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RESEARCH NOTE

Development of Work Breakdown Structure for Stadium Work as Project Guideline and Standard

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ABSTRACT

A Work Breakdown Structure (WBS) is a key visual project tool functioning as an obligation in managing construction projects, due to playing a crucial role from planning to execution. However, there are still several problems related to the implementation of WBS, such as miscommunication and poor development, where all involved execution parties do not accurately understand the scopes and objectives. This ultimately leads to project losses, based on cost, time, and quality, where standardization is not observed within the WBS preparation and development. Therefore, this study aims to develop a standard stadium WBS, for all involved execution parties to understand and achieve work information consistency. This was performed by mapping the Focus Group Discussions (FGDs) and Bill of Quantities (BQ) data of previous stadium projects with experts in their respective fields. The results showed the development of a standard WBS containing levels 1-6, including design alternatives, implementation requirements, and material specifications. During application, this tool helped to compile the entire scope of results-oriented projects as related guidelines and standards, with each hierarchical level from the top to the lower components. The obtained results also considered the consultants, contractors, and auditors at the planning, implementation, and monitoring stages, respectively.

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1. INTRODUCTION

The availability and adequacy of infrastructure are correlated to the economic growth of a country, due to being considered to have a positive and significant influence on environmental development and employment opportunities [1]. This is in line with the Indonesian government, which provides the efforts to intensify domestic development through the constructive elevation of state-owned buildings, whose classifications include stadiums. In this country, the construction of stadiums (new buildings or renovations) is found to be presently intensified. Therefore, this study aims to compile WBS standards, checklist and dictionary, which contains levels 1-6 including stadium alternative designs, implementation requirements, and material specifications. This is to indicate the needs of each Main Building, Field of Play, and Regional Works, respectively, where WBS shows materials and resources in level 6, as subsequent guidelines and standards for the performances of consultants, contractors, and auditors. Furthermore, Mangkuto et al. [2], Amelia and Yusuf [3] similarly argued that the stadiums were observed as architectural icons and benchmarks, which largely influenced the development of surrounding communities and infrastructures. In a construction project, a Work Breakdown Structure (WBS) plays an important role as the foundation for defining and establishing the framework for work management and completion, respectively [4]. This proves that creation of the tool is an obligation to be carried out from the planning to the execution stages. Despite being known as an important input in the management practice, many projects do not properly utilize the WBS, leading to the occurrence of errors in the work execution [5, 6]. In the construction industry, the key success factors are also being examined based on the perspectives of the owners, contractors, and consultants. These classified the identified indicators into

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five main categories, including financial, interactive processes, human resources, contract agreements, and project specifications [7]. Despite this, the WBS implementation is found to still encounter many challenges for the involved parties, such as miscommunication and poor development, which leads to the incomprehensive and inaccurate knowledge of project scopes and objectives. Subsequently, this causes work errors and project losses, based on time, cost, and quality. This was in line with Suanda [6], which stated that many Indonesian projects did not accurately utilize WBS, leading to several problems such as delays, change orders, construction claims, and contractual disputes, whose main source is based on the form of alterations. This confirms that any alteration submitted and instructed by the contractor and engineer from the specified sequence or timing in a program is found to qualify as a major change [8].

WBS also plays a vital role after project execution, with different perspectives related to the auditors' results often observed to cause the return of a large amount of money to the government, through the contractors involved in the work package. These differences are commonly caused by the absence of standardization, guideline, and calculation methods, which provides quick and easy guidance [9, 10]. The process of standardization helps to achieve consistency in work management and indirectly reduce conflicts among project teams. In adopting this process, the aim is often based on the development of a specific level of conformity [11, 12]. Documentation standards and project notes also help in the development of a reference line, due to the provision of a communication channel among the project team. This explains that a standard stadium WBS is commonly used as a guideline to help achieve consistency and data standardization, which is often internally and externally utilized by project teams and auditors both in each project implementation stage.

2. STUDY SIGNIFICANCE

For the stadium projects, the results of the standard WBS development are expected to be used as a guideline towards the achievement of work consistency and standardization. These are to be used by various stakeholders in every project execution stage, especially for state-owned building construction. With a standardized definition, the effective and consistent distribution of crucial information is also expected to minimize the contractual disputes related to project scopes and activities.

3. LITERATURE REVIEW

3. 1. Definition of Work Breakdown Structure

A Work Breakdown Structure (WBS) is a deliverable-oriented hierarchical work decomposition carried out by the project team, to achieve objectives and produce appropriate results [13]. This explains that deliverables are unique products, results, or capabilities, used to display the services that should be produced in completing a process, phase, or project. It is often used narrowly based on external deliverables, which are the subject of approval by the project sponsor or customer. A deliverable is also defined as any measurable, tangible, and verifiable outcome or item that should be produced to fully or partially complete a project [4]. According to Schwalbe [14], the WBS was described as an oriented analysis of work, which defined the overall scope of the project. It was also observed as a basic document in project management, due to providing the basis for planning and managing schedules, costs, and changes. The study conducted by Project Management Institute [15] also defined the WBS as a hierarchical structure, which described and managed the total construction scope through deliverables, with each descending level in the hierarchy being an increasingly detailed definition of project work.

This indicates that a WBS organizes and defines the overall scope of the project to be completed, based on the relationship among work elements to the work objectives. The tool also provides an efficient format for defining, planning, and tracking the progress of the project work. Moreover, it organizes the required work by wrapping it into small manageable chunks, which are subsequently scheduled, estimated, monitored, and controlled. Descending from the top of the WBS hierarchy, each level is observed as an increasingly detailed definition of a project work [15]. The WBS is also a hierarchical list of the project tasks defining the scope, based on effort, timeline, and budget. Subsequently, the patience exhibited in the WBS saves a lot of effort in project execution, by helping to avoid rework and errors [16], due to being used to record and communicate project deliverables and achievements. The identification of these elements also relies on the experience of team members and the consultation with expert respondents. After deliverables and achievements are listed, resources are then assigned to each element and sub-element.

3. 2. Importance of Work Breakdown Structure

Despite ensuring project success, the WBS is still a key visual tool for management as follows [4]:

1. Clarifies the project scope by defining all the work.
2. Reflects the input from all team members.
3. Provides the baseline for subsequent change control.
4. Serves as a primary input to other project management processes.
5. Provides the framework for project control, performance monitoring, and communication.

6. Ensures that work appropriately correlates with the Responsibility Assignment Matrix (RAM) and the Organization Breakdown Structure (OBS).
7. Serves as an essential planning deliverable, supporting key project management functions.

3. 3. Creation of Work Breakdown Structure

The creation of WBS is a process that involves the decomposition of project deliverables and work into smaller parts, with more manageable components. This contains three stages, namely inputs, outputs, as well as tools and techniques [13]. In the preparation of the WBS, inputs include the scope management plan, project statement, requirement documentation, enterprise environmental factors, and organization process assets, which are subsequently analyzed using decomposition and expert judgment techniques, to produce outputs based on baseline and documents updates. The creation of WBS is also an iterative process considering the project objectives, design criteria, scope, technical requirements, and other attributes [4]. As a document, a WBS Dictionary is used to provide detailed information on each work package, regarding a summary description. This helps to identify and describe each work package (lowest level) in the WBS while minimizing the presence of scoop creep (additional scope or uncontrolled changes in project scope) through weak project scope definitions [17].

A WBS dictionary is also progressively described as a planning process, with most information being developed by other procedures and added to this document at a subsequent stage. This shows that the dictionary is the result of iterative techniques in the planning process [18]. Although not limited, the information in this document includes code of account identifier, work description, assumptions and constraints, responsible organization, schedule milestones, associated fixed activities, resources required, cost estimates, quality requirements, acceptance criteria, technical references, and agreement data [13]. Another element is the WBS checklists, which aims to evaluate all the tasks previously defined in tool, due to containing the questions related to functions. This is commonly a component-specific structured tool, aiming to verify that the required steps have been successfully performed. The form of this element also varies depending on the needs of the affected project, due to ranging from a simple to a complex checklist, based on project requirements and practices. In addition, many organizations reportedly have available standard checklists, to ensure consistency during task performances. When a checklist is used to support project completion, the results become part of the work record [13].

4. METHODOLOGY

This study used a systematic qualitative approach to develop a WBS standard, for the construction of a stadium project. This contained four steps, as shown in Figure 1.

4. 1. Identification of WBS Components for Stadium Work

A documental review was employed to identify the work components within the WBS. This review used several related Ministerial documents, including the Minister of Public Works and Housing Regulation No. 22/28 of 2018/2016, concerning the Construction of State-Owned Buildings and the Guidelines for Work Unit Prices Analysis in the Public Works Sector, respectively. In the first regulation, the utilized data were specifically based on the information for the construction sector (Cipta Karya). In addition, the review also evaluated previous stadium project data, such as work plans and terms, bill of quantities, and owner's estimate price [5, 19, 20]. According to UEFA Guide [21] the design of football stadiums met several general requirements in the 21st Century, indicating that the identification process was also based on the criteria set by UEFA Guide and FIFA Standards [21].

Subsequently, the determination of the stadium-based WBS components was carried out through by mapping, as regards the Minister of Public Works and Housing Regulation No. 28 of 2016, which contains the coding and scope of building construction work, as well as the previous data to obtain the derivatives of the stadium's level 1-6 projects. This confirmed that the review used 56 stadiums' data, which contained 37 domestic and 19 overseas infrastructures, as summarized in Table 1.

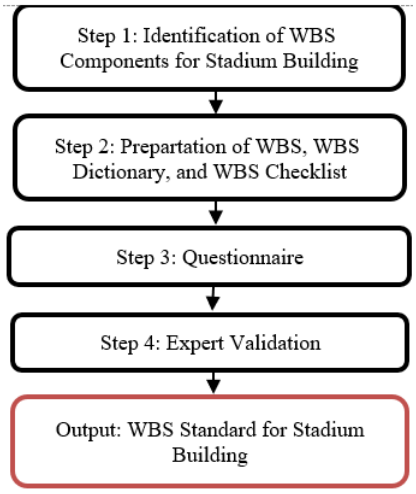

Figure 1. Study flow diagram

TABLE 1. Summary of stadium data

No	Name of Stadium	Location	Capacity	Status
1	Gelora Bung Karno Stadium	Jakarta	88,306	Domestic
2	Palaran Stadium	Samarinda	67,075	Domestic
3	Gelora Bung Utomo Stadium	Surabaya	50,000	Domestic
4	Utama Riau Stadium	Riau	45,000	Domestic
5	Jatidiri Stadium	Semarang	45,000	Domestic
6	Batakan Stadium	Balikpapan	40,000	Domestic
7	Gelora Sriwijaya Stadium	Palembang	40,000	Domestic
8	Jalak Harupat Stadium	Bandung	40,000	Domestic
9	Harapan Bangsa Stadium	Aceh	40,000	Domestic
10	Gelora Bandung Lautan Api Stadium	Bandung	38,000	Domestic
11	Wibawa Mukti Stadium	Bekasi	35,000	Domestic
12	Aji Imbut Stadium	Tenggarong	35,000	Domestic
13	Kanjuruhan Stadium	Malang	35,000	Domestic
14	Maguwoharjo Stadium	Sleman	30,000	Domestic
15	Gelora Delta Stadium	Sidoarjo	30,000	Domestic
16	Gelora 10 November Stadium	Surabaya	30,000	Domestic
17	Patriot Candrabhaga Stadium	Bekasi	28,000	Domestic
18	Manahan Stadium	Surakarta	25,000	Domestic
19	Sultan Agung Stadium	Bantul	25,000	Domestic
20	Gajayana Stadium	Malang	25,000	Domestic
21	Segiri Stadium	Samarinda	25,000	Domestic
22	Mandala Stadium	Papua	25,000	Domestic
23	Kaharudin Nasution Stadium	Pekanbaru	25,000	Domestic
24	Petrokimia Stadium	Gresik	20,000	Domestic
25	Papua Bangkit Stadium	Papua	40,263	Domestic
26	Kapten I Wayan Dipta Stadium	Bali	23,081	Domestic
27	Pakansari Stadium	Bogor	30,000	Domestic
28	Barombong Stadium	Makassar	40,000	Domestic
29	BMW (Jakarta International Stadium)	Jakarta	82,000	Domestic
30	Bekasi Stadium	Bekasi	25,000	Domestic
31	Istora PON Papua Construction	Papua	5,000	Domestic
32	Aquatic Stadium GBK Renovation	Jakarta	7,600	Domestic
33	Sport Center Manokwari Construction Planning	Papua	10,231	Domestic
34	Sports Facilities Improvement Project	Bogor	30,000	Domestic
35	DED Bekasi Stadium’s Document	Bekasi	25,000	Domestic
36	Gedebage Football Stadium Construction	Bandung	38,000	Domestic
37	CSU - ON Campus Football Stadium	Colorado	41,000	International
38	The Washington Nationals Ballpark	Washington	41,313	International
39	Houston NFL Stadium	Texas, US	72,220	International
40	Hrvatskih Vitezova Stadium	Croatia	5,200	International

No	Name of Stadium	Location	Capacity	Status
41	SRC Stozice	Slovenia	16,000	International
42	Viking Stadion	Norway	16,000	International
43	Arena im Allerpark	Germany	30,000	International
44	Estadi Cornella El-Prat	Spain	40,000	International
45	NN Stadium in London	London	15,000	International
46	Washington State Stadium	Washington	72,000	International
47	Stade de France Stadium	France	80,000	International
48	Stadium of Australia	Australia	80,000	International
49	Munich New Stadium	Munich	66,000	International
50	Sapporo Dome	Japan	42,122	International
51	Murakata Barabai Stadium	Barabai	10,000	Domestic
52	Buck Shaw Stadium	California	10,000	International
53	Community America Ballpark	Kansas	8,461	International
54	Barnet Copthall	London	10,000	International
55	County Cricket Ground	Bristol	10,000	International
56	New Meadow	Shrewsbury	10,000	International

4. 2. Preparation of WBS, WBS Dictionary and WBS Checklist Based on the identification process, the WBS of this project was divided into three sections, namely the main stadium, field of play, and surrounding works. Each of these sections had its WBS, with the Dictionary and Checklist also arranged according to the breakdown structure.

4. 3. Expert Validation According to Hansen [22], expert interviews were used to validate the proposed WBS, dictionary, and checklists. These experts were required to have a minimum of 10 years of involvement in stadium projects, and also a Certificate of Intermediate Expertise. In this study, twelve experts with various specialties such as architecture and design development, civil works, as well as mechanical and electrical orientations, were observed, with their profiles and interview collection data listed in Table 2.

5. RESULTS AND DISCUSSION

The results showed that the WBS project was divided into three sections, namely the main stadium, field of play

TABLE 2. Expert profiles and interviewed data

No.	Expert	Expertise	Experience (Years)	Expertise Qualification	Interview Duration	Date of Interview
1	E1	Architecture & Design Development	42	Advanced	53 mins	4/18/2021
2	E2	Architecture & Design Development	20	Advanced	115 mins	3/20&27/2021
3	E3	Civil	26	Advanced	76 mins	3/30/2021
4	E4	Civil	26	Advanced	59 mins	3/24/2021
5	E5	Civil	17	Advanced	70 mins	3/20/2021
6	E6	Architecture	16	Advanced	70 mins	3/20/2021
7	E7	Mechanical & Electrical	17	Intermediate	107 mins	3/24/2021
8	E8	Mechanical & Electrical	10	Intermediate	67 mins	3/24/2021
9	E9	Mechanical & Electrical	13	Intermediate	52 mins	3/24/2021
10	E10	Mechanical & Electrical	24	Intermediate	100 mins	3/17/2021
11	E11	Mechanical & Electrical	34	Advanced	216 mins	3/20,21,27&28/2021

(FOP), and surrounding areas' works, respectively. This division was based on the zoning area, where the coverage of each scope is shown in Table 3.

TABLE 1. Scope of work for stadium projects

Main Stadium Work	1. Tribune Area 2. Athlete Facilities 3. Activity Management Facilities 4. Building Management Facilities 5. Media Facilities 6. Commercial Area
Field of Play (FOP)	1. Soccer Field 2. Athletic Track
Surrounding Areas	1. Parking Area 2. Landscape 3. Shuttle Bus 4. Railway Hub

Subsequently, each scope was degraded into work items, to form a WBS hierarchy from level 1 to 6. For instance, Table 4 presents a standard WBS for main stadium work, as validated by the experts. WBS level 1 is related to the scope of the stadium project, namely the main stadium (MS), FOP, and surrounding areas' works, respectively. Level 2 is also a division of work for each scope, with 3, 4, and 5 explaining and identifying the task type and packages, as well as describing the activity, respectively. Meanwhile, level 6 is related to the resources, including labor, tools, and materials. After being validated as a standard WBS, this structure was converted into a dictionary and checklist, which were subsequently confirmed by three experts with similar qualifications. This was to obtain feedback and comments on various elements, such as work components from level 1-6, person-in-charge, delivery, references, and other required dictionary aspects. Based on the results of validation and interviews, Tables 5 and 6 present an overview of the WBS dictionary and checklist, respectively.

According to Figures 2 and 3, the WBS dictionary was mainly used to describe each element of the project activities (level 5) and resources (level 6), respectively. This confirmed that the validated format described the main elements, such as the codes, responsibilities, resources, and results of each defined activity. Therefore, the WBS dictionary was needed to alleviate potential problems (see Table 5), due to being easier to read and understand by all involved parties. During the construction process, it was also used to effectively monitor and control each specified work package. Besides serving as a project management tool, the validation process subsequently proved that the development of the WBS Dictionary functioned as a very important primary document for the front-end planning phase. This was in line with the project sustainability, based on time, cost, and quality performance during the project lifecycle, e.g., the procurement of environmental-friendly materials for the stadium. The material specification was also thoroughly defined using the WBS dictionary, due to being the basis for determining activities, resources and quality requirements. In addition, the issues arising due to environmental or sustainability considerations were facilitated through a detailed WBS [13].

Based on Table 6, there was no significant changes recommended, although some descriptions were simplified. From the WBS checklist, architectural works had more detailed information and descriptions, due to the tasks being more complicated than others. This was in line with a previous study, where architectural and interior works had detailed and much simpler tasks, respectively [23]. Based on the interview results, the WBS dictionary and checklist were used as a guide to assist project managers with detailed information and descriptions for each work. This verified the importance of the elements as planning requirements, especially for the construction of complex projects such as stadiums.

TABLE 2. Validated standard WBS for main stadium work

WBS LEVEL 1		**WBS LEVEL 2**		**WBS LEVEL 3**		
CODE	Scope	CODE	Division	CODE	Work Package	
1	Stadium Main Building	1.1	Design Development	1.1.1	Design Planning Work	
WBS LEVEL 4		**WBS LEVEL 5**		**WBS LEVEL 6**		
CODE	Work Package	CODE	Activity	CODE	Type of Resource	Resource
1.1.1.1	Preparation	1.1.1.1.1.	Administrative and technical preparation	1.1.1.1.1.	Labor	Team Leader, Administrator

TABLE 5. Validated WBS dictionary

1.1	**Work Group/Division**	**:**	**Design Development**
1.1.1	Sub of Work/Section	:	Design Planning Work
1.1.1.1	Work Package	:	Preparation
	Person in Charge	:	-
	Description	:	This work involves administrative and technical preparations, formation of drafting teams, preparation of surveys and field observations, and preliminary reports planning, according to the existing regulations
	Deliverable	:	Project cost planning document
	References	:	**1.** Image Document **2.** RKS/Technical Specification Document **3.** Expert Validation

Code	**Activities**	**Resources**		
		Man	**Material**	**Equipment**
1.1.1.1.1	Administrative and Technical Preparation	**1.** Team Leader **2.** Administrator	…	…
1.1.1.1.2	Formation of the Drafting Team	**1.** Team Leader	…	…
1.1.1.1.3	Survey Preparation and Field Observation	**1.** Team Leader **2.** Structural/building experts **3.** Architects **4.** Planologists	…	…
1.1.1.1.4	Preparation of Preliminary Report	**1.** Team Leader **2.** Administrato	…	…

TABLE 6. Validated WBS Checklist

WBS Level	**Code**		**Details**
1	1	Stadium Main Building Project	Name of the construction project being worked on
2	1.1	Design Development	There are several types of work in design development, namely planning, pre-design, the establishment of structures and drawings, construction implementation documents, procurement explanations & evaluations, periodic supervision, and insurance, according to the existing regulations.
3	1.1.1	Design Planning Work	Design planning work includes preparation, implementation, and submission of the final report, according to the existing provisions.
4	1.1.1.1	Preparation	This work involves administrative and technical preparations, formation of drafting teams, preparation of surveys and field observations, as well as preliminary reports planning, according to the existing regulations.

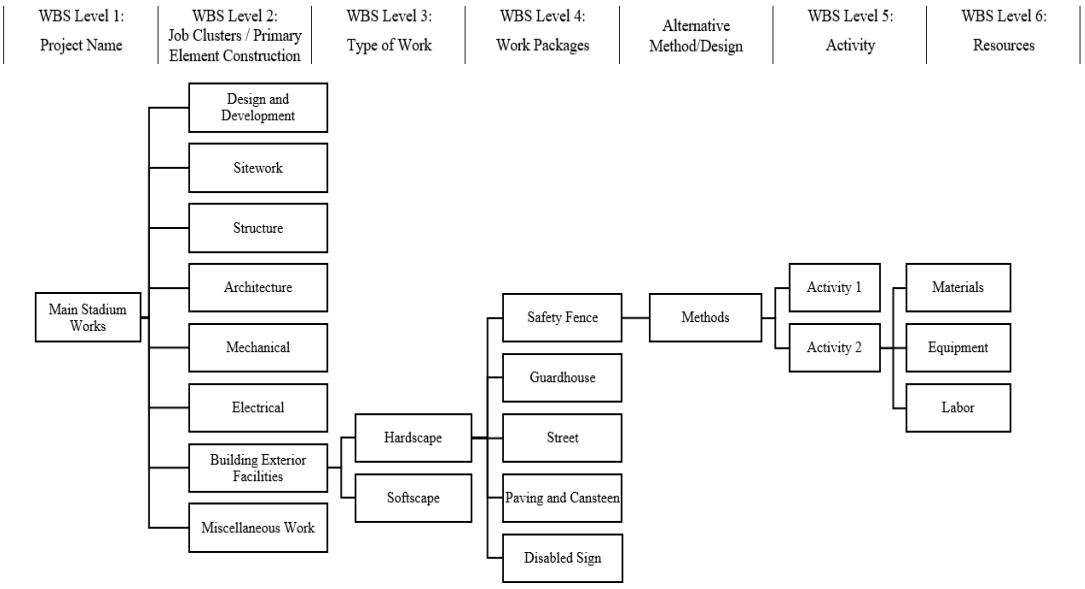

Figure 2. WBS Standard for main stadium works

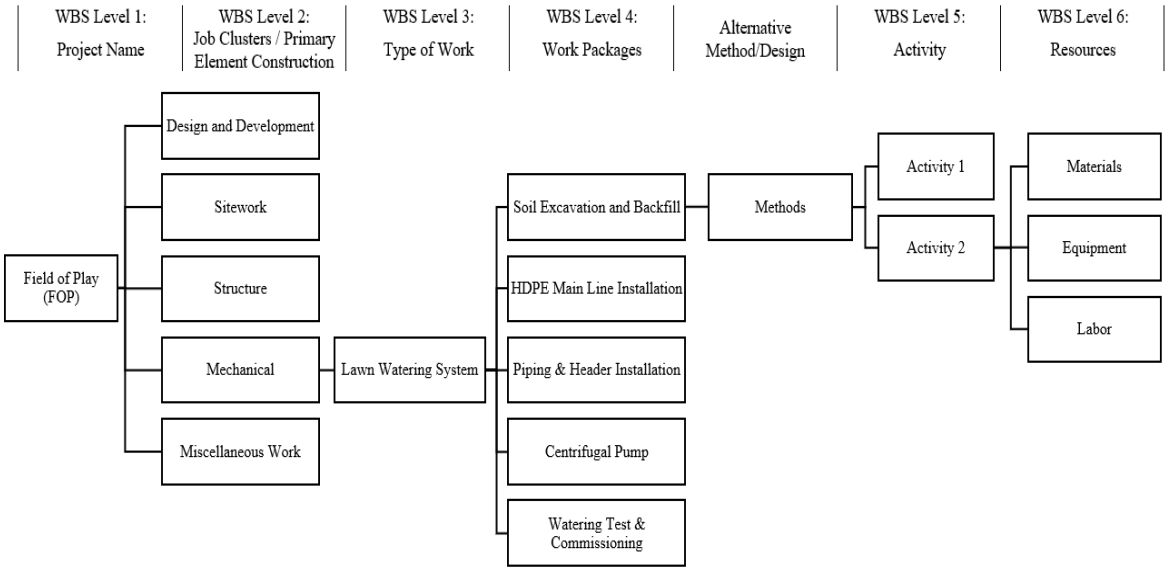

Figure 3. WBS standard for the field of play (FOP)

Despite being used to identify all required activities with detailed descriptions, these elements were often difficult to understand, due to the ambiguity of each job description. Therefore, word adjustments and modifications are essentially needed, especially when developing WBS dictionaries and checklists. The WBS Checklist also contributed to the easier evaluation of every required task, especially for stadium construction, which was divided into 3 categories, namely Main Stadium (MS), Field of Play (FOP), and surrounding areas' works, respectively.

6. CONCLUSION

This study aimed to create a WBS, which was to be used as a standard in the construction of stadium projects. From the results, the following conclusions were obtained,

1. The stadium-based WBS projects were grouped into 6 levels, namely scope (level 1), division (level 2), work type and packages (levels 3 and 4), activity (level 5), and resources (level 6).
2. There were also three WBS dictionaries and checklists each, for the main stadium, FOP, and surrounding areas' works, respectively.
3. Decomposing the components of WBS level 4 (work packages) was essentially necessary, based on the alternative or design methods to identify level 5 (list of activities).
4. WBS Level 6 was also identified after the definition of each activity implementation requirement.
5. A standard WBS document containing identification (level 1 to 6), dictionaries, and checklists, was successfully developed. These elements were related to each other and served as a guideline for stadium projects.
6. Using the proposed standard WBS, the consistency of work information was achieved.

Therefore, the preparation of a WBS standard for the construction of a stadium project was a guideline for all stakeholders, based on the achievement of accurate quality, cost, and time of implementation.

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Persian Abstract

چکیده

ساختار شکست کار (WBS)یک ابزار کلیدی پروژه بصری است که به عنوان یک تعهد در مدیریت پروژه‌های ساخت‌وساز عمل می‌کند، زیرا نقشی حیاتی از برنامه‌ریزی تا اجرا ایفا می‌کند .با این حال، هنوز مشکلات متعددی در ارتباط با اجرای WBS وجود دارد، مانند عدم ارتباط و توسعه ضعیف، که در آن همه طرف های اجرایی درگیر به طور دقیق دامنه و اهداف را درک نمی کنند .این در نهایت منجر به هدر رفت پروژه بر اساس هزینه، زمان و کیفیت می شود، جایی که استانداردسازی در آماده سازی و توسعه WBSرعایت نمی شود .بنابراین، این مطالعه با هدف توسعه یک استادیوم استاندارد WBS، برای همه طرف‌های اجرایی درگیر برای درک و دستیابی به سازگاری اطلاعات کاری انجام می‌شود .این کار با نقشه‌برداری از داده‌های بحث‌های گروهی متمرکز (FGDs)و (BQ)پروژه‌های قبلی استادیوم با متخصصان در زمینه مربوطه انجام شد .نتایج توسعه یک WBS استاندارد حاوی سطوح 6-1، از جمله جایگزین‌های طراحی، الزامات اجرا، و مشخصات مواد را نشان داد .در طول کاربرد، این ابزار به جمع‌آوری کل محدوده پروژه‌های نتیجه‌محور به عنوان دستورالعمل‌ها و استانداردهای مرتبط، با هر سطح سلسله مراتبی از اجزای بالا تا پایین‌تر کمک کرد .همچنین نتایج به‌دست‌آمده، مشاوران، پیمانکاران و حسابرسان را به ترتیب در مراحل برنامه‌ریزی، اجرا و نظارت مورد توجه قرار گرفت.