer be implemented. Once the project members realized that the current update frequency was beginning to affect the completeness of the product, they took measures to reduce the update frequency and limit resources consumption to keep the project running smoothly. There were two options as a solution at the time: lowering the frequency or lowering the degree of product completeness. Since reducing the frequency of updates to twice a month, as had been promised to users up until now, would result in an abrupt drop in user confidence, the project decided to keep the update plan as it was at the time and reduce the volume of update contents per update. The reduction in volume, however, also resulted in decreased user engagement and decreased playtime, which led to a decline in product performance. As of the present, the project has ceased its previous development plan and adjusted the frequency of updates downwards in response to the realities of its own development sites.

6.4 Discussion

According to the previous studies, flexible adaptation of products to changes in the external environment leads to higher performance (e.g., Buganza & Verganti, 2006; Cusumano et al., 2003; MacCormack et al., 2001). Nevertheless, the development model proposed in the previous studies assumes a steady deployment of subsequent

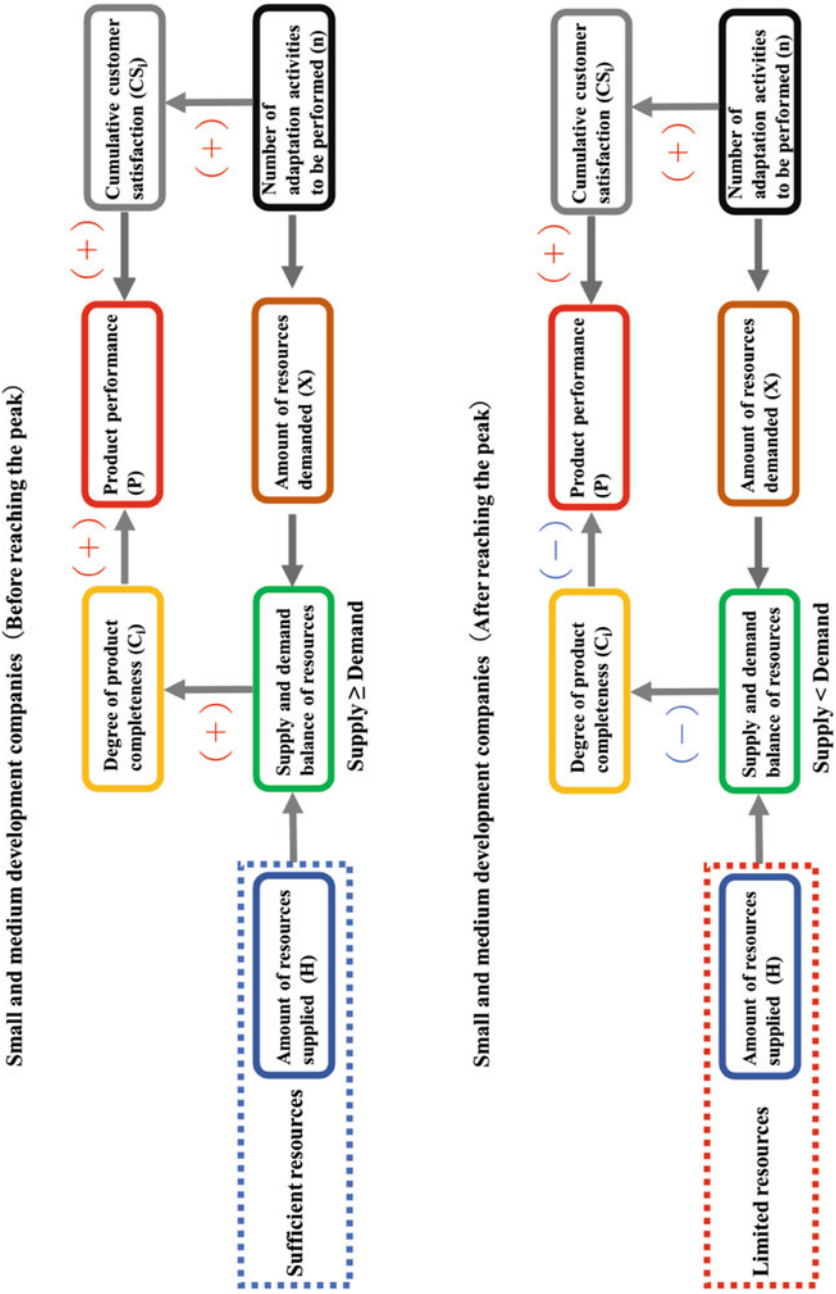

Fig. 6.2 The impact of development resource sufficiency (small and medium development companies)

development resources. Development projects are frequently in competition with one another for the availability of development resources, including budgets, technology, and development personnel, within the company. A common issue in many development sites is the lack of sufficient resources. Accordingly, the development models described in the previous studies are idealistic, and there is a substantial gap between them and the reality of development sites. Thus, it implies that previous studies are limited in terms of validity and scope of interpretation.

As users' needs become more sophisticated and diverse, and their expectations for game play and graphics increase, the level of quality requirements for products also rises. Maintaining excessive development flexibility, including shorter development times for updates and increased update frequency, not only accelerates resource consumption, but in addition makes it difficult to maintain product integrity, which requires a certain amount of validation time. It may also result in poor product performance in the long run. Especially when maintaining a degree of development flexibility excessively high in projects of small and medium development companies with low development resource sufficiency, not only will it exhaust the development organization, but it may also degrade user evaluations as a result of inferior product quality. In general, small and medium development companies are more likely to face resource constraints than large development companies. It is important to note that if resources are consumed beyond the capabilities of the project, it cannot maintain the completeness of the product while maintaining the established update frequency. This can have an adverse effect on the product's performance.

Accordingly, it is imperative to provide stable and continuous high-quality adaptation activities at an optimal frequency based on the circumstances of the development project.

There are three possible reasons for the negative relationship that was not confirmed in the survey, namely, the right side of the inverse U-shaped curve (Fig. 5.4). First, for large development companies, the peak of product performance has not yet been reached, and therefore there is still possible room for improvement in product performance due to the increase of development flexibility.

Secondly, small and medium development companies are likely adjusting the update frequency downward after reaching the peak in order to maintain a balance between the supply and demand of development resources to advance the project. Lastly, it is also possible that some small and medium development companies maintain or increase the update frequency after they have reached the peak, resulting in a lower degree of completeness of the product, lower product performance and eventual elimination from the market. It is difficult for surveys to reach respondents when they encounter failures such as this.

From comparison of case studies, it can be predicted that if small and medium development companies follow the lead of large development companies and compete at a similar update frequency, they will reach the peak faster, but eventually fall behind and be eliminated. Therefore, it is more advantageous to allocate development resources to independent development of original content. Although

they may belong to the second group with relatively low sales and product performances in their game genre, it may be possible for them to acquire sufficient earnings through the development of highly original content.

From the perspective of the supply side of development resources, this chapter examines methods for achieving an optimal balance between supply and demand through case studies. In contrast, there is still a possibility for developers to take the initiative in adjusting the amount of workload involved in development from the perspective of the demand side of development resources. The following chapter therefore clarifies the factors that influence the amount of development workload from the perspective of the demand side and then examines improvement measures that lead to optimization.

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Chapter 7
Management of Exhaustion in Continuous Product Development

7.1 Introduction

In Chap. 6, the author examines the relationship between development flexibility and product performance from a qualitative perspective. Based on the perspective of the supply side, it is imperative to provide stable and continuous high-quality adaptation activities at an optimal frequency based on the circumstances of the development project. If resources are consumed beyond the capabilities of the project, it cannot maintain the completeness of the product while maintaining the established update frequency. This can have an adverse effect on the product's performance.

Nevertheless, there is also the possibility of adjustment that not only from the supply side of development resources, but also from the demand side, the development organization may take the initiative in adjusting the amount of development workload. The amount of development workload is determined by factors such as the number of functions within the product and its architecture. The development organization can therefore improve the supply–demand balance for development resources by lowering the workload of functional requirements to be updated and the complexity of the product architecture while maintaining product performance. Particularly with regard to development personnel, the most important development resource, it will likely be difficult to increase the supply of development resources in the short term since it takes a great deal of time and resources for training new members. As such, it is crucial to reexamine improvement measures to reduce the development workload from the demand side of development resources.

Therefore the purpose of this chapter is to clarify how the development workload can be optimized in continuous product development.

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7.2 Case Study of Project A

This chapter analyzes Project A from a mobile game development company, Company X. Company X is a subsidiary of Company Y, one of the largest Chinese Internet service providers. Company X began as the mobile game development department within Company Y. In response to the rapid growth of the mobile game market, the entire department was spun off as an independent subsidiary. A majority of the development staff of Company X previously worked in the online game development department of Company Y before it became independent, and they have extensive experience developing mobile games. Due to regular capital infusion from venture capitalists and Company Y, Company X has maintained a stable financial position.

Company X has produced 14 game apps as of March 2019, six of which have been released internationally. About 30% of the company's total revenue is generated by overseas markets. Company X's game products consist mostly of RPG games that are highly praised by users in Japan and overseas for incorporating its unique play system into the RPG genre that focuses on character development. Project A's game has maintained a high ranking in the app store since its release, showing superior performance compared to other similar products.

Interviews were conducted in January and March of 2019. Interviewees included one manager, one project leader, and three game developers. Additionally to the interviews, an observation survey was conducted on the development site for approximately one hour.

The company X has two pre-release development projects and four post-release development projects, and each has its own dedicated team. The development projects are medium-sized organizations, consisting of 60–70 people on average. Typically, there are seven to nine staffs assigned to each development task, such as game planning, character design, graphics, user interface design, etc., and these staffs carry out the development tasks under the management of the project leader. A project leader manages the entire project and oversees the budget, schedule, personnel allocation, and the product quality. Each project is also assigned an operation team whose primary responsibility is to analyze and visualize user data after the product is released while providing maintenance services.

7.3 Development Workload and Exhaustion in Project A

In the development of games, the development workload can be described as the total number of tasks to create the game content. Figure 7.1 illustrates the task structure of Project A, which consists of two types of activities: development of updated content and the correction of defects. These tasks are handled by multiple development departments, including development planning, implementation, testing, and user data analysis. During pre-release development, development planning, testing,

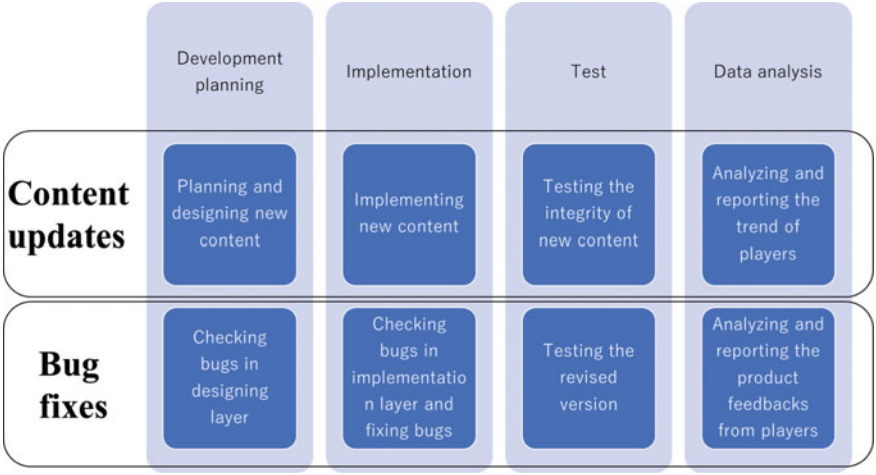

Fig. 7.1 Main work processes and composition of the development workload. *Source* Compiled by the author based on interviews

and implementation operations are all involved. Users' data analysis is added to the existing development organization after the game is released, and this department serves as a point of contact for developing new content and resolving problems as well as providing feedback on user trends related to the game product to other departments.

In a game development project, however, if a problem occurs, considerable development resources will be devoted to solving it. The development progress will be delayed if this reduces the allocation of resources to other parallel development tasks. In order to maintain the current schedule, various departments (primarily development planning and testing) are required to work overtime to accommodate the temporary increase in development workload. In addition, the large number of urgent cases induced many delays in the implementation work to fix problems. These issues are highlighted in red in Fig. 7.2.

With regard to the update plan, the leader of Project A was aiming to add weekly in-game events and monthly major updates. Following the official launch of the game, a certain number of users was secured and the game became profitable. Nevertheless, six months after the release, there was a problem of member exhaustion on the development site due to the repetitive tight schedule of 11 working hours each day. While the Project A managed to resolve the issues and maintain the performance of the game, four of the Project A 's development staff became ill and had to take sick leave, which caused some of the development work to stagnate. Moreover, it became increasingly difficult to secure sufficient time for planning and testing, and users began to complain about the lack of content in the monthly updates.

Due to the fact that limited development resources were frequently allocated to fixing defects, the development schedule for new content was frequently delayed, and the overall progress management was confusing. This resulted in a temporary

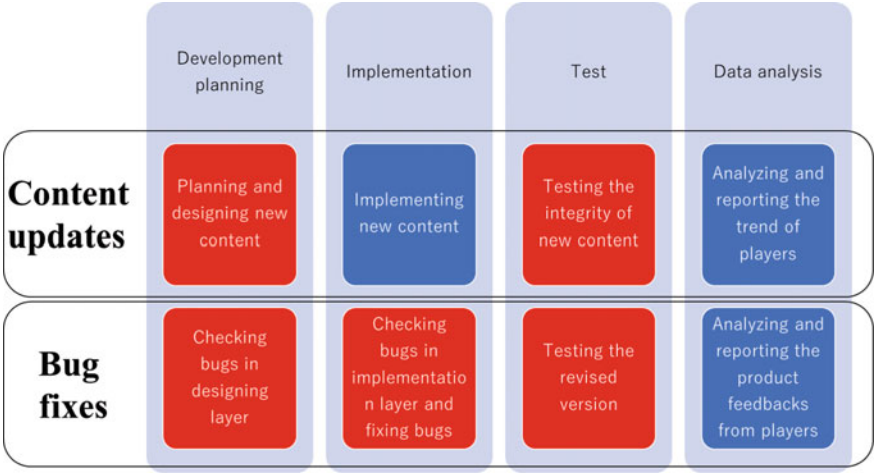

Fig. 7.2 Development tasks that tend to cause overtime. *Source* Compiled by the author based on interviews

high drop-out rate of new users and paying users, which impairs revenue growth and adversely affects the allocation of development resources within the company for the following period of time.

7.4 Breaking Out of Fatigued Development Sites

Project A conducted an extensive analysis of the factors causing schedule management confusion in order to bring the development site out of exhaustion. A key reason for the overtime work was the inability of the development team to solve unexpected problems in a highly uncertain game development environment. In the course of product development, it is common to increase development resources by assigning new staff from within and outside the organization to deal with unexpected problems. Nonetheless, since game development requires an in-depth understanding of the whole product, it takes some time for new development personnel to be able to perform effectively in the sites immediately. Therefore, to address the shortage of development resources in the short term, the development personnel in the existing development system are required to work an additional amount of overtime in addition to their regular schedules. Many of the defects in Project A were to be resolved by the overtime work of the existing development staff.

In light of the resource's shortage, it is not feasible to compensate by means other than overtime work, since it will be difficult to add new development personnel in the near-term. Therefore, Project A attempted to start by identifying the source of the increase in workload and how it was handled, while keeping in mind the potential for more effective use of resources already in place.

As for the source of the rapid increase in workload, after carefully reviewing the estimated workload data for the whole project, it became apparent from the changes in development man-hours after release that about 70% of the cause for the rapid increase in development work was bug fixes. The detailed classification of the defect situation in Project A revealed that many of the fixes were actually related to specific events and items, and very few to the core functionality of the game. In other words, although problems did occur, they were generally not fatal or urgent. For the past several months, fixing defects had been the top priority. However, in view of the effective utilization of development resources, there is no need to disrupt the current development plan by working overtime in order to address non urgent issues.

Therefore, Project A has changed the existing development plan to take different measures based on the nature and cause of the problem. For emergencies related to the core game system, such as inability to log in or crashing in the middle of a game, the development members will respond as before, but for other emergencies, the development members will not need to respond as quickly. Whenever a bug was not addressed in time for this quarter's update, Project A decided to incorporate the fixes into the next quarter's update without overpressuring themselves. By implementing these changes in defect handling, Project A was able to drastically reduce the number of overtime hours per developer from 90 to 20 per month.

Further, Project A focused on the departments where overtime was most likely to occur and analyzed the development workload according to the type of game content, and found that the production and consumption periods for different types of game content varied.

There are two categories of content in Project A's game: PvE and PvP. PvE means "Player versus Environment" and refers to a type of game in which user completes tasks within the game to defeat a set of enemies. Through this experience, the user will acquire a deeper understanding of the game system by fighting a set number of enemies in a set environment. In PvE, as the user completes tasks and rises in level, more and more content is been consumed, and the appeal of the game gradually erodes. The average time it takes to create PvE content is four weeks for planning and implementing, one week for testing, for a total of five weeks, but the average consumption time is only two weeks.

On the other hand, PvP refers to "Player versus Player," i.e., a game where users compete with each other for ranking points according to the rules specified in the game environment. If the basic battle rules and environment are designed well, even after completing PvE, users can play against various competitors in PvP, allowing them to continue playing for a long period of time, and it is anticipated that this will reduce the abandonment rate of existing users. Particularly in the case of online games, PvP content is imperative. Considering the increasing influence of charged items and newly added items in the game system, detailed verification tests on rule settings and item values must be conducted to maintain the balance of battles among a variety of users.

The average development time for PvP content was 4 weeks for planning and implementation, 2–3 weeks for testing, and 6–7 weeks overall. Table 7.1 summarizes the differences between development in PvE and PvP.

Table 7.1 Comparison of PvE and PvP content development

	Planning and implementation period (weeks)	Consumption period (weeks)	Test duration (weeks)	Target players	Profitability
PvE	4	2	1	New users	Low
PvP	4	8–10	2–3	Existing users	High

Source Compiled by the author based on interviews

In the initial nine months after release, Project A devoted most of its new content to PvE, which was quickly consuming. Previously, the content of the game consisted of 70% PvE and 30% PvP. However, based on the analysis of user play data, the majority of users cleared PvE content within 10 h. In other words, the actual play time was substantially shorter than the planned clearing time (30 h).

In contrast, PvP, with its slower content consumption, found less frequent planning and implementation of content than PvE, but it required more time to verify the content's validity. In other words, an increase in the proportion of PvP content would result in a reduction in development work on the planning and implementation sides, while an increase in the development work on the testing side.

Moreover, since PvP is primarily a social activity, it is crucial to build and maintain a strong and healthy ecosystem within the game. The long-term performance of the product could be adversely affected if the content is tailored for a particular user group (Huang, 2018). This raised the question of the necessity of validation. In an effort to validate the product efficiently, Project A implemented automated testing as well as simulating some of the user matches. This method effectively reduced the testing time by about 35%. As of March 2019, the game content composition is 40% PvE and 60% PvP, reversing a trend that had been observed previously. By introducing automated testing, Project A has been able to reduce the workload on PvP content development, allowing it to increase the proportion of PvP content, which has a longer consumption period. Furthermore, the implementation of product content adjustment has further reduced the workload of Project A.

Additionally, Project A has taken into account the relationship between the parameters of the game's major components and streamlined the game's architecture in order to reduce the workload.

In the same product category, since products with a higher degree of integration have a more complex structure than those with a lower degree of integration, we can anticipate a larger amount of work such as interfaces between component parts and parameter adjustment. The numerical values of some of the items in the update contents are determined by the interaction of various components. For example, the actual attack effect of a normal weapon L in the game is calculated by a complex set of factors including attributes of the user, the attributes of the targets, as well as the attributes of other items in addition to the attributes of the weapon itself. This situation calls for the consideration of multiple influencing factors, and these factors

are tightly associated with one another. Investing a large amount of development resources is required in order to verify the validity of the values.

Normally, when developing a product that is integral, it is important to demonstrate some degree of interdependence between the components, but in Project A, where the level of development resources was low, there was a strong tendency to work overtime to meet the deadlines. The problem had become widespread throughout the entire project. Accordingly, several departments involved in the design of Project A's product structure worked together to reduce the dependence between component parts that were not part of the core game system. By organizing the relationships among the Fig. s and maintaining their integrity, the intricate and complex development environment was simplified. As a result of these efforts, the amount of time required for verifying new content and fixing bugs has been reduced substantially.

7.5 Discussion

This chapter discusses Project A from the mobile game development company X, where the development team was exhausted because the workload of bug fixes was added to the workload of new content development while the development schedule was unstable and user information processing and analysis activities continued.

Many existing studies have assumed that flexibly adapting to changes in products and external environments leads to greater product performance (e.g., Buganza & Verganti, 2006; Buganza et al., 2009; MacCormack et al., 2001). However, as with the case of Project A discussed herein, the cumulative workload in ongoing development activities exhausts development teams, making long-term maintenance of product performance difficult.

By changing the methods for fixing bugs, increasing the percentage of user-generated content, and improving the product architecture, the development team was able to break free from the exhaustion, while still meeting the demands of its users.

Specifically, in order to maintain high product performance while using limited development resources, Project A was able to reduce the number of intensive development resources input and reduce the development workload by changing the way bugs were fixed. As for the product structure, Project A was able to maintain a balance between the development and consumption phases by proactively utilizing user-generated content such as PvP content. By increasing the proportion of highly social PvP content, Project A was able to attract new users and monetize existing users.

Therefore, if development resources are constrained, implementing long-term development activities by the same development agency may result in an accumulation of development workload which will lead to organizational exhaustion. While it is possible to add development personnel as a valuable development resource, it is difficult to increase the supply of development resources in the short term. For integral products that are highly integrated, it is therefore necessary to adapt the

product architecture according to the project's development capability. A product integrative level that exceeds the development capability may result in an excessive development workload, which may in turn compromise the product's performance. The adjustment of the integral degree of product architecture thus may be effective as a means of reducing the development workload at the project level.

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Chapter 8
Product Interactions with the External Environment: The Impact of User Interactions on Product Performance

8.1 Introduction

In Chap. 6, the issue of effective management of continuous product development is discussed in terms of the process of development activities. On the supply side of the development resources, it is imperative to provide stable and continuous high-quality adaptation activities at an optimal frequency based on the circumstances of the development project. As outlined in Chap. 7, on the demand side of development resources, it is proposed to lessen the development workload associated with product adaptation by modifying product functions and architecture. Therefore, even in the case of low resources sufficiency for development, it illustrates the possibility that the development organizations can optimize the supply/demand balance by adjusting both sides of development resources in accordance with the development status of the project. A positive cycle can thus be envisaged in which a development system is designed to respond quickly to user requests while keeping the development workload within an appropriate range, thereby promoting long-term maintenance of high product performance.

However, in the case of continuous product development, the product interacts with the external environment multiple times, and the constantly changing external environment is a major factor that is deeply involved in the adaptability of the product. In order to manage continuous product development effectively, it is necessary not only to consider the development activities but also to consider the interaction between the product and its external environment.

Therefore, this chapter examines how changes in the external environment, such as user trends, impact product performance and discuss which approach development organizations should adopt to adapt to such a rapidly changing external environment.

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8.2 Previous Research on the Interaction Between Products and Users

It is increasingly recognized that successful product development requires not only internal resources but also the successful utilization of external sources (Chesbrough, 2003). The information generated by the interaction between the companies and the end consumers is one of such external resources that can be used to support marketing and development activities and enable the company to offer high product value while meeting customer needs.

A number of constructs have been developed to investigate this interaction between companies and end consumers, e.g., user innovation, opinion leaders, and user communities (e.g., Jeppesen & Frederiksen, 2006; Valente & Davis, 1999; von Hippel, 1976). It has been emphasized that product innovation is not solely dependent upon the companies that develop the products, but also on the promotion of innovation by consumers (von Hippel, 1986).

The previous research tend to focus on word-of-mouth dissemination activities carried out primarily by opinion leaders and influencers as well as product development activities carried out primarily by lead users, thus restricting the scope of the research to specific user groups (e.g. Jensen et al., 2014; Jeppesen & Laursen, 2009). The interaction between the product and the entire user population, including general consumers, has not been sufficiently considered. Especially when multiple different user groups use the same product, it is likely that the expectations for product utility and the effects on the environment in which the product is used will differ depending on the attributes of the different user groups.

Differentiation of the customer experience has been highlighted as an important monetization strategy for freemium products such as software and games. Nevertheless, since different user experiences, including non-paying users and paying users, may interfere with and affect each other, excessive differentiation may instead damage the overall experience for some user groups, degrading the long-term performance of the product.

During the recent development of information processing technology, the collection, analysis, and visualization of big data (e.g., huge and complex data sets) have become widely employed by government agencies and corporations, and are becoming an essential component of decision-making. Users' usage information is automatically generated as a by-product of product usage and is constantly transmitted to companies via products. Development organizations are faced with a large amount of information processing work in this case. Due to the diversity of user demands, it becomes extremely difficult to decide how much attention to pay to each.

This chapter examines the effect of user interaction on product performance through case study analysis and computer simulation, highlighting activities involved in the development and operation of online games. Specifically, Project R of the Chinese online game developer, Company C, is used as the research object to examine

the effects of introducing charged items that differentiate the user experience. A simulation model is constructed and verified based on the actual game environment of Project R.

8.3 Business Model and Big Data Analysis of the Online Game Industry

Depending on the genre of the game content and the method of generating profits, the game industry can be divided into three basic types of business models: experience-based business model, packaged business model, and freemium business model.

The experience-based business model is a business model that involves the user paying a fee in exchange for the opportunity to experience and enjoy a game. This business model has been applied to a number of arcade games. It is important to note that the user does not own the game, and payment is made each time the game is played. The packaged business model has been developed for video game consoles and software. In this model, companies sell the game software and consoles as products, and users purchase them in order to play the games.

A freemium business model involves acquiring large numbers of users by making the game basically free to play, and generating revenue by attracting a small number of paying users (users who purchase charged items within the game) from them (Tanaka & Yamaguchi, 2015). Incentives for purchasing charged items are provided in the form of game benefits. Online games with a highly social component often employ the freemium business model. Freemium is characterized by the fact that users decide how much they wish to spend on the game. Within such games, different user groups, including a limited number of paying users and a large number of non-paying users, coexist under the same content.

Particularly in the case of online game products, unlike console games, the revenue of the product depends upon the number of paying users, so securing enough paying users over a long period of time following official release of the product is extremely important. Generally, the main types of charged items in online games fall into three categories based on their use effect: consumable items, ability-enhancing items, and decorative items (Table 8.1).

Users' playing behavior records, payment histories, and opinions about games make up the bulk of big data in games. The majority of the data is generated by online games that are played on a variety of terminal devices, such as tablets and smartphones, and the average daily data volume has risen from GB level to TB level. A significant increase in the reliance on data across the gaming industry has made identifying and filtering valid and accurate information from large amounts of data an increasingly difficult task for development companies (Huang, 2018).

In online game development sites, the project's operation team is responsible for processing and analyzing these data. Following the official launch of the product, the operation team, in collaboration with the development team, contributes to the

Table 8.1 Main types of charged items in mobile games

	Consumable items	Ability-enhancing items	Decorative items
Availability	In-game purchases	In-game purchase or paid gacha (loot box)	In-game purchase or paid gacha (loot box)
Effect of use	Provide gaming convenience within a certain period of time	Constant increase in character abilities	Decorative effects to customize character appearance
Frequency of adaptive activities (update)	Middle	Low	High
User willingness to purchase	Middle	High	Low
Impact on game balance	Small	Big	None

enhancement of the game content by working on development activities such as the analysis of user data, the addition of additional content such as maps and items, and the reworking of graphics. Operational tasks include viewing and analyzing user and product data after the release of the product, as well as maintenance duties. The operation team is also responsible for assembling a verification model based on the results of the analysis. The operation team provides regular feedback on user trends to the development team, along with proposals for the addition of new items and balance adjustments for the next update.

A game's evaluation in online gaming consists of two components: the quality and enjoyment of the game itself, as well as the overall game environment, including the experience of competing and collaborating with other users. It is therefore imperative that developers maintain a good playing environment while continuously providing new content.

8.4 Case Study of Project R

To examine the relationship between user interaction and product performance, Company C of a Chinese online game developer, Project R was selected as the research target. A field survey of Program R was conducted in September 2019, with one producer and five management personnel interviewed. In the subsequent construction of the simulation model, the model was modified through multiple phone interviews with the management personnel.

Project R at Company C is organized as a medium-sized team of around 60–70 development staffs. There are five full-time staff members assigned to the operation department. After about one and a half years of development, the Project R's product has now been officially released.

Table 8.2 User configuration of project R

	Paying	Non-paying
Longer playing time	High-paying users (5%)	Existing users (50%)
Shorter playing time	Low-paying users (10%)	New users (35%)

Source Compiled by the author based on interviews

Project R's product is a game app for Android and iOS for the domestic and international markets. The genre of the game is MMORPG (Massively Multiplayer Online Role-Playing Game), and the revenue model is based on sales fees for charged items.

Regarding the performance of the product, since its official release, it has maintained the top 50 ranking in the relevant genre in the Chinese Android and iOS markets. On the other hand, the overseas market is still struggling to acquire paying users due to the short period of operation. As for the overall revenue composition, the Chinese market accounts for 85%, and the overseas market accounts for 15%.

Project R's game content can be broadly divided into two categories: PvE and PvP. The term PvE is short for "Player versus Environment," which means that users complete tasks in the game environment and fight against a set of enemies. In contrast, PvP refers to "Player versus Player", which means that users compete against each other according to the rules set forth in the game environment.

In terms of content volume, PvP accounts for 80% while PvE accounts for 20%. PvE content is designed to attract new users and help them better understand the game system, while PvP content is designed to enable multiple groups of users to compete individually or in teams according to the same game rules. By introducing highly uncertain battles, PvP content is intended to provide more detailed content and to increase overall game time consumption. Users have been observed to spend approximately a week playing PvE content before moving on to PvP content.

In Project R's game, there are 4 types of user groups: high-paying users, low-paying users, existing users, and new users, grouped along two axes: paying behavior and usage history.

As regards the composition of the overall user group, according to Project R's monthly data for the Chinese market (as of August 2019), the structure is 5% high-paying users, 10% low-paying users, 50% existing users, and 35% new users (Table 8.2).[1]

Following its official release, Project R had achieved steady monetization and maintained a high position on the Chinese market, while expanding into international markets. Despite their success in achieving key performance indicators such as user activity and profit, there were some deviations in goals such as the amount of charged items and the conversion rate of paying users. In relation to the first anniversary of the

[1] Due to the sensitivity of user data, exact values cannot be provided. The values shown here are approximate values based on actual values.

official launch, a major update, the proposal to increase the effectiveness of charged items was discussed in depth within Project R.

Specifically, it was a plan from management to encourage charging behavior by enhancing the effects of using some charged items in matches. The comparison demonstrates the plan using uncharged item A and charged item B from the same category (Table 8.3). Traditionally, only consumables and decorative items were applied in game, and charged items had little impact on game balance. The uncharged item A, which has the effect of enhancing abilities, was equipped to a large number of users. Considering the existing charged item system from the user's perspective, there was a weak relation between the effects of charged items and the game experience, and the user could enjoy the same gaming experience without paying. As a result, significant revenue growth was not expected. Thus, the plan, based on the concept of creating a demand for charged items through differentiation of the game experience, was to add new decorative items and a series of charged items with new enhancement effects based on the ability values of uncharged items. By comparing the effects of uncharged item A and charged item B, it can be seen that charged item B may cause more damage during a match than uncharged item A. With the implementation of this plan, non-paying users would be encouraged to pay for powerful and rare items.

Among the members at Project R, there was a difference of opinion on whether or not the game environment should be balanced. However, since Company C develops and operates multiple mobile games projects at the same time, the competition for development resources within the company is extremely fierce. Eventually, due to the pressure to meet KPIs, Project R compromised on adding the ability-enhancing items to the anniversary update.

Two weeks after the release of the update, the enhanced effectiveness of the charged items attracted many non-paying users, and the ownership rate of new charged items grew rapidly. Due to the increase in the number of new paying users as well as the increase in revenues from existing paying users, monthly sales increased approximately 20% compared to the previous month before the update. Following two months, however, the increase in ownership rate of new charged items began to

Table 8.3 Comparison of uncharged item A and charged item B in the same category

	Uncharged item A	Charged item B
Availability	This item can be obtained at a certain rate as a reward after achieving the specified request	This item can be obtained at a certain rate by using paid gacha (loot box)
Effect	Increase of a certain value of character attributes	Increase of a certain value of character attributes When attacking normally, there is a certain rate of inflicting more damage
Ownership rate	36.2%	1.3%
Usage rate of owned users	43.7%	65.8%

Source Compiled by the author based on interviews

slow, and at the same time, abandonment was becoming more evident, as well as lower activity (number of app launches during a day and play times after launch) of existing unpaid users.

Upon closely examining the play histories of existing non-paying users who had become less active since the update, it was found that there was a strong correlation with the total win rate. As the total win rate falls below a certain level, it has a direct negative impact on the game experience, resulting in lower evaluations of the game, decreased play frequency and duration, and even the tendency to leave the game. Having examined the playing history of new users before leaving the game, it was observed that they also tended to discontinue playing the game when their overall win rate fell below a certain level. Due to this, the introduction of charged items with strong effects on balance was able to increase the willingness to pay temporarily, but it widened the gap between non-paying users and paying users, leading to a loss of equilibrium in the community.

The Project R therefore held multiple emergency plenary meetings regarding the effects of the charged items. According to its existing development plan, Project R would end up reinforcing the effects of each charged item one after another, making PvP matches impossible to win without paying. If this situation continues, in addition to nonpaying users leaving the game, paying users will also become bored with paying. In a series of meetings attended by the entire project team, the development department and operation department came to a consensus that changes to the current development plan were required. As a result of the discussion, the final suggestion for improvement was to downwardly adjust the effects of charged items.

Although adjusting the effect of charged items is not technically difficult, determining whether it is an appropriate value is considered extremely difficult. Correcting the effect of a charged item may harm a particular group of users that own it. Due to this, as a temporary solution, the Project R has decided to strive to continually fine-tune the values of related items while monitoring user reactions. Within two months of implementing two corrective updates, the average revenue per user has dropped by 20%, however the average total win rate of non-paying users has recovered to the level before the implementation of the anniversary update. Moreover, the usage rate of all charged and non-charged items has returned to normal, and the overall balance of the game has been gradually returned to its state before the implementation of the anniversary update. The game system, however, requires more than just a few updates to be restored to its original equilibrium. In the near future, Project R plans to make modifications through smaller updates over a longer period of time (6–9 months).

As a way of motivating users to make a payment, Project R promoted the introduction of ability-enhancing items. From a long-term perspective, however, it failed to maintain a balance between non-paying users and paying users, resulting in a loss of equilibrium among users as well as a decrease in the long-term profitability of the product. Therefore, a contradiction may exist between short-term and long-term evaluation indicators. To ensure long-term profitability over the life cycle of a product, it is necessary to examine the consistency between indicators while product's development and operation continue.

It is also necessary to adjust product content from time to time when multiple user groups are using the same product, considering the disparities between user groups, in order to maintain a satisfactory configuration. The long-term performance of a product is not only determined by the number of paying users, but by the size of the potential paying users' base. Non-paying users are also an integral part of the game community. Thus, securing a certain level of influx of new users and activity from existing non-paying users could contribute to the development of a sustainable revenue model.

8.5 Overview of the Simulation Model

Based on the case of Project R, it is evident that the management of user interaction is critical to maintaining the performance of a product over time. Hence, in this study, the author investigates the importance of balancing the game environment in the interactivity process of users by creating a multi-agent simulation model.

Multi-agent simulation is a type of computer simulation model that simulates the actions and interactions of autonomous agents (which may be an individual or an aggregate, such as an organization or group) in order to evaluate their impact on the system as a whole. Based on a reasonable abstraction of the complex behavior patterns of individuals, this model can be used to simulate the interaction processes of multiple factors existing in the real world, as well as to construct and deepen the understanding of the impact of individual behavior on the whole system (e.g., Uhrmacher & Weyns, 2009; Macal, 2016). Especially in the field of product development, where some products interact with diverse users during the development process and face extremely high uncertainty, simulating the situation and understanding the underlying process in advance can have a significant impact on the product's performance (Garcia, 2005). The issue of revenue generation from a diverse user base is always a concern in online game development projects. Since online gamers typically belong to a variety of user groups with various behavioral styles, there may be differences in how they perceive and interpret game content. The task of understanding the interaction process between different user groups and making decisions regarding future game development based on this understanding is extremely difficult. Through multi-agent simulation, it is possible to construct a model of how users behave according to their usage habits in the game, simulating the interaction between users in a real-world environment. It is, therefore, a feasible and effective way to further examine the interaction process between multiple user groups and its impact on product performance.

In detail, based on the game environment before and after the introduction of ability-enhancing items in the case study, the author constructs two models

using artisoc4,[2] a generic multi-agent simulation platform. The simulation is implemented in a balanced model (before introduction) and an unbalanced model (after introduction), and then the long-term performances of both models are compared.

As an initial step, the author simplifies the interaction between users in the game by assuming that it is a competitive action involving the comparison of match points. In online games, the form of interaction between users is more intense and is characterized more by competition and confrontation than collaboration. Although the form and content of these competitions and confrontations may differ from one game to another, they are essentially the process of users fighting each other according to certain rules and dividing into winners and losers. Therefore, in order to effectively construct the simulation model, the author simplifies the process of competition in the game by comparing the match points held by the users.

With respect to the abandonment of users, the abandonment of non-paying users would lead to a reduction in active users, which would in turn negatively impact the overall ecological environment of the game. In particular, the abandonment of paying users would have a direct influence on the game revenue. In the real world, users may decide to stop playing a game for a variety of subjective or objective reasons. Among the many reasons, the most important one is the game experience. In the event that the experience of playing a game does not meet the expectations of the user, the user will give up and choose another game. According to the analysis of users' behavior before quitting the game in Project R, the total win rate, which is an important aspect of the game experience, has a strong relationship to the abandonment of users. New users, in particular, tend to quit playing after being disadvantaged in a duel for a considerable period of time. In light of the above, the author chooses to use the total win rate as a criterion for determining whether to abandon or not.

When an agent's total win rate falls below a default value, it is immediately removed from the model to represent the abandonment of the users from the game. To construct the model, monthly data from Project R for August 2019 are used to determine the composition of each user group.

To establish a place for interaction, the author assumes the capacity of a game server and set it up as a 50 by 50 space. This means that up to 2500 users may connect simultaneously. It is common to build servers with a certain amount of slack for sudden increases in traffic or problems. Furthermore, the author abstracts the behavior of seeking out opponents when playing against each other, and defines the 40×40 battle space in the middle. The matching of opponents begins as soon as the user enters the battle space.

In order to examine the impact of charged items on user interaction, the author assumes a static game environment without adding new users or conversion between users (conversion from non-paying users to paying users or from paying users to non-paying users).

Behavioral rules for each agent can be described as searching for opponents and playing against them in a space. In order to abstract the game play behavior, the author assumes that the game is designed by comparing the match points. In

[2] https://mas.kke.co.jp/en/artisoc4/.

general, match points are determined by three variables: the user's understanding and ability of the game as the initial value, the responses to opponent's actions in each match and the user's own play status in each match. Accordingly, the points in a match is calculated as the sum of three variables: the user's initial points, the operation points that is automatically generated for each match, and the play points that is automatically generated for each match. Each value corresponds to a uniform random number between 0 and 1.

In general, users decide whether to continue playing the game after having experienced it for a certain period of time. Based on the Project R data, the author sets the game experience period to 300 steps. The total win rate value as abandonment condition is determined based on the abandonment trend of data from Project R's game users.

The specific rules for agent behavior are as follows (Fig. 8.1).

1. The agents are randomly placed in a two-dimensional grid.
2. Then move in a random direction.
3. Calculate the number of other agents in the field of view after entering the battle area.
4. In the case of more than one other agent, one will be randomly selected from among them for the match.
5. After the match is over, move in a random direction.

The revenue generated by a game can be used as a performance indicator. In this study, the amount of revenue generated by high-paying users is set at twice that of low-paying users based on the averages from different paying user groups in Project R.

$$\text{Revenue} = \text{Number of high-paying users} + \text{Number of low-paying users} \times 0.5$$

The simulation is set to end when the revenue falls below 40% of the initial value. Once the game is released, if the revenue falls below a certain level, it is difficult to regain the original level, and this results in the inability to continue to promote the development, which is often the cause of the cancellation of the project. Therefore, the author sets this as 40% of the normal revenue, according to the warning value set by Project R.

In addition to the above assumptions about the simulation model, this study conducts simulations based on the following two situations (Table 8.4).

Balanced type

Composition of points: Since charged items have no effect on the game, a uniform random number that takes a value of 0 to 1 is used for the initial points, operation points (vary with each match), and play points (vary with each match).

Abandonment condition: For each user group, the total win rate is set at 0.45.

Unbalanced model

Composition of points: A uniform random number that takes a value of 0 to 1 is used for the initial points, operation points (vary with each match). Because of the effect

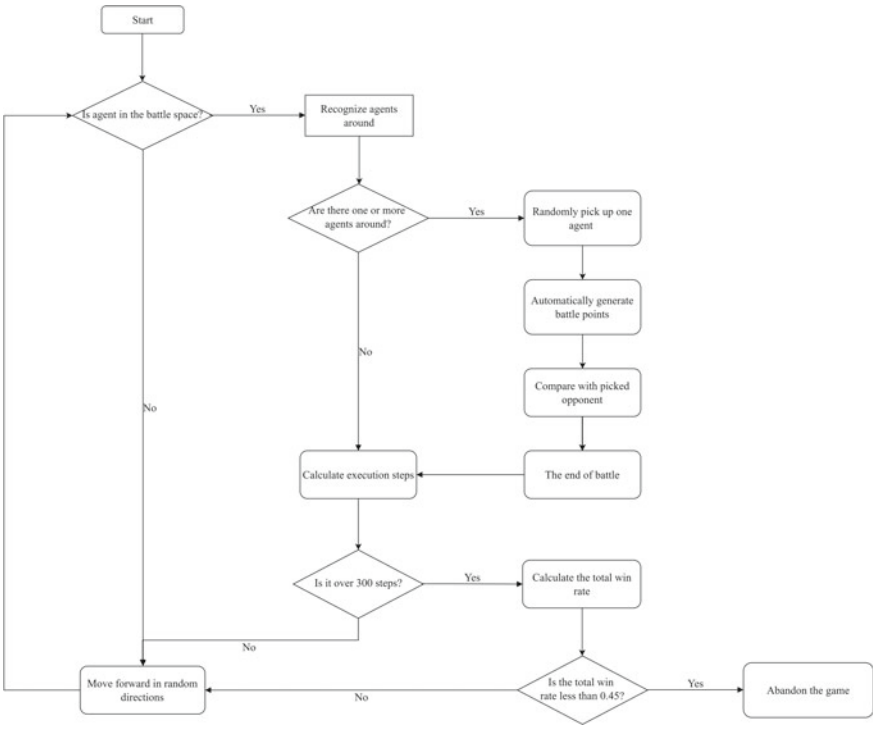

Fig. 8.1 Flowchart of the agent (user). *Source* Compiled by the author based on interviews

of charged items in the matches, bonus points shall be given according to the user's attributes for play points per match (Table 8.4).

Abandonment condition: Because of charged items in the game, the value of the total win rate is determined in accordance with the user's attributes. In the case of paying users, it is reasonable to assume their expectations of the game will increase to some extent with the purchase of charged items.

Simulation results (average of 100 simulation end steps).

Balanced model: 5547 steps

Unbalanced model: 3682 steps

In terms of the transition of new users and existing users, the unbalanced model shows a rapid decline. Both groups of users disappear midway through the simulation, and after 2000 steps, the game is almost exclusively played by paying users.

However, the balanced model exhibits a gradual decline in the number of new and existing users, and it is observed that a certain number of new and existing users remains at the end of the simulation (Fig. 8.2).

Table 8.4 Comparison of the two models

	Balanced model	Unbalanced model
User's initial points	Uniform random number between 0 and 1	Uniform random number between 0 and 1
User's points	Initial points + operation points + play points Each value corresponds to a uniform random number between 0 and 1	New user Initial points + operation points + play points Existing user Initial points + operation points + play points Low-paying user Initial points + operation points + play points × 2 High-paying user Initial points + operation points + play points × 3 Each value corresponds to a uniform random number between 0 and 1
Criteria for abandonment (total win rate)	New user $< = 0.45$ Existing user $< = 0.45$ Low-paying user $< = 0.45$ High-paying user $< = 0.45$	New user $< = 0.5$ Existing user $< = 0.5$ Low-paying user $< = 0.6$ High-paying user $< = 0.65$
Criteria for ending of simulation	Revenue falls below 40% of the initial value	Revenue falls below 40% of the initial value

8.6 Sensitivity Analysis of Simulations

Throughout this study, the author has discussed that the performance of a product life cycle can be enhanced by a highly balanced usage environment. In line with the case study of Project R, the simulation model replicates the results of the analysis that showed how the disparity between different user groups affected product performance. Since this result may have been derived using overly idealized assumptions, it is important to examine its robustness to changes in parameters. In light of this consideration, the author conducts sensitivity analyses of the effects of the abandonment condition of paying users and the effect of charged items in the unbalanced model.

The author has previously set the effect of charged items in the unbalanced model as follows.

Low-paying user

Initial points + operation points + play points × 2

High-paying user

Initial points + operation points + play points × 3

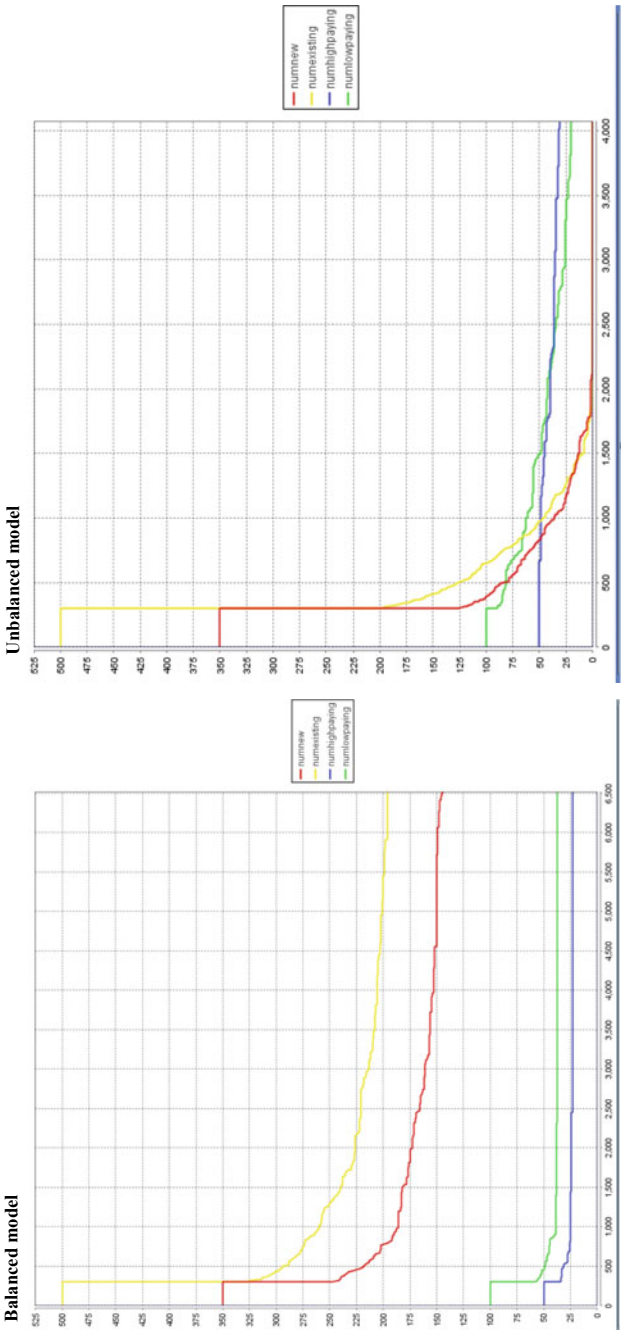

Fig. 8.2 Comparison of the number of users in two models

Table 8.5 The results of sensitivity analysis for changes in effect of charged items

	Number of simulation end steps
Low-paying user 1.5 High-paying user 2.5	Around 3200 steps
Low-paying user 2.0 High-paying user 3.0	Around 3700 steps
Low-paying user 2.5 High-paying user 3.5	Around 4000 steps

The following simulations entail varying the effect amount for low-paying users between 1.5 and 2.5, and for high-paying users between 2.5 and 3.5, in increments of 0.5. Three cases are used to analyze the sensitivity to the effect of charged items.

The results are presented in Table 8.5. Firstly, in cases of small effects, the average value of simulation end steps is approximately 3200 steps, which is about 500 lower than the normal value of unbalanced model (3682 steps). Furthermore, 150–200 non-paying users did not meet the abandonment condition at the end of the simulation and remained in the game. The reduction of the bonus effect for paying users could contribute to correcting the balance to some degree, since it affects the total win rate for the entire user groups, not merely the paying users. It proposes a method of accelerating the abandonment of some paying users while at the same time delaying the abandonment of unpaying users. When the effect is large, the average value of simulation end steps is approximately 4000 steps, which is about 300 more than the normal value for the unbalanced model. In regard to the survival period of non-paying users, all non-paying users leave approximately 1600 steps, which is approximately 400 steps less than the normal value for the unbalanced model. It is expected that greater effectiveness of charged items will increase the gap between users and thus accelerate the abandonment of non-paying users. In regard to the increase in the average value of simulation end steps, since non-paying users exit the game at an earlier stage, the competition with strong non-paying users who might appear at a certain rate ends earlier. It can be interpreted that eliminating the stronger non-paying users at an earlier stage, on the contrary, temporarily slowed down the decline in the total win rate of the paying users.

Regarding the impact of abandonment condition on product performance, in the aforementioned model, the author has set the total win rate to be 0.6 or less (low-paying users) and the total win rate to be 0.65 or less (high-paying users), referring to the user abandonment condition of Project R. In this section, the author simulates the abandonment condition for low-paying users in the unbalanced model by varying it from 0.58 to 0.62, and that for high-paying users from 0.63 to 0.67 in increments of 0.1.

Table 8.6 shows the results of the sensitivity analysis for the abandonment condition. As the abandonment condition is set low, it contributes to the extension of the product life cycle by slowing down the abandonment process of paying users, which is approximately 800–1200 steps more than the normal value of the unbalanced model (3682 steps). When the abandonment condition is set high, it accelerates the

Table 8.6 The results of sensitivity analysis for changes in abandonment condition of paying users

	Number of simulation end steps	Survival time of non-paying(new and existing) users
Low-paying user 0.58 High-paying user 0.63	Around 4900 steps	All abandoned around 2300 steps
Low-paying user 0.59 High-paying user 0.64	Around 4500 steps	All abandoned around 2200 steps
Low-paying user 0.6 High-paying user 0.65	Around 4700 steps	All abandoned around 2000 steps
Low-paying user 0.61 High-paying user 0.66	Around 3300 steps	Less than 5 users remain at the end of the simulation
Low-paying user 0.62 High-paying user 0.67	Around 3100 steps	Less than 10 users remain at the end of the simulation

abandonment process of paying users, resulting in a shorter product life cycle. The result is 400–600 steps less than the normal value of the unbalanced model. However, the presence of a certain number of non-paying users at the end of the simulation can be interpreted as implying that the early abandonment of paying users leads to a reduction in the experience gaps between the multiple user groups.

With the sensitivity analysis described above, it has been reconfirmed that the performance of the unbalanced model is lower than the balanced model (5547 steps), so the simulation results described in the previous section are generally robust.

8.7 Discussion

The purpose of this chapter is to explore the impact of charged items on product performance through a case study of Project R, a mobile game development project. In order to examine these relationships in greater detail, an additional simulation model was developed and validated by replicating interactions between different user groups within the game environment. This analysis revealed that a well-balanced product usage environment with small disparities between users improves performance over the lifecycle of the product.

The importance of differentiation of the customer experience has been highlighted as a key element of the freemium business model (Liu et al., 2014; Seufert, 2014). However, this is dependent upon the situation where each user's experience is isolated or where there is a weak correlation of relevance among users. If the experiences of different users intersect and affect each other, excessive differentiation may undermine the experiences of some user groups and lead to poor long-term performance. As demonstrated in the case study of Project R, the introduction of charged items temporarily increased short-term revenue, but upset the equilibrium of the game balance and user community causing a decline in long-term revenue.

In the event that multiple different user groups interact with the same product, it is necessary to keep the experience gap between them within a certain range while also paying attention to the impact of differentiation on the overall user experience. In addition to paying attention to the weekly product performance as a short-term indicator, it is also important to execute product updates while taking into account the indicators that could influence long-term product performance (e.g., user abandonment rate, new user entry rate, etc.).

One of the key preconditions for the simulation model to function is the abandonment behavior of the users. Specifically, when a user's total win rate falls below a default value, the user is immediately deleted from the model, which represents the user's abandonment from the game. The author simplifies the factors affecting abandonment behavior in order to illustrate the relationship between abandonment behavior and product performance. The decision to leave a game or not depends on complex factors, including the subjective enjoyment of the content, operation support, and content quality. Accordingly, when interpreting the effects of differentiation, attention should be given to the conditions in which leaving occurs and the factors that affect it. Further, although the construction of the simulation model depends on the data from the case study, it cannot be denied that it may capture user behavior patterns that differ from other game products, so it is necessary to adjust the simulation model based on the user composition and behavior patterns of the research target.

The simulation results of this study can be regarded as sufficiently suggestive for considering user data analysis and utilization. Practically, the study illustrates effective measures for maintaining disparities between user experiences within an appropriate range while simultaneously accounting for the influence of differentiation, when experiences of different user groups are intertwined within the same product. In addition, as a future research topic, further verification involving both the transition process of changes in user behavior patterns and interaction patterns between user groups based on more user data of similar game products, should be carried out from multiple perspectives.

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Chapter 9
Final Chapter

9.1 Conclusion

In this chapter the author re-organizes the results of previous discussions, and then derive conclusions by answering the analytical questions presented in Chap. 2.

This book aims to identify effective management practices for continuous product development. The term continuous product development is defined in this book as a process of adapting products to changes in the external environment multiple times during their development. There are four key differences between continuous product development and traditional intermittent product development.

- Adaptive activities are completed within the same product, and that same product is continuously evolving while adapting to environmental changes.
- In order to maintain a product's performance, repeated (iterative) adaptation activities are vital.
- As information is continuously flowing into the development organization from the external environment, it is more difficult to manage uncertainty.
- The development activities of the same development organization must be continued for a long time to ensure product performance.

Therefore, in order to effectively manage continuous development activities, the ability to adapt products to environmental changes is necessary. The performance of products is significantly influenced by the adaptation activities of development organizations.

The author presents three research gaps that have not been adequately explored after summarizing the previous research. It is relevant to note that the effective development pattern as presented in previous research considers development activities as intermittent processes, which makes it difficult to interpret such development activities with continuity. For the management of continuous product development in particular, theoretical and empirical approaches have not been sufficiently explored. In relation to adaptation activities, from the perspective of product structure, modular products, including commercial software, are often taken up as research targets,

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while it is lacking a comprehensive view of integral products. In the case of integral products with a complex product structure, adaptation activities to rapid change are considered to be more challenging. Further, in relation to the effects and targets of adaptation activities, previous studies suggest that there is an implicit assumption that increased flexibility will allow the product to adapt quickly to external environmental changes, ultimately resulting in increased performance. However, the logical development that appears in the previous studies is predicated on a supply of development resources that is sufficient and steady. The challenge for development organizations is securing enough development resources when needed, and how to allocate limited development resources to provide high-quality adaptation activities at an optimal frequency and in a continuous manner is a pressing concern within the development sites. When dealing with vast amounts of external information as part of adaptation activities, there is likely to be a research gap in the area of how to separate and identify useful information from the development organization as well as from the external environment, as well as how to incorporate this information into the product.

In this book, two analytical issues are presented.

Analytical issue 1

What impact does the multiple adaptation activities that take place during the product life cycle have on the product's performance as development activities become more continuous?

Analytical issue 2

What are the most effective development patterns for products and industries characterized by continuous development activities?

For analytical issue 1, the author examines two aspects of adaptation activities of development organizations: targeting and implementation.

According to the adaptation target, development organizations are required to implement adaptation activities following the decision of the development policy of what changes to adapt to based on the analysis of external information. Due to this, it is believed that the selection of the adaptation target will influence the long-term performance of the product. Differentiating the customer experience has been discussed as a means of monetization. Nevertheless, it should be noted that, if the experiences of different users are inter-connected and interact with each other, excessive differentiation may adversely affect the experience of some user groups, resulting in a reduction in the long-term performance of the product.

With respect to the implementation of adaptation activities, it has been suggested that it is critical to implement adaptation activities at a high frequency and as promptly as possible in a rapidly changing external environment. For continuous product development, the progress of the product development project is supported by long-term development activities by the same development organization, resulting in a high probability of organizational exhaustion over time. Consequently, the effectiveness of

adaptation activities cannot be generalized. The adaptation activities must be implemented according to the development capacity of each project. The implementation of excessive adaptation activities may exhaust the development organization.

For analytical issue 2, the author explores effective development patterns from four perspectives, focusing on adaptation activities: external information and products as adaptation targets, development flexibility and collaboration among departments (especially in the development and operations) as the adaptation entities.

To begin with, in terms of dealing with external information, it is extremely difficult to determine how much should be addressed due to the enormous amount of information and the varied nature of user requests that the development sites have to deal with. Especially in game products that require a high degree of product integration, it is extremely important to develop content from a long-term perspective and implement long-term verification work. If development is heavily dependent on data that changes on a daily basis, it is highly likely that the aforementioned tasks will interfere with the development process as well as negatively impact the integrity of the product itself. Thus, excessive reliance on external information, such as user data, may adversely impact the product performance.

With respect to the product structure, it is to be expected that the amount of workload including the interface between component parts and parameter adjustments will increase, since products with a high degree of integration tend to have a more complicated structure than products with a low degree of integration. Based on the empirical analysis, no significant results are found with respect to the degree of integrity of product architecture, thus rejecting the hypothesis that a higher degree of integrity of product architecture has a negative effect on product performance. However, the mean value (3.48) of the degree of integrity is relatively high as an indicator. Furthermore, the case study suggests that adjusting the integral degree of the product architecture can be an effective means of reducing the development workload. Therefore, the relationship between the characteristics of the product architecture and the development workload, should be investigated further in the future.

Moreover, with regard to development flexibility, by including the factor of development resource constraints, the relationship between development flexibility and product performance is not necessarily linear, indicating the possibility of an inverse U-shaped relationship. The development model described in the previous research can guarantee the stable input of subsequent development resources. In practice, it is the reality that adequate resource input is not assured in many development projects. Thus, the effectiveness and scope of the interpretation of previous research are limited. According to the stratified analysis and the case studies of both groups (the group of small and medium development companies vs the group of large development companies), if a project in the group of small and medium development companies is over-adapted, then the amount of man-hours required will exceed the amount of man-hours the project could provide. This will result in a decreasing degree of completeness of the product. This means that the more the project adapts, the worse the performance of the product will be. Moreover, the optimal number of adaptation activities differs according to the degree of development resource sufficiency. Consequently, it is imperative that high-quality adaptation activities are provided in

a stable and continuous manner while adjusting the amount of adaptation activities in accordance with the development project's circumstances.

Lastly, with regard to collaboration among departments, the study demonstrates that collaboration between development and operation has a positive effect on product performance. A number of studies have indicated that enhancing interdepartmental collaboration has benefits such as improved efficiency in information sharing and communication, and the creation of new ideas (e.g., Ernst, 2002; Hoegl & Gemuenden, 2001; Nakata & Im, 2010). Nevertheless, most of the above discussions have been in the context of intermittent product development. In this book, the author extends previous research to confirm the benefit of interdepartmental collaboration in continuous product development, as well as demonstrate the benefits of maintaining close collaboration even after a product is released.

9.2 Practical Implications

In this book, the author focus on the online game industry, which is representative of the continuous product development process. Recently, the online game industry, represented by mobile games, has experienced rapid growth in the world's major markets, such as Japan, the United States, South Korea and China. A key factor supporting this growth is the excellent management of development activities. As game software becomes more complex and richer in content, many development companies are experiencing serious shortages of personnel and rising development costs. Effective project management is essential for maintaining low development costs and adding necessary content on schedule, while responding to the changing needs of users.

This book presents three implications regarding project management in the development sites.

Preparing the buffer always

In allocating development resources, project leaders tend to estimate the required man hours based on the assumption that the project will proceed as planned. Game development, however, faces high degrees of uncertainty from the very start of the process. Even if excellent product performance is achieved, it does not necessarily indicate that the project will progress as planned. Due to the occurrence of unexpected problems, there is a very high risk of rapid increases in development workload. It is essential to have a margin of schedule and development resources in order to manage such uncertainty. It is especially concerning that, unlike intermittent development projects, there is a potential that the workload will accumulate once excessive workloads and digestion processes occur multiple times. Thus, it is urgent to promote the development of a common understanding of the importance of buffers within the company. Even if the development resources allocated as buffers are not fully utilized, it will be possible to achieve a higher level of product quality and growth

of development capabilities by utilizing the surplus for further optimization of the product and training of new staffs.

Designing a development strategy that does not follow the lead of large development companies

To survive in the gaming industry, many game development companies are forced to choose the development strategy of reducing the number of new elements in the game, reducing the testing time as much as possible, and releasing the game as soon as possible. Also, they may choose to abandon existing development projects with long development cycles in favor of games with shorter cycles that are easier to monetize. This has a detrimental effect on innovation activities in the game industry. Companies with fewer development resources, particularly small and medium development companies, face a more difficult market environment. When they follow the large development companies and compete at the same pace, they will eventually be eliminated since they will reach the peak sooner, as previously discussed in Chap. 6. Thus, rather than investing development resources in increasing the frequency of updates, it would be more appropriate if these resources were used to develop original content rather than following the lead of major developers. Small and medium development companies are unable to provide product updates at the same frequency as major developers, making them part of the second group of companies with relatively low product performance in the same game genre. However, it may be a viable strategy for small and medium development companies to secure sufficient revenue by creating highly original content. Additionally, they are responsible for innovation in niche markets by creating new genres and new ways to play existing game genres, contributing to the diversification of game content and promoting innovation among the industry overall.

Maintaining a balance between user data and independent development

Across the entire game industry, user data is becoming increasingly important. As a byproduct of product usage, usage data is automatically generated and conveyed to companies through their products. Development organizations are faced with the task of processing vast amounts of information in this instance. Nevertheless, for games that require a high level of product integration, it is extremely important to develop content from a long-term perspective and to conduct long-term verification tests. If development relies heavily on user data, which changes daily, it is likely to interfere with the aforementioned tasks and may not maintain product integrity adequately. In this regard, excessive reliance on user data may negatively impact product performance. Consequently, when developing new content, it may be more beneficial to make independent decisions based on long-term trends rather than being distracted by short-term fluctuations in use data, thus enhancing product integration.

As the experiences of different users interact within the same game, it is suggested that maintaining the disparity in user experience within a reasonable range, while always considering the effects of differentiation of charged items, will contribute to keeping the product in operation over the long run.

9.3 Future Research Topics

The following two issues should be considered in future research. Considering that the online game industry is an advanced aspect of the IT industry, it is imperative to conduct comparative research with other industries. In this empirical study, the focus was specifically on the online game industry. Therefore, it cannot be ruled out that the analysis results may be relevant to the online game industry only. Future studies examining other industries characterized by continuous product development are required to generalize the findings of this study.

Furthermore, the optimal development model for each level of development resource sufficiency will also be a subject of future research, since this study did not allow for a comprehensive discussion. In the context of the project, how to adjust the frequency of adaptation activities and product architecture to provide high-quality adaptation activities in a stable and continuous manner is an issue that needs further analysis using empirical studies and statistical analysis.

The provision of high added value requires continuous evolution in product development. Continuous development activities aid in realizing such evolution as an important development model that utilizes development resources and external information effectively. Utilizing quantitative and qualitative approaches to analyze development activities in the online game industry, this book attempts to identify effective management practices in continuous product development. With an increasingly fierce competitive environment, the continuous product development model has attracted the attention of companies, and there is a more pressing need for management of its implementation at the development sites. The two research topics discussed are considered to be important research questions for a deeper comprehension of the management of continuous product development.

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Appendix

A.1 Survey Questions

Survey Request for Online Game Development Projects

As online games become richer in content, development activities for online games have become larger and more complex. In response to changing user demands, it is necessary to add necessary content on schedule while keeping development costs low.

The purpose of this survey is to clarify the actual state of development activities and propose better development management strategies that are informed by the results of the survey. It aims to develop an index which can be used to rate the suitability of online game development projects, to compare projects over time, and to track changes in projects over time. In other words, we are interested in conducting a "health check" for development projects, which will allow management to identify and address potential issues before they arise and keep them in a good shape. It is important to note that we will only use results without revealing the names of individual companies or projects, and we promise to use only aggregate data in the presentation of research findings.

Thank you for taking the time to participate in this survey. We would appreciate your understanding of the survey's purpose and your cooperation. (Filling out the form will take about 10–15 min.)

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Precautions on Filling Out the Survey

Please select one to five projects that represent your company's product development and invite the person in charge of that project (project leader, producer, or equivalent) to complete the survey.

For each question, please click on the corresponding number.

Please note that responding to the questionnaire is voluntary. In responding to the questionnaire, you are considered to have agreed to cooperate in the research. In any event, you may withdraw your consent at any time by contacting the person responsible for the research.

The information provided in this questionnaire is intended for academic and research purposes only and will not be used for any other purpose.

After we conduct the survey, we will send each participating company a report summarizing your company's performance compared to the industry average (e.g., product development data as measured by an industry-wide index).

I. **About user data**

1. **How important is user-generated content (UGC) in your game titles?**
   - ☐ 1 Not important
   - ☐ 2 Slightly important
   - ☐ 3 Fairly important
   - ☐ 4 Important
   - ☐ 5 Very important
2. **During the creation of new content, what is more important, the opinions of users or the independent planning of the development team?**
   - ☐ 1 Independent planning is extremely important
   - ☐ 2 Independent planning is more important
   - ☐ 3 Both are equally important
   - ☐ 4 Opinions of users is more important
   - ☐ 5 Opinions of users is extremely important
3. **How often do you analyze user data?**
   - ☐ 1 Once a month
   - ☐ 2 2 to 3 times a month
   - ☐ 3 Once a week
   - ☐ 4 2 to 3 times a week
   - ☐ 5 Daily
4. **How important are the results of the analysis of user data?**
   - ☐ 1 Not important
   - ☐ 2 Slightly important
   - ☐ 3 Fairly important
   - ☐ 4 Important
   - ☐ 5 Very important

5. **In analyzing user data, which is more important: trends among paying users or trends among non-paying users?**
   - ☐ 1 Trends among non-paying users is extremely important
   - ☐ 2 Trends among non-paying users is more important
   - ☐ 3 Both are equally important
   - ☐ 4 Trends among paying users is more important
   - ☐ 5 Trends among paying users is extremely important
6. **Up until now, how much of the game content has been modified to reflect the user data?**
   - ☐ 1 Only a part of the contents of the game
   - ☐ 2 Less than half of the contents of the game
   - ☐ 3 About half of the contents of the game
   - ☐ 4 More than half of the contents of the game
   - ☐ 5 Most of the contents of the game

II. **About product structure of the project**

7 **The interfaces (connections) that link the components of the game are specific to it.**
   - ☐ 1 Strongly disagree
   - ☐ 2 Disagree
   - ☐ 3 Undecided
   - ☐ 4 Agree
   - ☐ 5 Strongly Agree
8. **In order to achieve the required functions of the game, the design parameters of the component parts need to be finely tuned to each other.**
   - ☐ 1 Strongly disagree
   - ☐ 2 Disagree
   - ☐ 3 Undecided
   - ☐ 4 Agree
   - ☐ 5 Strongly Agree
9. **In order to realize the required functions of the game, each development process and operation needs to be finely coordinated with each other.**
   - ☐ 1 Strongly disagree
   - ☐ 2 Disagree
   - ☐ 3 Undecided
   - ☐ 4 Agree
   - ☐ 5 Strongly Agree
10. **When developing an online game, which is more important: using general-purpose technologies (development platforms and middleware) or developing your original technologies (plug-ins and other customized development tools)?**
   - ☐ 1 General-purpose technologies is extremely important
   - ☐ 2 General-purpose technologies is more important
   - ☐ 3 Both are equally important
   - ☐ 4 Original technologies is more important
   - ☐ 5 Original technologies is extremely important

11. **In developing the current game title, what is the usage ratio of your original technologies and general-purpose technologies?**
    - ☐ 1 Almost all use general-purpose technologies
    - ☐ 2 More than half use general-purpose technologies
    - ☐ 3 50% original technologies and 50% general-purpose technologies
    - ☐ 4 More than half use original technologies
    - ☐ 5 Almost all use original technologies

III. **About the development process of the project**

12. **What percentage of the total project do you think is proceeding according to schedule?**
    - ☐ 1 Rarely on schedule
    - ☐ 2 About 25% on schedule
    - ☐ 3 About 50% on schedule
    - ☐ 4 About 75% on schedule
    - ☐ 5 Completely on schedule

13. **The development of online games seems to involve different ways of thinking, such as A and B below. Which way of thinking is closest to your project?**

    A: It is important that development projects proceed as planned. Consequently, we aim to minimize specification changes and backtracking during development by completing the overall requirements design in advance of beginning implementation.

    B: In promoting a development project, it is important to be flexible. Therefore, implementations begin with only approximate specifications and without a detailed list of requirements, allowing for specification changes and backtracking, which allows for the creation of the game to be accomplished by repeated trial and error.
    - ☐ 1 A
    - ☐ 2 Close to A
    - ☐ 3 Between A and B
    - ☐ 4 Close to B
    - ☐ 5 B

14. **What is the average length of time it takes to update (adapt) the content of a game to meet changing user demands and the trends of competitors?**
    - ☐ 1 Within 2 to 3 months
    - ☐ 2 Within 1 month
    - ☐ 3 Within 2 weeks
    - ☐ 4 Within 1 week
    - ☐ 5 Within 2 to 3 days

15. **From planning to implementation, how long does it take to make one of the simplest changes to game content (features) after its official release?**
    - ☐ 1 Within 2 to 3 months
    - ☐ 2 Within 1 month
    - ☐ 3 Within 2 weeks
    - ☐ 4 Within 1 week
    - ☐ 5 Within 2 to 3 days

16. **How long does it take on average for a bug to be fixed after the official release, from the time a cause has been identified to the time the fix is implemented?**
    - ☐ 1 Within 2 to 3 months
    - ☐ 2 Within 1 month
    - ☐ 3 Within 2 weeks
    - ☐ 4 Within 1 week
    - ☐ 5 Within 2 to 3 days

IV. **About the collaboration between the development and operation of the project**

17. **How often do the development team and the operation team meet regularly?**
    - ☐ 1 Once a month
    - ☐ 2 2 to 3 times a month
    - ☐ 3 Once a week
    - ☐ 4 2 to 3 times a week
    - ☐ 5 Daily

18. **In addition to regular meetings, how often do the development team and the operation team communicate with each other?**
    - ☐ 1 Once a month
    - ☐ 2 2 to 3 times a month
    - ☐ 3 Once a week
    - ☐ 4 2 to 3 times a week
    - ☐ 5 Daily

19. **How do you evaluate the current collaboration between the development team and the operation team?**
    - ☐ 1 Very Poor
    - ☐ 2 Poor
    - ☐ 3 Acceptable
    - ☐ 4 Good
    - ☐ 5 Very Good

20. **Following the official release, what is the importance of operation team's suggestions in the development process?**
    - ☐ 1 Not important
    - ☐ 2 Slightly important
    - ☐ 3 Fairly important
    - ☐ 4 Important
    - ☐ 5 Very important

21 **What percentage of the suggestions made by the operation team will be incorporated into the game?**
    - ☐ 1 Only a part of suggestions
    - ☐ 2 Less than half of suggestions
    - ☐ 3 About half of the suggestions
    - ☐ 4 More than half of suggestions
    - ☐ 5 Most of the suggestions

Thank you for your cooperation in completing this questionnaire.

A.2 List of Survey Responses

Questionnaire	Questions	Minimum value	Maximum value	Average value	Standard deviation
Q1	How important is user-generated content (UGC) in your game titles?	3.00	4.00	3.05	0.22
Q2	During the creation of new content, what is more important, the opinions of users or the independent planning of the development team?	2.00	4.00	3.14	0.57
Q3	How often do you analyze user data?	2.00	4.00	3.02	0.27
Q4	How important are the results of the analysis of user data?	2.00	3.00	2.88	0.33
Q5	In analyzing user data, which is more important: trends among paying users or trends among non-paying users?	2.00	3.00	2.50	0.51
Q6	Up until now, how much of the game content has been modified to reflect the user data?	2.00	3.00	2.17	0.38
Q7	The interfaces (connections) that link the components of the game are specific to it	1.00	5.00	3.33	1.12

(continued)

(continued)

Questionnaire	Questions	Minimum value	Maximum value	Average value	Standard deviation
Q8	In order to achieve the required functions of the game, the design parameters of the component parts need to be finely tuned to each other	2.00	5.00	3.48	1.02
Q9	In order to realize the required functions of the game, each development process and operation needs to be finely coordinated with each other	2.00	5.00	3.50	1.13
Q10	When developing an online game, which is more important: using general-purpose technologies (development platforms and middleware) or developing your original technologies (plug-ins and other customized development tools)?	2.00	5.00	3.48	0.83
Q11	In developing the current game title, what is the usage ratio of your original technologies and general-purpose technologies?	2.00	5.00	3.64	1.08

(continued)

(continued)

Questionnaire	Questions	Minimum value	Maximum value	Average value	Standard deviation
Q12	What percentage of the total project do you think is proceeding according to schedule?	2.00	5.00	3.24	0.69
Q13	The development of online games seems to involve different ways of thinking, such as A and B below. Which way of thinking is closest to your project?	2.00	5.00	3.14	0.72
Q14	What is the average length of time it takes to update (adapt) the content of a game to meet changing user demands and the trends of competitors?	2.00	5.00	3.24	0.82
Q15	From planning to implementation, how long does it take to make one of the simplest changes to game content (features) after its official release?	2.00	5.00	3.24	0.66
Q16	How long does it take on average for a bug to be fixed after the official release, from the time a cause has been identified to the time the fix is implemented?	2.00	5.00	3.12	0.74
Q17	How often do the development team and the operation team meet regularly?	3.00	4.00	3.79	0.42

(continued)

(continued)

Questionnaire	Questions	Minimum value	Maximum value	Average value	Standard deviation
Q18	In addition to regular meetings, how often do the development team and the operation team communicate with each other?	3.00	4.00	3.86	0.35
Q19	How do you evaluate the current collaboration between the development team and the operation team?	3.00	4.00	3.05	0.22
Q20	Following the official release, what is the importance of the operation team's suggestions in the development process?	3.00	4.00	3.38	0.49
Q21	What percentage of the suggestions made by the operation team will be incorporated into the game?	3.00	5.00	3.81	0.45