

# Modeling Sport Events Legacy based on Olympic Games

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**Abstract:** This article presents a conceptual model of sport events legacy based on the Olympic and Paralympic Games as a reference. The legacy of mega sport events has gained ever more importance during recent years for both academics and practitioners. The International Olympic Committee looked at the concept of legacy, as it is the best argument with which to illustrate the lasting benefits that are derived from the Olympic Games. The Legacy is the way to structure the capitalization of the benefits and lessons related to the organization of major sporting events. So, our motivation is to develop a tool of the sport events legacy. The aims of the article are first, to investigate the legacy sport events literature, second, to propose a Legacy Conceptual Model (LCM) and to transpose it to a database which will be support to analyse the changes related to legacy. This research target also has a practical implication. So, we investigate how the LCM helps to analyze the legacy left by a sport event using a case study.

## 1 INTRODUCTION

The number of sport events organized around the world continues to grow. In this dynamic context, France occupies a leading position and has hosted many major competitions. (CNDS, 2016) has identified 41 Major International Sports Events organized on French territory between 2015 and 2018 (see figure 1). In 2024, France will host Olympic and Paralympic Games. Indeed, these sport events have economic, environmental and societal issues. Organizers and stakeholders look at how positive legacy can be achieved by hosting these sport events, specifically the Olympic Games.

Generally speaking, the legacy is any outcomes that affect people or space caused by structural changes that stem from sport events as Olympic and Paralympic Games. The organization of events, by a sports federation, aims to promote high level sport, attract new licensees and energizes the federation. However, the stakeholders want to generate income, attract tourists, and develop the local economy, among others. Our motivation is to characterize and classify the legacies of sport events and to improve the previously built legacy sport event system. This system was presented by (Grim-Yefsah and Bucher, 2019).

According to the Knowledge Principle of (Lenat and Feigenbaum, 1991) "If a program is to perform a complex task well, it must know a great deal about the world in which it operates. In the absence of knowledge, all you have left is search and reasoning, and that isn't enough", the modelling of knowledge that describe the environment in which applications are operating; allow them to reach their full potential. So, we focus our research work on modelling of the concept of legacy of the Olympic Games. The Olympic Games are the most visible representation of all sports events.

In this paper we propose a Legacy Conceptual Model (LCM) and transpose it to a database which

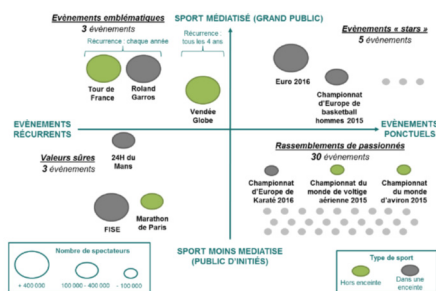



Figure 1: Typology of Sport Events organised in France between 2015 and 2018 (CNDS, 2016).

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will be the support to analyse the changes related to legacy. This paper is organized as follow: The literature review on legacy sport event is outlined in section 2. The proposed Legacy Conceptual Model (LCM) is described in section 3. In section 4, we propose an approach, based on LCM, which defines the actions to be implemented to evaluate the legacy left by a sport event for the territory hosting the sport event. In section 5, we show how the LCM helps to analyse the legacy left by a sport event using a case study. At the last, in section 6, we recall the contributions and outline limitations and some perspectives of this work.

## 2 UNDERSTANDING OF LEGACY CONCEPT

This section deals with concepts that are employed in this paper regarding to context and elements of mega sporting events such as Olympic and Paralympic Games and the benefit to be gained from the legacy that will be left behind.

Mega sport events like the Olympic Games have become flagship events generating considerable and varied structural and tourist impacts on the urban fabric of the host territories (Ritchie, 1984; Harada, 2005). Timothy (2011) argues that sport has played a central role in various cultures and societies for millennia, while the relics, events and locations of sporting past are celebrated, venerated and protected like any other heritage. Preuss, (2015) considers that “staging a mega event transforms a city”. In this logic, we looked at the definitions of the legacy and specifically sport event legacy.

The first use of the word legacy in regard of the Olympic Games was for the 1956 Melbourne Olympic Games. The term legacy has different meanings for different people, languages and cultures. Preuss (2019) has largely investigated this concept of legacy.

Cashman (2005) considers that legacy is often assumed to be self-evident, so that there is no need to define precisely what it is.

Preuss (2007) proposes the following definition “Irrespective of time of production and space, legacy is all planned and unplanned, positive and negative, tangible and intangible structures created for and by a sport event that remain longer than the event itself”. Preuss (2007) has identified also some impacts of mega sport events: economic impact, urban development, employment impacts, environmental and social impacts. He argues that the sport events

accelerate city development by built some sport infrastructures, training sites, villages of athletes, technical officials and media. In another hand, the supervisors of technical structure developed power plants, telecommunication networks, and cultural attractions.

Chappelet (2012) proposes this definition “The legacy of a mega sport event is all that remains and may be considered as consequences of the event in its environment”. Please, note in this definition the association between sport events and legacy. Hinch and Ramshaw (2014) highlight a first explicit association between sports events and legacy (heritage) through the concept of ‘Sport Heritage Attractions’. The IOC (2017) proposes this definition “Olympic legacy is the result of a vision. It encompasses all the tangible and intangible long-term benefits initiated or accelerated by the hosting of the Olympic Games/sport events for people, cities/territories and the Olympic Movement.” and outlines some Games legacies : Sport Practices enhancement, Social development through sport, Urban development, Culture and creative development, Economic, Environment enhancement. Please, note that the scope of Olympic Games legacy varies for each edition, according to the specificities of the city and the territory vision.

## 3 LEGACY CONCEPTUAL MODEL

In this section, we propose a Legacy Conceptual Model (LCM) based on the domain literature.

Grim-Yefsah and Bucher (2019) propose the conceptual model for sport events (see figure 2).

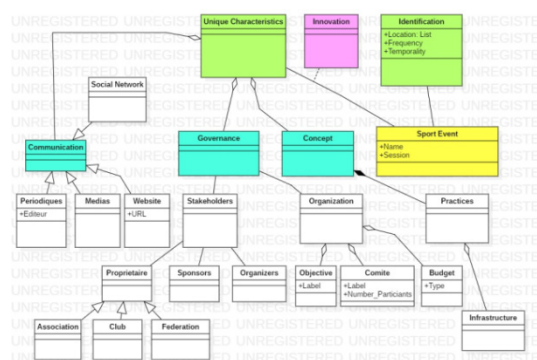


Figure 2: Conceptual Model for Sport Events (Grim-Yefsah and Bucher, 2019).

In this conceptual model, three dimensions are

expressed: the temporality, the location and the uniqueness. This uniqueness is considered in several ways:

- Interactions between the environments; their internal organization which can include the budget, the goals targeted by the event, etc. (see Figure 3, “Organization” Class)
- Interactions between people; the personalities organizing the events, (“Stakeholders” Class)
- The management systems for these events, namely the design, planning and programming elements they generate, and the communication (“Governance” Class)
- The concept of the sport event, i.e. practices and their infrastructures (“Practices” Class).

The two others dimension ‘temporality’ and ‘location’ are attributes of ‘Identification’ Class. Please, note here the important distinction between principle and secondary location.

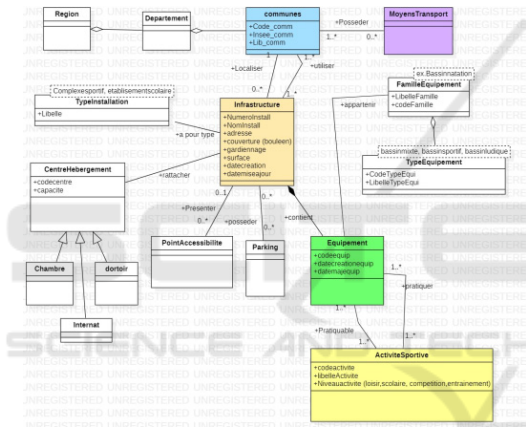


Figure 3: Class Diagram of “Infrastructure”.

- Principle location represents the hosting country (see Figure 2, “Identification” Class). Example: In 2024, France will host Olympic and Paralympic Games.
- Secondary locations represent the all cities where each sport takes place. Each infrastructure is located in “communes” Class. The term “commune” (see Figure 3) designs the municipality.

From the definitions of the previous section (c.f. § 2), we retain firstly the association between sport events and legacy (see Figure 4). The legacy is any outcomes that affect people or space caused by structural changes that stem from sport events.

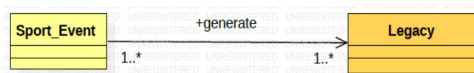


Figure 4: The association between sport events and legacy.

Now that legacy is relatively developed topic, we propose the Legacy Conceptual Model (see Figure 5). The definition of (Preuss, 2007) highlights five dimensions (space, time, tangible/intangible, planned/unplanned, positive/negative). According to this definition, we retain those elements:

- Dimension1: Space.
  - Dimension2: Time of the event. We don’t consider the duration of a legacy.
- Space and time are intrinsically linked to the mega sport event.

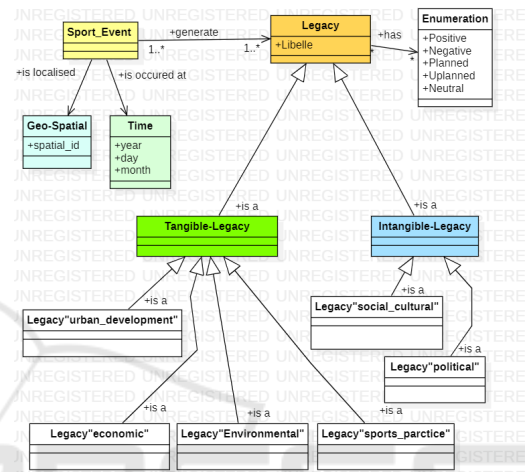


Figure 5: Legacy Conceptual Model.

- Dimension3: Tangible/ Intangible
- Tangible is easily captured by images and tends to dominate the public debate around the subject. Firstly, tangible legacy are sports infrastructure and others urban infrastructures as hotel, housing, transport infrastructure, neighborhood renovation. In another hand tangible legacy are the measurable quantitative quantities, example increase in tennis practice, new business sector development.

Intangible is not as easy to identify, define or measure, and has been less present in the public debate, although it is likely the most relevant in regard to actual benefits to people and society., i.e. better skilled people, knowledge and sport governance.

- Dimension4: The outcome can be neutral, positive or negative.
- Dimension5: The outcome can be planned or unplanned.

The Legacy Conceptual Model (LCM) aims to provide knowledge for analysing the legacy of the Olympic Games. To model each kind of legacy, the LCM should be expanded. We realize that this conceptual model becomes complex. In order to

achieve at a readable model, we break the LCM down into manageable units (class diagrams). For each diagram we inventory appropriate classes and model them.

#### 4 LEGACY MODELLING APPROACH

We agree with (Parent, MacDonald, and Goulet, 2014) which showed that hosting sports events requires organizers to learn from past events to not repeat mistakes. So, we focus on building a capitalization system for sport events legacy. This section describes the approach to implement a process of validation of the use of our Legacy Conceptual Model.

The Legacy Modelling Approach (LMA) consists of three main steps. The previously Legacy Conceptual Model (LCM) built will be expanded by adding the model of each type of legacy progressively. The following steps show the implementation of this process.

Table 1: Types of Legacy (Extract).

| Legacy                           | Items   |
|----------------------------------|---|
| Sport Practices                  | Level of competitive sports development in local up since the hosting of Olympic Games; New/upgraded sports venues used for training and competition; |
| Urban Development                | Transport and mobility infrastructure development (metro or train system, airport); Basic urban infrastructure (housing, water);                      |
| Economic                         | Increased global profile and visibility of city/territory; Tourism and event industry development ;   |
| Environment                      | Sustainable sports infrastructures; Transition to low-carbon technologies;  |
| Social development through sport | Health and well-being benefits from the practice of recreational sport and physical activity; Olympic values and sport;                               |

1. At the first step, we choose one type of legacy based on the LCM (see Figure 5). Then, we proceed to know a great deal about the domain. Thus, we proceed, firstly to requirements gathering which encompasses the following tasks: interviewing federations and clubs, organizers, sponsors, managers, participants, volunteers and spectators, browsing through sports databases. In other hand, we use the scope of sport practices legacy, defined by IOC (see Table 1). The result of this step is the Conceptual Model of the topic legacy.

<sup>2</sup> <http://www.sports.gouv.fr/>

2. At the second step, we use a tool which is based on model-driven approach to carry out this step automatically. The model obtained in the first step will be automatically translated towards a customized relational schema. This structure helps us to collect the data and instantiate the database.

3. So at the third step we deal with ‘transform data into information’, ‘derive new information from existing’ using analytics tooling and creation of storyboards. Finally, we proceed to analyse the legacy left by a sport event, both for the territory hosting the sport event and for future sport events.

Because the Legacy is thinking by cities interested in hosting the Olympic Games as early as the dialogue stage, we focus on the candidature to find the elements for their verification and validation of changes. However, we focus also on the existing literature, the capture of the legacy of past Olympic Games and the scope of Olympic Games Legacy defined by International Olympic committee to list fundamental questions.

In fact, we use a case study, in the following section, to implement the Legacy modelling approach.

#### 5 CONCEPTUAL MODEL OF SPORT PRACTICES LEGACY

In this section, we choose to focus on sport practices Legacy.

##### 5.1 Building Conceptual Model

We first proceeded to know a great deal about the domain. Thus, we proceeded, firstly to requirements gathering which encompasses the following tasks: interviewing federations and clubs, browsing through sports databases<sup>2</sup>. In other hand, we have used the scope of sport practices legacy, defined by IOC (see Table 1), which includes these items:

- Competitive sports development in local up
- Organised grassroots sports development (sports initiation, clubs, etc.)
- Discovered and practice of less known sports
- Improved efficiency of the organised sports system (federations, support and governing bodies)
- New/upgraded sports venues used for training and competition
- New Sports equipment

We propose the Conceptual Model of Sport Practices Legacy (see Figure 6).

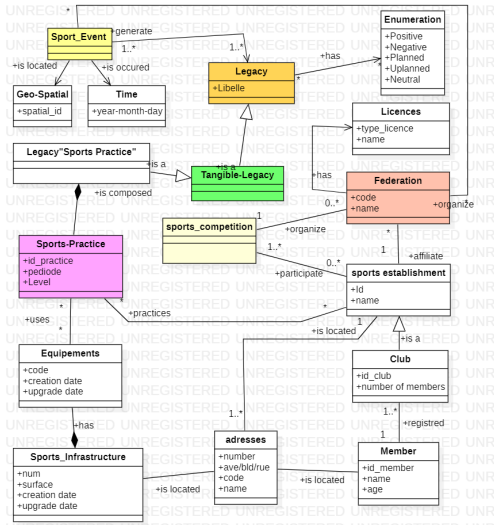


Figure 6: The Conceptual Model of Sport Practices Legacy.

This conceptual model can also be expanded by the previously model built to sport event (see Figure 3). The classes “CentreHébergement”, “Parking”, and “accessibility” characterize “Sports Infrastructure” Class of our conceptual model (see figure 6).

Finally, we realize that the vision of sports practice overlaps with the vision of urban development, specifically the sport infrastructure. The Urban development topic includes:

- Transport and mobility infrastructure development (airport, metro, train, etc.)
- Basic urban infrastructure (housing, water, sanitation, etc.)
- Advanced urban services and infrastructure (technology, smart buildings, etc.)
- Upgraded/new venues for multiple social/economic uses Economic
- New/upgraded sports infrastructure/ Sports equipment.

Remember, we have broken the LCM down into manageable units (class diagrams). Then this overlap makes sense.

### 5.2 Mapping the Conceptual Model to Relational Database

To carry out this step automatically, we used a tool which is based on model-driven approach. We obtain the following relational schema.

|   |
|---|
| <b>Sport_Event</b> ( <u>Id_SE</u> , Name_SE, Date_debut Date, Date_fin)                     |
| <b>Legacy</b> ( <u>Id_legacy</u> , Libelle)   |
| <b>Generate</b> ( <u>Id_legacy</u> , Id_SE)   |
| <b>Enumeration</b> (positive, negative, neutral, planned, unplanned)                        |
| <b>Geo-Spatial</b> ( <u>Id_spatial</u> )  |
| <b>Time</b> ( <u>Id</u> , Year, Month, Day)   |
| <b>Tangible_Legacy</b> ( <u>Id_TL</u> , <u>Id_legacy</u> , Libelle)                         |
| <b>LegacySPactice</b> ( <u>IdLSP</u> , Id_TL, Libelle)                                      |
| <b>Sport_Practice</b> ( <u>Id_practice</u> , period, level, <u>IdLSP</u> )                  |
| <b>Equipment</b> ( <u>codeEQ</u> , creation_date, upgrade_date, <u>Id_Sinfra</u> )          |
| <b>Use</b> ( <u>Id_practice</u> , <u>codeEQ</u> )   |
| <b>Sport_Infrastructure</b> ( <u>Id_Sinfra</u> , creation_date, upgrade_date, surface)      |
| <b>Sport_Establishment</b> ( <u>Id_SEst</u> , name)   |
| <b>Practices</b> ( <u>Id_SEst</u> , <u>id_practice</u> , date)                              |
| <b>Federation</b> ( <u>codeSF</u> , name)   |
| <b>Organize</b> ( <u>codeSF</u> , <u>Id_SE</u> )  |
| <b>Sport_Compétition</b> ( <u>Id_Scompt</u> , date_creaion, date_D, Date_F, <u>codeSF</u> ) |
| <b>Licences</b> ( <u>id_licence</u> , type_licence, name, <u>codeSF</u> )                   |
| <b>Participate</b> ( <u>Id_SEst</u> , <u>Id_Scompt</u> , dateparticipate)                   |
| <b>Club</b> ( <u>Id_club</u> , NumMem)  |
| <b>Member</b> ( <u>Id_member</u> , age, name, <u>Id_club</u> )                              |
| <b>is_locatedMem</b> ( <u>Id_adress</u> , <u>Id_member</u> )                                |
| <b>is_locatedSEsta</b> ( <u>Id_adress</u> , <u>Id_SEst</u> )                                |

Finally, we instantiate the database previously created with data obtained from www.sports.gouv.fr.

### 5.3 Analyse the Legacy

Now, we have to evaluate the changes related to sports practice. Thus, to validate a legacy, one needs to consider the before and after of the Olympic Games. We propose some queries (see Table 2).

Table 2: Types of queries.

| Query   |
|---|
| What is the level of competitive sports development in local up since the hosting of Olympic Games? |
| Is there organised grassroots sports development (sports initiation, clubs, etc.)?                  |
| The hosting of Olympic Games do it allows of the discovered and practice of less known sports?      |
| The organised sports system (federations, support and governing bodies) is there improved?          |
| The new (upgraded) sports venues are there used for training and competition?                       |
| How the new sports equipment are there used by citizens and clubs?                                  |

These queries show how we succeed in capturing the changes related to the hosting of Olympic Games, through the sport practice vision.

According to scholars and practitioners the legacy is embedded through the Olympic Games lifecycle. Thus, to provide direction of how this approach can be used in practice with real data we focus on the data of JO' 2024 preparation stage.

In the case of the 2024 Olympic Games in France, we have to consider three intervals.

- [2010, 2015]: precedes the acceptance of the candidature of France in the Olympic Games;
- [2015, 2023]: concerns the Olympic Games preparation stage;
- [2025, 2030]: concerns the after the hosting of the Olympic Games.

In this study, we focus on data between 2010 and 2018 and specifically the data of the 'Ile de France'. The 'Ile de France' includes Paris and its suburbs.

In first, we have selected the data from the Olympic uni-sport federations approved in Ile de France ([www.sports.gouv.fr](http://www.sports.gouv.fr)). We have retrieved detailed data on licenses and sports groups from annual censuses from approved sports federations.

The second work consists in treatment of this data, using R language. Its return the following results (extract).

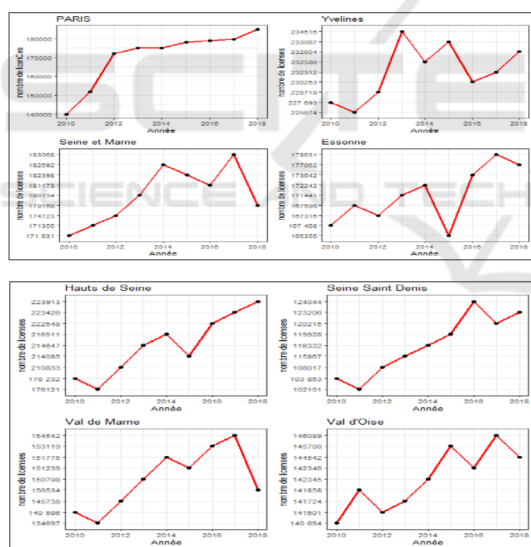


Figure 7: Evolution of the number of sports licenses by department.

Overall, there is a net increase in licenses across the 'Ile France', despite the decrease in certain departments. From a statistical point of view, the analysis on the basis of a single factor does not however allow conclusions to be drawn on the interaction between the announcement in 2015 of the candidature for the Olympic Games and the growth in the number of athletes. Indeed, further studies are

needed with relevant indicators in order to conclude to a possible link between the candidature for the Olympic Games and the increase in the number of professional athletes. This study is in progress. The answers of questions in table2 depend on data and authorities. Funding of studies on the legacy Olympic Games is ensured through authorities but the financing is falling. In fact, other studies are conducted by students in master degree to show how use the LCM to implement a process of validation with stakeholders.

## 6 CONCLUSIONS

The Legacy of sport events is the lasting benefits which can considerably change a territory, its image and its infrastructure. So modeling the legacy sport events can share the common understanding of the knowledge for actors of federations and clubs, organizers, sponsors, etc. Therefore, this paper proposes a modeling approach to sport events legacy based on the Olympic and Paralympic Games as a reference. This reference is selected because of the most visible representation of the Olympic Games compared to all sports events. This Legacy modelling approach consists of three successive steps: building conceptual model, mapping the conceptual model towards a relational database, and analyse the changes related to legacy.

As a starting point of our work, we propose a generic legacy conceptual model based on the literature using the UML diagrams. The aim is to propose a uniform way to represent several sport events legacy. Then we expanded it by a specific model of the sports practice legacy.

We illustrate the application of the approach with the sports practice legacy, we obtained the conceptual model, the database and we propose some questions to analyse this type of Legacy demonstrating the ability of the approach to find the tangible elements of each legacy. Observe that our approach is not dedicated to the sports practice legacy field but can also be deployed in other tangible legacy. Indeed, other studies are doing with students in master degree to implement the LMA with environmental legacy and urban legacy.

In this work, we help stakeholders to perceive the effects of the Olympic Games as the increasing of licenses, the improvement of sports practice by citizens but we don't assess the legacy. Thus, the main limitation of this work is about the legacy measurement. As an outlook, the next step is the real measurement of a legacy. (Koenigstorfer, 2017) has

proven that only very few scholarly papers investigated how to measure the different legacies. Our idea is to measure the different legacies following a goal-question-metric approach (Van Solingen et al, 2002): as case study, we associate metrics at each question of sport practice legacy (see table 2).

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