

# Enterprise Architecture Study for Design and Development of Systems to Support the Game Operations

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This article describes an enterprise architecture study to design and develop systems for supporting game management. Furthermore, the article focuses on the methodology used to plan and design a large number of applications with limited resources and provides insights into how to proceed with the development and operation of applications that are not yet mature. The importance of governance rules and the key points in promoting them are also described.

**Keywords :** Information system, Requirement definition, Governance rule

## 1. Introduction

The development of new systems for the Olympic and Paralympic Games Tokyo 2020 (hereinafter referred to as “Tokyo 2020”) started from a situation where information on the scale and difficulty of the development was not fully understood.

After the Rio 2016 Games, we began a full-fledged system planning study, using the list of applications developed for the past Games. From the list, we were able to obtain information on the kind and number of systems developed, but we could not obtain detailed information on how long and how many man-hours were spent on the development and when they were developed.

It was expected that many business applications would be released just before the Games and used mainly during the Games period. As of 2016, many businesses did not yet exist, and it was difficult even to specify business and system requirements. On the other hand,

the systems that would play a fundamental role in the organising committee’s operations, such as financial accounting, electronic approval, and procurement, were required to be implemented as soon as possible from the early stages of the project.

In other words, the number of staff will rapidly increase during the Games, and the organising committee will launch various new operations. Therefore, it was clear that if individual systems were designed and procured based only on immediate business requirements, optimization and systematization of the overall system for the convention would not be realized, and there was a high risk of inefficient development and rework. Therefore, a project for studying enterprise architecture was launched in September 2016, and an analysis was conducted mainly on business architecture.

First, we organized the business operations according to the following four elements (Figure 1).

- Business system : The structure and roles of the entire organization are defined, and business processes and information are modeled.
- Data system : Defines the data handled by the organization, including where each data originates, how it is processed, and when it is deleted.

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- Application system : Defines the functions of the system that supports business processes and the capability to realize them.
- Technology system : Defines “technology standards” for the stable construction, operation, and expansion of information systems in the future.

By doing this, the overall image and outline of the business and systems for which applications must be developed gradually emerged.

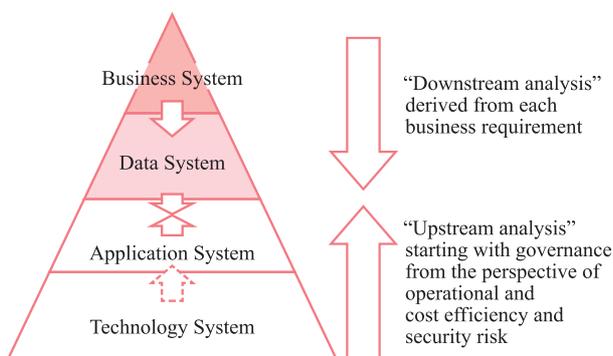


Figure 1 Four Elements for Organising Application

## 2. Architecture of Convention Management Operations

As a result, the operations were successfully classified into the following four themes by “Downstream Analysis” (Figure 2).

### Theme 1 : Sports Operations

Group of operations closely related to competition management : Competition management (operations), medical services, doping control, accreditation issuance management, and so on.

### Theme 2 : Event Operations

Group of peripheral operations required to organize and operate large-scale events, which are closely related to the logistics and transportation of equipment and supplies : Logistics, procurement of goods, cleaning and waste disposal, etc.

Another group of operations is related to the movement and guidance of the Games officials and spectators : Transportation of people, immigration, accommodation, torch relay, signage, spectator services, etc.

Classification	Theme 1 : Sports	Theme 2 : Event		Theme 3 : Business	Theme 4 : Facilities
Definition	Systems related to competition management.	Systems for managing goods and services transactions and logistics.	Systems for managing various operations associated with the movement of people, during competitions and events.	Systems for supporting activities for which profit-making is one of the objectives.	Systems required to manage facilities, equipment, etc.
Corresponding system	Sports Entry & Qualification	Group on Human Movement Accommodation Management System Arrivals and Departures System (ADS) Fleet Management System Portal for Games Stakeholders	Admission and Crowd Management Systems (parts related to guidance)	Food Ordering Portal & Concession POS	Admission and Crowd Management Systems
	Competition Schedule		Lost and Found Management System (The part related to location information management)		Lost and Found Management System
	Doping Sample Management System		Torch Relay Management Runner Selection System (part related to guidance and location information management)	MEDICAL ENCOUNTER SYSTEM (part related to facilities)	
	MEDICAL ENCOUNTER SYSTEM		Group for Movement of Goods Goods Delivery Scheduling System Procurement Systems	Access Control System (parts related to guidance)	CRM (Spectator Information Management System)
	E-Judgement System	Access Control System (parts related to guidance)		Ticket Sales Management System	Access Control System
	Advance Player Information Management (The Sportal)	Rate Card Application Portal	Signage Management Portal (parts related to guidance)		Signage Management Portal
	Entry Order Lottery System	TEAP (IT Equipment Deployment Process) Support = VESPA (parts related to logistics)			TEAP (IT Equipment Deployment Process) Support = VESPA (portion related to equipment)
					Frequency Request Portal
				Vehicle Permit Application Portal (VAPPS)	
				Athletes' Village Management System	
				Systems related to Construction Management	

Figure 2 Example of Application Classification by Downstream Analysis

### Theme 3: Business Operations

Group of operations related to financial accounting, revenue-generating business, and public relations activities: Ticket sales, license management, food and beverage sales, financial procurement, etc.

### Theme 4: Facility Operations

Group of operations closely related to the construction and operation of venues and infrastructure facilities: venue management, athlete's village management, power supply at each facility, security, etc.

Of the above four types of operations, those developed and operated mainly by global partners (sports operations) and those managed mainly by suppliers using existing tools and methods, such as drawing management and progress management (facility operations), were limited in terms of the elements that the Technology Department of Organising Committee had to design and build. Therefore, the following three areas were identified as the areas in which the Organising Committee's Technology Department needed to focus on examining business requirements and system procurement.

- (1) "Theme 2: Logistics and Transportation of Goods in Event Operations"
- (2) "Theme 2: Movement and Guidance of People in Event Operations"
- (3) "Theme 3: Business Operations"

With only a few engineers available, resources are not sufficient for approaching each project individually.

Therefore, based on these classifications, we assigned a full-time engineer to define application requirements as relevant as possible and established a system to implement business relevance and database commonality. Then, an "Upstream Analysis" was conducted for the above three areas. This enabled smooth linkage and standardization among applications to meet each system requirement that emerged from the business requirements.

In chapter 3., business applications are grouped explicitly by relevance, and the study contents are described in each of the above three areas.

## 3. Consideration of Business Applications Supporting Financial Accounting of Games Management

The "Financial Accounting System" belongs to the aforementioned "Theme 3: Business Operations" and is one of the core components of the Games management operations. In 2015, there were only about 300 staff members, and the "Financial Accounting System" used at that time was a small-scale system for small and medium-sized companies. After that, the system was upgraded to meet the demands of the Games with the participation of 8,000 people and was completely operational in 2017.

It was also necessary to link the "Contract Management System" and the external "Electronic Bidding System" in conjunction with the "Financial Accounting System", and these systems also started full-scale operation and linkage in 2017. In the meetings (or processes) where procurement decisions are made, several hundred cases a year are deliberated, and the linkage of these systems plays a significant role in smoothly handling the large number of procurement cases decided during deliberations.

Furthermore, the stakeholders discussed the debts of the organising committee and its management. As a public interest incorporated foundation, the organising committee cannot directly manage accommodation facilities for the stakeholders. For this reason, we discussed and organized the division of roles with outside vendors and the timing of information coordination. In particular, ticket sales to the Olympic and Paralympic Committees of each country and the payment method such as when to record sales and how to handle cancellations or postponements of the competitions were complicated. Therefore, there were many cases to be discussed. The handling of credits and debts will be the focus during each Games event in the future because various cases can be considered under the laws of different countries regarding these themes.

In most cases, when the use of an application used for Games is terminated, the system is closed. However, it is imperative to consider how to close back-office systems, such as the "Financial Accounting System", when the organising committee is dissolved. For example, whether the reduced-size system should be retained or whether the data output and saving the data are needed. For a company that is assumed to be sustainable, the financial data will be retained in the



Figure 3 Large Volume of Goods Stored in a Logistics Warehouse for the Games

system unless the company goes bankrupt. However, the Organising Committee is a very special organization that is assumed to be dissolved; Therefore, such a discussion was necessary.

#### 4. Study of Business Applications that Support for Logistics and Transportation of Large Quantities of Good

The logistics system is one of the most challenging applications to define in analyzing the business. This application is mainly for transporting goods delivered to and stored in the logistics warehouse of the Organising Committee to the competition venues and other related locations. The system had to be built to withstand the tremendous number of operations, including 8,000 trucks (total for the Olympics and Paralympics) and 62,000 logistics staff (Figure 3).

The absence of a business owner was an additional problem. Difficulty in determining requirements is usually common in a typical project, but in this case, there was no one to determine the requirements in the first place. This was because no department could bundle and promote the systemization of the various items requested to be transported to each venue from various sources.

On the other hand, given the expected development scale, waiting for the business owner to be determined would not be allowed us to release the system in time. Therefore, in the summer of 2017, a study task was launched under the leadership of the Technology Services Bureau to promote the project with the involvement of members of related departments.

Discussions about who would be in charge of tasks ranging from ordering, receipt of delivered items, acceptance inspection processing, method of delivery to



Figure 4 SKUs Affixed on All Goods Stored in the Warehouse

the warehouse, transportation planning and instructions, method of delivery at the venue, to removal after the Games were conducted daily until late, involving all stakeholders. Eventually, it was decided to introduce ATS (Asset Tracking System), which manages goods by SKU (Stock Keeping Unit) codes.

The design of the ATS was adapted from an Enterprise Resource Planning (ERP) package for general trading companies. The system was designed to treat each venue as a warehouse, with operations based on the assumption that goods are moved in the warehouse. Goods procured by the organising committee are considered purchases from outside, and the final return or sale of goods to the outside as shipment. As a result, this system was used not only for logistics but also as a management ledger for asset management and asset disposal. It enabled the smooth disposal of goods after the Games in consideration of sustainability.

An SKU code is a unit for counting the minimum number of items in inventory management. An 11-digit code with a 3-letters assigned for each Games management function was defined for each type of item. The total number of SKU codes, or the number of items registered, was 15,328, and the total number of movement instruction slips input by the ATS was 128,264 (including cancellations after movement instructions) (Figure 4).

Although the system ultimately functioned well and contributed to the success of the Games, a problem occurred in the early stages of operation that all goods scheduled to be moved were recorded as “they had already been moved” in the system. The cause was an operator error in which all goods were processed at once. It should have been recorded that “only the goods that had arrived were moved”. Initially, the system was designed to be operated by all the operators in charge of each Games management function that requests the delivery of goods. However, it was concluded that this

would be difficult due to the lack of cost and time available. Alternatively, a backup operation was improved to manually restore erroneous operations and the number of operators who operate the ATS system was limited as possible.

This was a critical case that staff should be assigned to train the operators when operations are not sophisticated and the time available for system operation training is limited. Trained operators were also expected to become proficient promptly, and the number of members with access to the system should be limited as possible.

In addition, when assigning SKU codes, many unexpected situations occurred in actual operations, such as how to count sand used at a beach volleyball venue as one unit. Each time this happened, we gathered all stakeholders to discuss the issue and created various operation workarounds rather than changing the system.

## 5. Study of Business Applications that Support the Movement and Guidance of Games Officials

Firstly, for “Theme 2: Movement and Guidance of People in Event Operations”, immigration information management, accommodation, and transportation-related systems were required. Their systems were especially important because Olympic Games were held during the coronavirus disease 2019 (COVID-19) pandemic. For example, “immigration information management systems”, “accommodation systems”, and “transportation-related systems” are a group of applications related to the movement and transportation of people.

Although the number of Games officials entering Japan from overseas was lower than expected due to the impact of COVID-19, 43,000 people entered the country for the Olympic Games (peak entry of 4,200 on July 18 and peak departure of 9,600 on August 9), and 11,000 for the Paralympic Games (peak entry of 2,000 on August 20 and peak departure of 4,200 on September 6). These people had to complete quarantine and other procedures at the airport without delay. Then we needed to arrange for special vehicles to facilitate smooth transportation between the airport, the athletes’ villages and hotels. In addition, making reservations for places where media representatives and other people are likely to be concentrated was needed. For this reason, it became

increasingly important to share data of Games officials through the systems that support the movement and guidance of convention officials. These systems must have data of Games officials.

The accreditation system developed and operated by global partners, in which the personal information of Games officials is registered and managed, has unique limitations in its design and operation to meet the specific requirements of sports operations since the past Games. Therefore, the information managed by the accreditation system was used as the master data for the development and operation of a business application by the Organising Committee to support the movement and guidance of the Games stakeholders. A duplicate of the master data was built on a platform (public cloud service) independently procured and operated by the Organising Committee as a database of the Games stakeholders, ensuring a degree of freedom in development and operation. This architecture was adopted from the Rio 2016 Games, but Tokyo 2020 has the additional requirement of operating during the COVID-19 pandemic. The database has proven highly effective as a user information management platform for the rapid and secure development and operation of new business systems, such as a reservation system for media coverage areas to prevent media triangulation and a support system for infectious disease control operations for Games stakeholders.

The database holds information on 420,000 Olympic and 310,000 Paralympic Games stakeholders. Naturally, access to the data is strictly restricted. The data that each application must access is defined in terms of which data is absolutely necessary for business purposes, in which situations, how often the data must be updated, and how to manage user privileges and operations for accessing the information. The members in charge of business applications that support the movement and guidance of Games stakeholders played a central role in the detailed scrutiny of these issues, starting from the time of requirement definition.

## 6. Conclusion

As the feature of a limited-time organization that plans and operates a public event, we faced many challenges, such as requiring several days to determine business requirements and developing the needed staff operation systems. For example, the detail of requirements for asset management, including the disposal of

assets after the event, was not always finalized on time. In such cases, it was effective not only to “ask to user requirements” but also to “show the model”. Eventually, business departments could understand the requirements smoothly and decide to proceed with their consent.

Even if there is a delay in determining business requirements or a rework in the process, it is important to have an established technical standard for architecture to optimize the overall system design.

In the development and release of all the applications, it was effective to keep the common governance rules established as a result of this enterprise architecture study, such as security review of design, procurement specifications, provision of penetration tests (developed in-house), and pre-release judgment meetings. The design review for the access to the Games stakeholders database described in “5”. was also conducted in this framework.

It was also important to establish rules that enable the technology department to be involved in all system procurement and outsourcing contracts that handled the business and data of the Organising Committee, rather than leaving system development entirely to suppliers. Although this article focused on applications handled by the Technology Services Bureau, this framework could also apply to large-scale projects led by other bureaus (e.g., ticket sales, fleet management, etc.). The framework was designed so that the Technology Department is always involved in the review of non-functional requirements (network environment, reliability design, security design) and release decisions.

Furthermore, the understanding of the Organising

Committee executives of the need for “cyber security measures” and “cost optimization” was a great encouragement for this activity.

It should be noted that the best design cannot be made with various technologies, techniques, and mechanisms even if we scrutinize the architecture sufficiently. Even with only authentication infrastructures for users, it was necessary to use four or five different designs, such as for competition information, back-office, external users, etc.

Furthermore, technology is evolving so rapidly these days that even if the nature of the work has not changed significantly from past Games, it is expected that every Game event will be a challenge, especially in terms of system architecture, to incorporate new information into the activities.

Similarly, it can be said that the introduction and renewal of mission-critical systems in companies. Therefore, it is essential always to consider and update the proper architecture based on the latest technological trends for each company. In addition, the understanding and support of top management are also needed.

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