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On the Performance Management System to Analyse the Effectiveness of Type Approval System for Railway Vehicle

Young Hoon Lee*†, Jee Ha Lee*, Chan Kyung Park*, Young Min Kim**†

**Chief Researcher, Korea Railroad Research Institute, Korea*
***Associate professor, Department of Systems Engineering, Ajou University, Korea*
yhlee@krri.re.kr, jhlee@krri.re.kr, ckpark@krri.re.kr, pretty0m@ajou.ac.kr

Abstract

The type approval system for railway vehicle has been in effect since 2016 in order to establish a regular safety management system to secure railway safety and enhance the technological competitiveness of the railway industry, abolished the conventional performance test system through the reform of the Railroad Safety Act in 2012. Until now, there has been appreciated it has been making significant contributions to railway safety and industry of operation and manufacturing companies, taking their place in accordance with the implementation of the system. But there has been no case of quantitative analysis on the effectiveness of the actual system. In this study, in order to examine the full-scale performance of the approval system and quantitatively analyze effectiveness, we identified and defined the relationships with the major elements of the type approval system based on system thinking principle and determined the calculated outcomes to relevant stakeholders. A method of establishing a type approval performance management system that can be grasped, utilized, and adjusted from a point of various stakeholders' views was proposed. This is expected to be more helpful in the implementation of the system, such as improving and applying quantitative effects to analysis by closely reviewing the effects and influencing factors of the type approval system based on the data accumulated through continuous performance management and reflecting to system improvement.

Keywords: *Type Approval System, Performance Management System, Measure of Effectiveness, Measure of Performance*

1. Introduction

With the advancement of technology, today's railway industry has achieved high-speed and unmanned technology by applying high-level technology. As a result, the complexity of the system configuration of the railway vehicle has been greatly increased, and thus, the number of grafted parts is increasing exponentially [1][11]. Increasing the complexity of the system is directly related to the safety and satisfaction of customers using railroad vehicles [2]. Therefore, in order to ensure the safety, reliability and quality of railroad vehicles, the government established a type approval system in 2012 and has been implementing it until now. As shown in Figure 1, Type approval of railroad vehicles is classified into Article 26 Type Approval, Article 26-3 Manufacturer Approval, and Article 26-6 Completion Inspection of the Railroad Safety Act for the case of manufacturing or importing railroad cars operated in Korea, respectively, according to the enforcement regulations of the Railroad Safety Act [4]. It is implemented in accordance with established detailed procedures [3].

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Corresponding Author: pretty0m@ajou.ac.kr(YoungMin KIM)
Tel: +82-31-219-3949, Fax: +82-31-219-2334
Associate professor, Department of Systems Engineering, Ajou University, Korea
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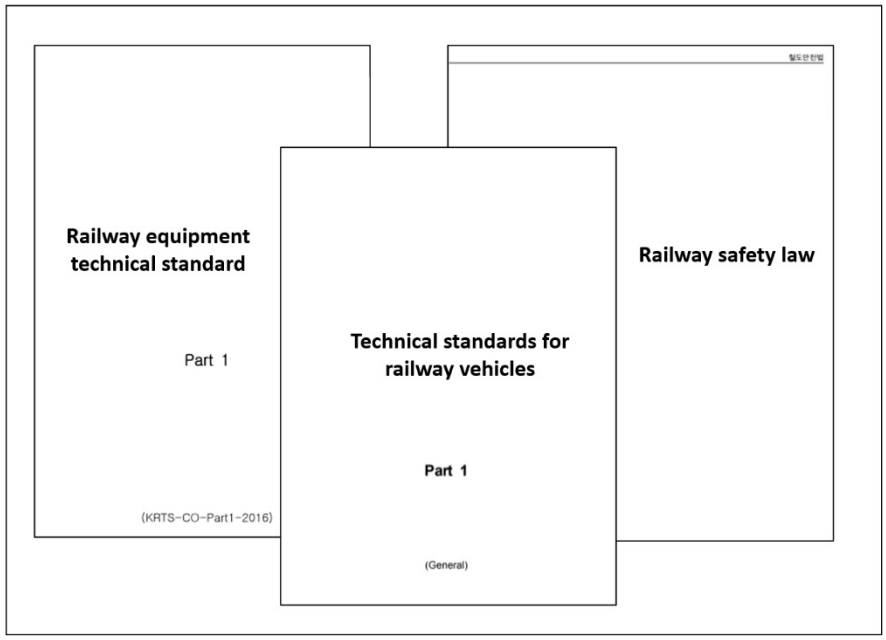

Figure 1. Standards for compliance with domestic railway vehicles and equipment type approval certification

Railroad vehicle type approval inspection is largely divided into three stages is carried out by dividing into design conformity inspection, conformity inspection, and vehicle type test in accordance with Article 48 of the enforcement regulations. In addition, according to Article 53 of the Enforcement Rule, the manufacturer's approval inspection is divided into two stages: a quality management system conformity inspection and a production inspection, and the completion inspection is divided into two stages: a finished vehicle inspection and a driving test according to Article 26-6 of the Enforcement Rules. Here, as the technical standards, the railway vehicle technical standards pursuant to Article 26 (3) of the Railway Safety Act and the railway vehicle manufacturer approval technical standards pursuant to Article 2-3 (2) are applied. Inspection agencies that perform such type approval-related inspections are entrusted with type approval inspection, manufacturer approval inspection, and completion inspection in accordance with Article 63 (2) of the Enforcement Decree of the Railway Safety Act pursuant to Article 77 (2) of the Railway Safety Act [5].

The type approval system not only inspects railway vehicles, that is the major life stages of the product from product design to manufacturing and testing, but also inspects the quality management system of the manufacturer, that is, management activities for quality maintenance such as application of manufacturing procedures or processes [12]. In addition, a total inspection is performed on the mass-produced railway vehicles. As such, the railway vehicle type approval system includes features performed from the perspective of the entire life cycle, the relationship between each life cycle stage is close, and the result of the type approval inspection performed at the design stage is the later life cycle stage, production and Since it greatly affects the completion stage, mutual traceability and consistency are very important factors, and continuous management is required [6]. In particular, in order to analyze the effectiveness of a more systematic type approval system by increasing the complexity of railway vehicles according to the development of technology, increasing user demand, and the application of new technologies, etc., the core elements of type approval were derived and related based on this. A system for monitoring and evaluating the performance related to system operation from the perspective of stakeholders is required.

Regarding the type approval system, a number of studies have been conducted, and the preceding study [7] conducted a study on the improvement of the type approval technology standard system, and the preceding study [8] was through the improvement of the railway safety law to improve the type approval system. In

addition, efforts were made to improve the type approval system. Prior research [9] conducted a study focusing on the identification of improvement factors through comparison and comparison between the TSI standard, which is an overseas railway technology standard, and the domestic technology standard. Most of the previous studies are mainly on the improvement of the type approval system itself. In relation to this, it was possible to identify the inadequate part of the study on the improvement and efficiency of the type approval system, centered on the inspection results that this study intends to perform.

Therefore, through this study, in order to establish and operate a more systematic and efficient management system by reflecting the status of rail vehicle type approval, we intend to establish a performance management system that considers the impact on the key elements of type approval. In particular, in order to reflect the characteristics and management characteristics of type approval, we intend to build a monitoring management system that reflects the Vee-Model of systems engineering techniques, traceability, and consistency as a problem solving approach from the perspective of the entire life cycle. The structure of this paper is as follows. In the introduction, the research trend and necessity of society and research were presented, and in Section 2, the problem definition was mentioned by describing the related research and research goals. In Section 3, a performance management system model is presented by identifying the core elements and components that the developed performance management system must have. In Section 4, the actual construction is performed based on the model of the type approval performance management system presented in Section 3. In Section 5, the procedure for verifying the usability through implementation of the established system was performed, and in the last Section 6, the results of the thesis are summarized and summarized.

2. Definition of the problem

2.1 The necessity of establishing a performance management system based on effectiveness

A considerable amount of time has passed since the type approval system was implemented. The current type approval system is implemented in two main contexts: procedure and output. Therefore, it is difficult to separately manage factors that determine the success or failure of development, such as safety, quality, and reliability for manufactured products. As various requirements such as technological change and social change are increasing, a uniform management plan may lead to limitations in improving competitiveness for producers who enter the domestic market and overseas. Therefore, it is necessary to establish a performance management system based on the effectiveness of analyzing the effectiveness of the type approval system, confirming the system goals, and supporting a virtuous cycle such as adjustment and improvement.

2.2 Necessity to reflect systematic Thinking-based management

Type approval is a system applied from the design stage. In later stages, an inspection is made during the manufacturing process to see if the manufacturing has been made based on the design output. In the current system, inspections are carried out from the perspective of the life cycle of railroad vehicles, but there is a limit to securing correlations between life cycle stages due to item-oriented inspections specified in the technical standards. It is necessary to monitor the type approval system from the perspective of the entire life cycle based on system accidents in order to more systematically support the production and completion inspection based on continuous and consistent design products from a life cycle perspective. In this regard, As shown in Figure 2 [10], the elements of the effectiveness measure (MOE) and the performance measure (MOP), which are key indicators of performance management, are the core elements of the system engineering analysis and have a very close relationship as the effect analysis-related elements of this study.

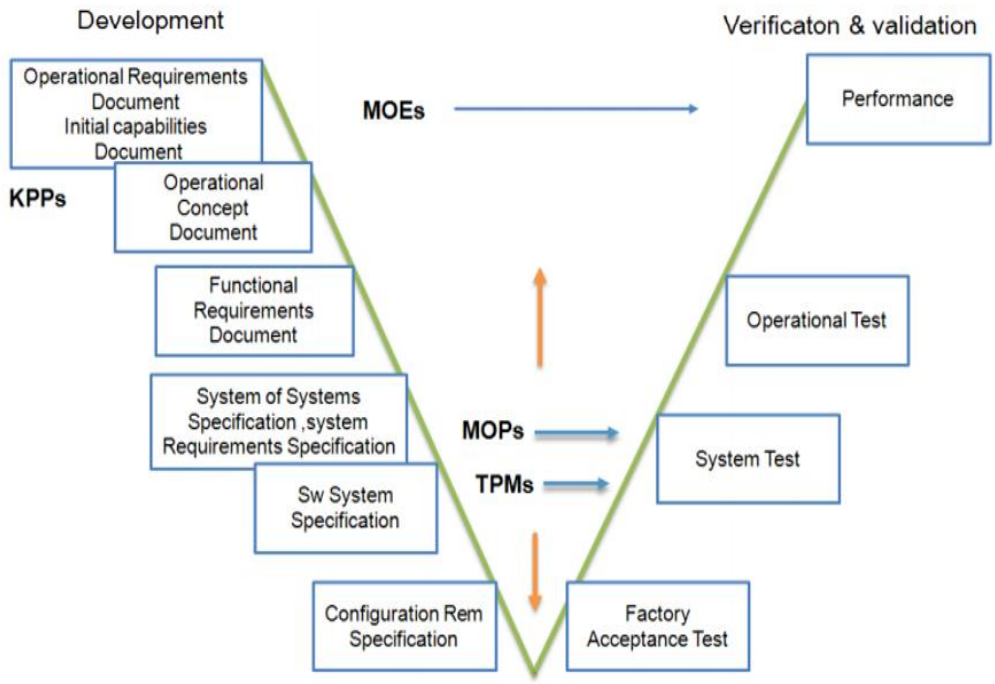

Figure 2. MOE/MOP based vee-model

2.3 The importance of improving the type approval work of the inspected institution

More than 90% of manufacturing companies in the domestic railroad industry were surveyed as small companies, and the operation of small companies was made based on the experience of key personnel, so it was difficult to create a basis for engineering processes and quality activities It is a situation that is suffering. Today, when developing items with increasing complexity, the degree of influence with external interlocking factors is not sufficiently considered and is being developed and managed. If a monitoring management system based on effectiveness is established, the engineering process will be internalized, allowing companies to respond to type approval work based on the engineering process, and will improve engineering capabilities.

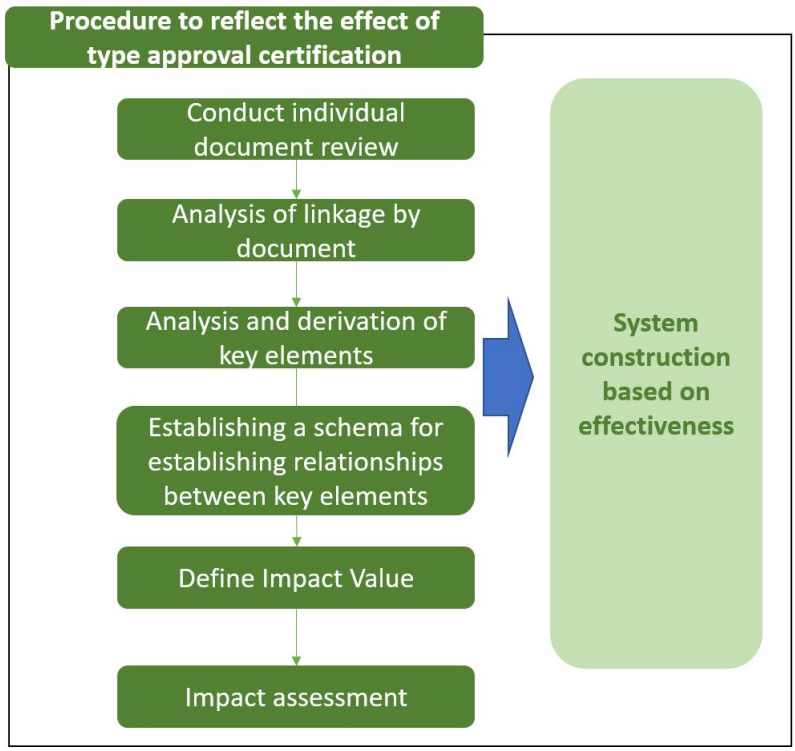

Figure 3. Overview of research conduct

2.4 Goals and scope of Research

As shown in Figure 3, the scope of this study was limited to the type approval stage, which is the design stage of railway vehicles and supplies. By identifying key elements in accordance with the technical standards and type approval task procedure, we attempted to derive and reflect quantitative elements for performance management. A monitoring management system was established through the creation of a management system model of these effects.

3. Developing a Type approval performance management system model

3.1 Derivation of Key indicators through Technical standard analysis

Based on the 86 requirements of the railway vehicle technical standard (2014, Ministry of Land) and the requirements presented in the technical standard for railway goods, in order to identify the factors that are linked to the quantitative indicator, first classify the categories by dividing the types of individual requirements. Requirements including core functions were separately extracted from the classified categories. Based on the extracted requirements, the requirements including the performance elements were extracted and a list was obtained as the core management target requirements. After that, if the requirements are not performed or the maturity level is low based on the review of experts, key indicators that consider the impact on safety, rel iability, and quality, which are the essence of the formal approval system, and the management aspect, The 38 key indicators were derived.

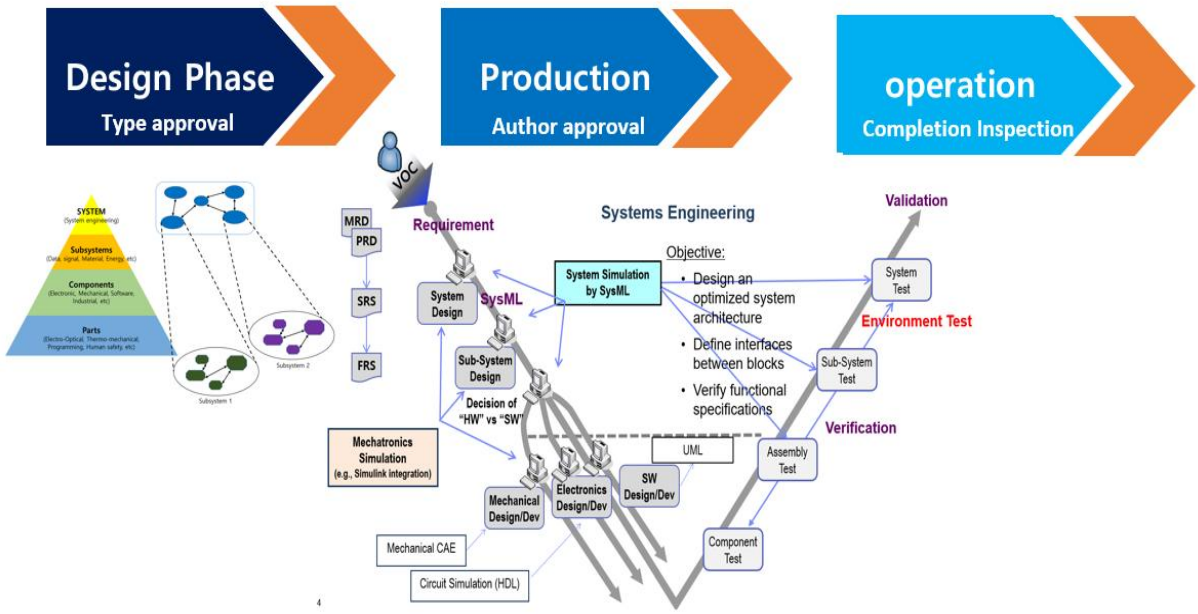

Figure 4. Certification test phase by life cycle stage

3.2 TASK analysis activities for Type approval work

As shown in Figure 4, the procedure for performing the type approval work affects the steps after the type approval work, and the type approval work also goes through several steps. In the stage of conducting this research, documents/standards referenced for performance and tasks to be performed were analyzed, and the effect of attributes and items of individual documents and procedures was analyzed. In the type approval stage, the final type approval inspection confirmation is issued after going through the pre-technology review stage, the type approval plan execution stage, the design conformity inspection stage, the conformity inspection stage, and the vehicle type test stage. As shown in Figure 4, for documents performed at this stage, task-to-task analysis activities were performed based on information on linkage between sub-activities and outputs performed in subsequent stages, producer approval and completion inspection.

3.3 Identify Core elements of Performance management system tools and Develop interlocking models

To develop a monitoring system model that considers the aspect of the effectiveness of the type approval work, it is first necessary to analyze the instrumental characteristics of the target system. Therefore, verification data such as the type approval procedure, which is a process required for the operation of the type approval system, and the technical standards and test procedures to confirm compliance and application by each step, were required and utilized. In order to require full lifecycle management from type approval, manufacturer approval, and completion test, functions to support traceability and consistency of documents and guidelines should be supported. In particular, in order to follow the hierarchical approach model, which is one of the approach methodologies in system engineering, the Vee-Model-based effect also followed a detailed method.

Table 1. Derived era factors

Name	Variable Factors	Description
Entity	**Performer**	Subject of the performance Tester or test subject
	Requirement	Technical standards and safety law technical requirements
	Source Doc.	References / Sources
	MOP/MOE	Performance factors
Relation	**Refined**	Refined
	Derived	Derived
	Traced	Tracked
	Performed	Performed
	Impact	Affecting
Attribute	**Doc. Type**	Document type
	Critical	Major Influence
	Normal	Normal Influence
	Continue	Lasting impact

4. Tool-Based Type Approval Performance Management System Analysis

4.1 Establishment of Attributes and Relationships of Performance management system

Our Research be performed based on a tool, an entity for the execution subject and item must be established. The identified objects should be identified by what kind of relationship they consist of by identifying the elements of the effectiveness measure (MOE) and performance measure (MOP), which are the core performance management indicators of this study. In addition, in order to supplement specific relationship information for mutual relations, establishment of attribute information must be performed. Therefore, in this study, it was possible to establish tool-based type approval items, suffixes, and relationships as shown in Table 1, centering on key indicators for performing subjects, outputs, guidelines, guides, and procedures.

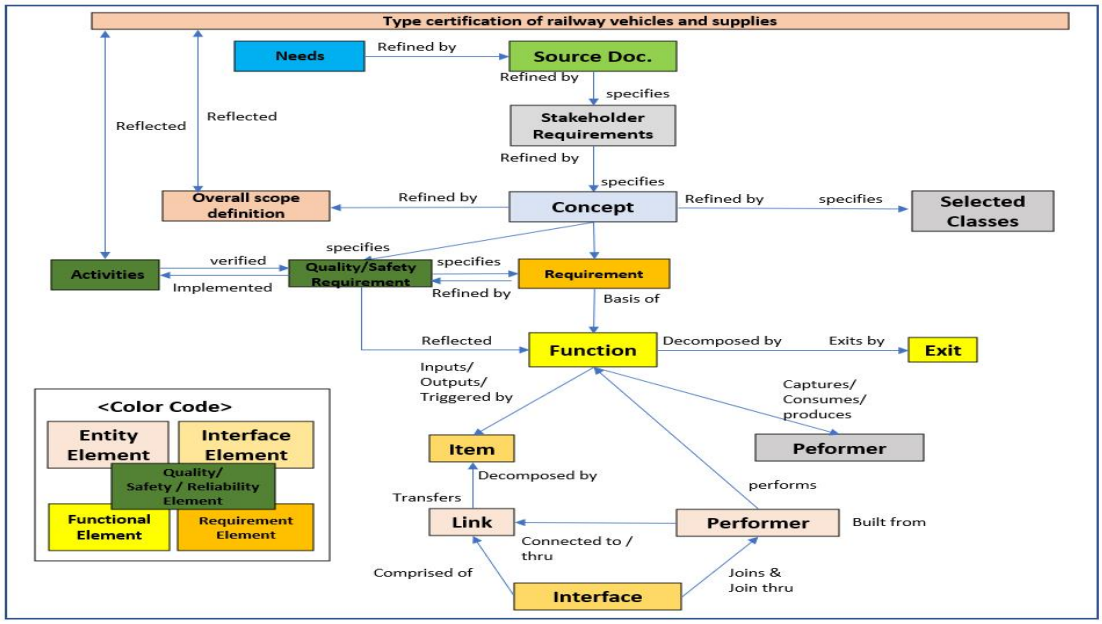

Figure 5. Schema construction for computerized construction of type approval system

4.2 Establishment of Attributes and Relationships of Performance management system

The result of this Research that is finally constructed based on tools. Therefore, in order to minimize mistakes and errors through voluntary performance by companies performing the formal approval system, a schema modeled on the interrelationships of components and activities that can serve as guides is established. I did. As shown in Figure 5, the schema was constructed so that any performer could easily follow the guide role through the constructed schema. The schema was expressed in a schematic representation of the relationship between the performer and the activities performed by the performer, the products of the activity, the guidelines and guides that are the basis for each activity, and served as an important guideline for the establishment of a tool-based system in the later stages.

5. Establish a System based on Effectiveness and Perform Useability Verification

In order to implement the core elements of system construction identified and defined through this study, it was built on the basis of Siemens' Polarion tool, which is widely used domestically and internationally for configuration management and project management. Reflected on the matters to be built through Polarion. Through this study, traceability, change management, and attribute management elements were identified as key elements in building an effectiveness-based system, and it can be seen that they were reflected through Figure 6 as follows. As shown in Figure 6, through this study, an environment capable of performing the tool-based type approval certification system was established, and a system of the type approval system built through verification to confirm the reliability of the usability of the established tool-based environment was established. Made Figure 6 As a result of error analysis on the schema construction items for the computerized construction of the type approval system, no errors were identified regarding the quality, so it was possible to confirm the suitability of the established result generation procedure.

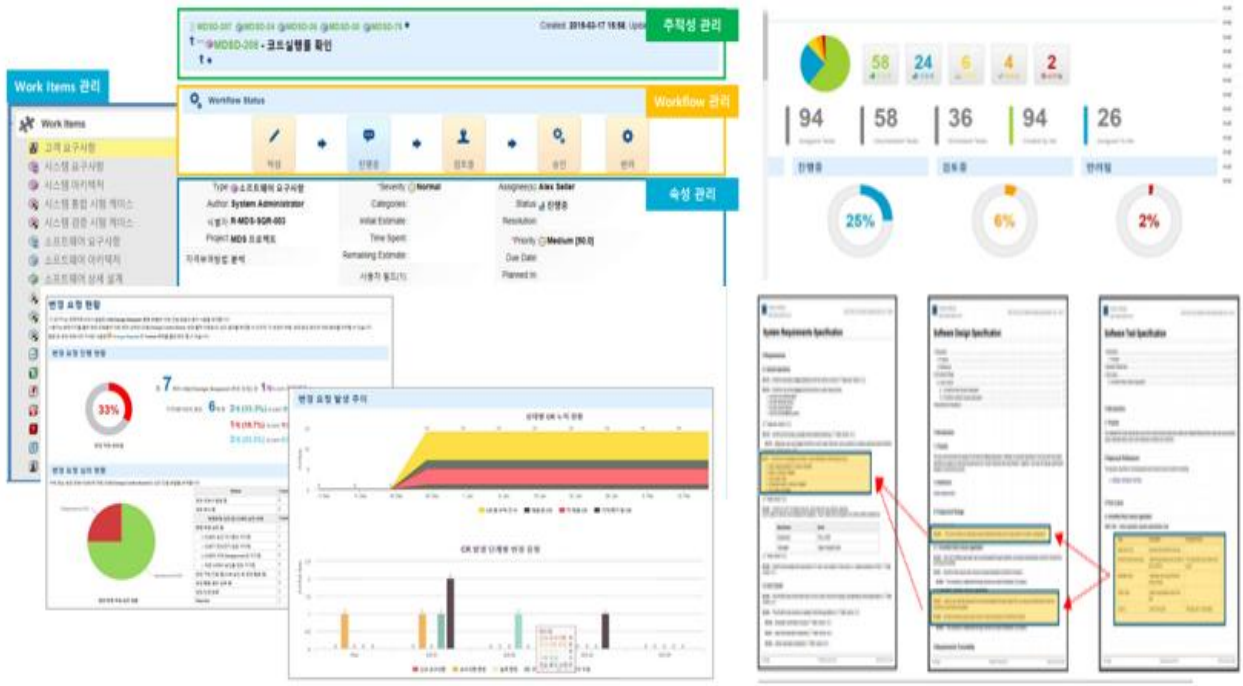

Figure 6. Establishment of type approval monitoring system reflecting performance

6. Conclusion

We researched to improve the railway type approval system should be improved from the perspective of the subject of the existing inspection agency through improvement of the activities required to perform the type approval certification inspection from the viewpoint of the role of the inspector institution, the subject of type approval certification. A study of the point of view was conducted. In particular, We researched focusing on computerization was conducted to identify factors related to effectiveness and to support efficient management, centering on the technical standards that are the standard for performing type approval. Through this study, if the domestic type approval system is operated, it is predicted that it will provide a considerable mutually organic operation plan not only for the type approval system, but also for the manufacturer inspection and operation evaluation. Therefore, it is expected that the engineering capabilities and product quality of numerous companies belonging to the railroad industry, mostly composed of small domestic companies, It will also significantly improve. The type approval system, which is the essential purpose of this study is expected to be a systematic configuration management plan for each item prepared by the company.

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