Establishment of Railway Safety Management System Using Systems Engineering Management Plan

H.M. Noh¹ and Y.O. Cho^{2,*}

Received: September 2009 Accepted: February 2010

Abstract: In this paper, the processes which are currently under development in South Korea, concerning railway safety management system are introduced. Railway safety management system in South Korea is briefly presented, making particular attentions to Systems Engineering Management Plan (SEMP). To make huge national R&D projects successful, systematic management process is essential. In this respect, detailed applying SEMP on railway safety management system of South Korea is discussed including Systems Engineering process and Verification and Validation procedures. Furthermore, a computer-aided systems engineering tool (Cradle) is used in order to make the management process more easily controllable.

Keywords: Systems Engineering Management Plan (SEMP), Requirements, Railway Safety Management System, Verification and Validation Process

1. Introduction

Safety securing technology is one of the most important factors for ensuring operational safety of high-speed trains. Since Korea dose currently have a weak technological basis for safety evaluation and traceability of the accident causes, there are demands for a definition and procedure development of safety regulation system, organization of safety case system, establishment of detailed safety standard, evaluation technology development for safety, construction of test assessment basis, technology development for a prevention of critical accidents and construction of safety information management system, etc, then the developed technologies need to be incorporated into the overall system, in order to prepare an efficient enforcement basis of the railway law already taken effect.

2. Body

2.1 Systems Engineering Management Plan (SEMP)

The Systems Engineering Management Plan

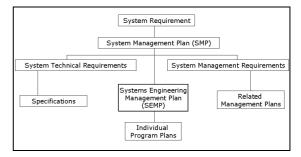


Fig. 1. Place of SEMP in system management plans

(SEMP) is the primary, top level technical management document for the integration of all engineering activities within the context of, and as an expansion of, the project plan [1]. A SEMP should be prepared for each project and regularly updated as development progresses.

The SEMP is not necessarily a long document. For some projects, it could be a page long, for others it could be hundreds of pages long. The plan needs to be specific to the needs of that project. It needs to be a "living" document, updated as often as needed as new information becomes available. The most important function of the SEMP is to ensure that all of the many active participants know their responsibilities to one another.

The figure 1 shows us the place of the SEMP in the system management planning.

^{*} Corresponding author. Email: yocho@krri.re.kr

¹ Assistant Researcher, Korea Railroad Research Institute, South Korea.

² Chief Researcher, Korea Railroad Research Institute, South Korea.

2.2 Systems Engineering Process for the National Safety R&D Project

Systems engineering process should begin during the new business development and preproposal phases of a project, and should continue throughout the system life cycle [2]. The process is critical in responding to a request for proposal (RFP). Early application of the systems engineering process ensures that a company's proposal is responsive to all the customer's requirements.

From requirements analysis, functional and physical solutions should be developed. Functional solutions are a set of activities or functions arranged in a specified order that, when activated, achieves a defined requirement. Physical solutions are capable of carrying out processes and the interconnection between components indicates that a directed flow is possible.

Decision making from functional and physical solutions should be considered after effectiveness analysis. Generally, effectiveness analysis includes production engineering analysis, test and verification analysis, deployment and installation analysis, operational analyses, supportability analyses, training analysis, disposal analysis, environmental analysis, life cycle cost analysis [3].

System specification is a guide line document

for developing railroad safety system product. A system requirements document, operational requirement document or draft system specification form the customer will have to be completed or transformed into a system specification to the mutual satisfaction of the customer and contractor. All of the requirements in all of the lower tier product requirements documents should be traceable from and to system specification. All of the requirements in the system specification should be traceable to the customer's need through a logical process of decomposition, allocation, functional and requirements analysis.

2.3. Detailed Verification and Validation Process

Validation and verification are tasks associated with activities within the systems engineering process. Validation ensures that the requirements are consistent and complete with respect to higher level requirements. Verification ensures that the selected solution meets its specified technical requirements and properly integrates with interfacing products.

In verification process, project teams should make verification plan documents referred from requirements, functional and physical architectures, railroad safety system products.

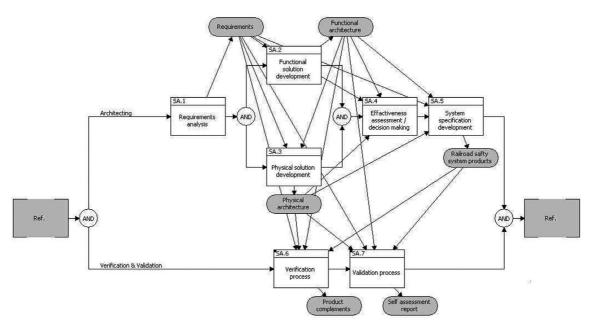


Fig. 2. Tailored SE process for national safety program

Table 1. Verification and validation check lists

Statements Verificati	Grades
What is our systems	
engineering	
project for this process ?	
What are the methods that we	
will	
task for each SE apply ?	
What are the tools we will use	
to	
hod these supportmet ?	
How will we control	
configuration	
development?	
When/conduct we lwil How	
review technical?	
How will we esatblish the need	
for	
trade manage and-studies off?	
Who has authorization for	
technical	
control change?	
ll we manage How wi?	
requrirement	

These verification documents should be approved by SE management teams. The project teams make VRTM documents and the SE teams approve them after investigation. Based on Approved VRTM by the SE teams, project teams perform verification and make verification reports. These reports are reviewed by management teams.

In validation process, firstly architectures derived from requirements should be reviewed by SE teams. After reviewing architectures, consistency and completeness should be validated. Even though our SE management teams are consisted with multidisciplinary experts, expert reviews are sometimes necessary for perfect validation. We made validation check lists as shown table 1.

The SEMP is not necessarily long document. For some project it could be a page long, for others it could be hundreds of pages long. The plan needs to be specific to the needs of that project. It needs to be a 'living' document, updated as often as needed as new information

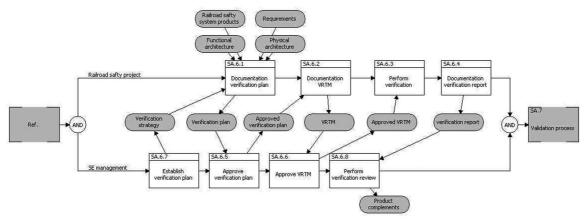


Fig.3. Detailed verification process

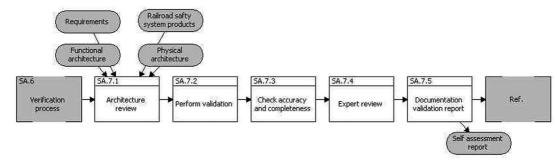


Fig.4. Detailed validation process

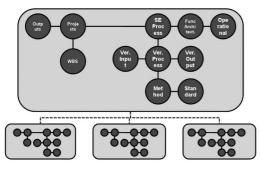


Fig.5. Tracibility of SE Architecutre.

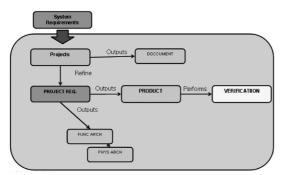


Fig.6. Process of SEMP

available. It is often best if the SEMP references existing organizational policies and procedures. There is no need to duplicate what already exists.

The SEMP forms the foundation for all engineering activities during the entire project and is the means for documenting the tailored SE approach to be used for a specific project. The development of the SEMP is a systems engineering management responsibility, but it must reflect the combined, coordinated inputs of the Project Manager and all other participants in the project.

The contents of the SEMP are described in EIA 632 and many include three parts as depicted as follows:

Part 1, Technical Program Planning and Control, describes the proposed process for planning and control of the engineering efforts for the system's design, development, test and evaluation.

Part 2, Systems Engineering Process, includes specific tailoring of the SE process, implementation procedures, trade study

Cradle WorkBench - SSS	5 - MANAGER - (84 unread alerts)	e	X
04905×4 80805	Mindow Help Vere Project Reg - Reg Review ♥ ■ ■ ■ ■ ● ● ☆ ● ☆ Table type: RTF Table type: RTF Table type: CTF	V Items to publish: All items in this set	-
J Worldanch A 용-표 Cata Display 응는 Process 응는 전체고객 용는 시설용당 - 시설용당 VRTM	Description Table style: Identity Name Description Image: Previous Image: Previous View the resulting Image: Previous Image: Previous Image: Previous Image: Previous Image: Previous <t< td=""><td>table</td><td>_</td></t<>	table	_
C	3 PR.1.1.3 SP.1.3 프로 북로는 Stive 등 특히, 조망하다. 4 PR.1.1.4 SR.1.4 프로 북로는 통합사태5백 등 구속, 운용하다. 5 PR.1.1.10 SR.1.10 프로 북로는 통합사태5백 등 구속, 운용하다. 6 PR.1.1.15 SR.1.11 프로 북로는 통합시는 전망하다. 7 PR.1.1.16 SR.1.16 프로 북로는 철로인전성 분석시스템 가능 건물 및 필차서를 개발	Open Bern Copy Bern Delete Bern, Undelete Bern Set Owner, Find Unked Berns - Alt Unked Berns - By Navisation,	
응 () 위험동문석 응 () 인적으로 응 () 요속문헌 응 () 인전운영공기 응 () 인전운영공기 응 () 전전운영공기 응 () 전전운영공기 응 () 전전운영공기 응 () 전전운영공기	PROJECT REQ: PR.1.1.1 (A) Image: Project registry PR.1.1.1 Author: M Sensity: PR.1.1.1 Subtype: PROJECT REQ Name: Sr.1.1 Draft: A Version: Seculty: UNCLASSIFIED Owner: MMARKER Sateller: Status: Modified IC.	Confirm Herarchy Integrity Confirm Herarchy Integrity Compare with Baselined Compare Selected herms Submit,	
P 24 € P 27,212 P Catabase -1 Ants -00 Source Documents -00 Requerements -01 Events -01 Source Source Note	Overen Prevention: Produced A. Text: 표조학회는 사업 요구사업 변경관감을 수행한다.	Ouery Details View Details Annotation Details New Markic Close Ouery Publish Tablo	
×	Maker Identity: Ascending - Case insensitive	Spell Check 13 M	
1 item selected	Edentity: Ascending - Case sensitive	15 items	

Fig.7. Requirements Inputs

W Cradle	e WorkBench - SSS	5 - MANAGER	- (84 unread alerts))									
Elle Edit hem Style Admin Window Help											لمارك		
	O & X & O	Form Verification -	Complete	< B	×	Baseline	<unset></unset>	~	Nevigation	Down	wards		v
8 00 8									9.0			an ĝ	1 0
						_		_	~ •			~ 8	
Master Tree	Top Lev	e -											Þ
	Requirements	<u> </u>											
-6	Events												
	DATA BLOCK												
	DEFINITION												
- B	DOC SECTION												
8-B													
B-B													
- D													
	PBS												
B B													
E B													
• <u>0</u>		VERIFICATION	Verif.1.1.1 (A)										Þ
		N Verf.1.1.	(A)										
		-					Last moor	100: 40	intina.				~
		건증 기준:											-
8-6			위험으면 해당해 약할까지		_			Gurren	20402362		_	-	
		2 233 2 23	사항의 경이와 목은 적렬한)	71					JIMIDAND				1.00
B	SYSTEM RED	3 요구사항의	시작시험과 환료시험은 적태	2히 선택되었는가									
6-6		1 CMAR 2	2구사항은 RFP를 충실히 반응	101110101									
ĬĬĨ	Previous												
6	-												
	B- VERIFICATION: 1	~ 0 영상											
	- D VERIFICATIO												
	VERIFICATION	X											
	VERIFICATIO	Procedure:											
<													Y
											RW		

Fig.8. Verification and Validation Inputs

W Cradle WorkBench - SSS	5 - MANAG	FR - (B4 unread alerts)					ne	
	Window He							20	لغين
D& B O S X P	Form Verifical		plete × 8	Paralisa	«Unset»	al Nation	ion Downwards		~
				Castering	construction				
						4 E	9648	an Up	£
Master Tree Top Level *	QUERY: VRTM			-	-				Þ
WorkBench	NRIM_PP								
Process	Id	SR.No	\$R		메상성과	-			^
8-6 2823					6 8.94	26 22 2	0210		1
R	4 PR.3.2	SR.2	프로젝트는 선로구조물 안전기준을 작성하여야 한다.						10
B-CD 치량안전			프로장트는 궤도 아전기준은 정성하며야 한다. (궤도-						JU,
8-6 시설안전	5 PR.3.2.1	SR.2.1	프로젝트는 궤도 만전기준을 적성하여이 한다. (궤도- 선로변, 만전구역 등)	72,	궤도 안전기준(1.1 국내자료와 - 호	2리나간 일정에 3 1자의 기술수준으	16671 로	10
	6 PR.3.2.2	SR.2.2	프로젝트는 노반 안전기준을 작성하여야 한다. (토용) 및 경로), 선호지하황단시설 등)	(제왕	노반 연전기관(1.1 국내자표와 - 후	21나라 영정에 적 제외 기술수준으	(방학가) 로	7
·····································	7 PR.3.2.3	SR.2.3	프로젝트는 구조랑(화제포함) 안전기준을 작성하여야 (고경, 터널, 건속함계/진입물제 등)	i 한다.	구조물(함) 제포함)	1.1	김나라 실정에 진 제의 기술수준으	1207	1
- Q, 시설안전 최종보고서 - Q, 시설안전 01위역처 경	8 PR.3.2.4	SR.2.4	프로젝트는 역시설(함께포함) 안전기준을 장성하여야	e de Ci	역시설(함 개도함)	1.1 - 5	211121 입장에 집	(같아?)	11
8-0 sw88	9 PR.3.3	58.3	(승강장, 충입구, 방화시설/대력 등) 프로칭트는 거널은 아저기준은 장성하여의 하다.		제보망)	SUMER - 2	제의 기술수준으	ž	~
8-00 HAU8	9 PK.J.J	28.3	프로젝트는 건설록 안전기분을 적결하여야 한다.				_	>	
8~(1) 위험도분석								2	-
응 () 연적오류	VERIFICATION		2.1 (A)						Þ
8-11 2482	Verif.3.2	.1 (A)							
8-00 999				L	ast modified	1: 31/15/08			~
응-()) 안전성평가 응-()) 차량충동	검증기준:								
B-C 95370	- 우리나라 9	[경에 작	(1)7i			ANNOTATIONS			
8-00 초학당성	· 현재의 기종	+ees	달성가능한가 에 방송성 는 것						
8-00 2948	- 국제규경 및 국내규정에 부합하는가 - 관련기관의 의견을 수렴하였는가								
8-10 971277	- 전문가 자동 - 현장 장유성	이미루	(泉と)).)(and))						
🕀 🕘 Database	29 22:								
🖲 💼 Queries	1.1 2072	와비교							
🖲 🧰 Admin	1.2 외국자동								
	3.1 국제규격 3.2 국내규정	무성							
	Procedure:								i.,
<	μ								Y
							RW	(edited)	

Fig.9. VRTM Checks

methodology, types of models to be used for system and cost effectiveness evaluation, generation of applicable documentation and specifications.

Part 3, Engineering Specialty Integration, describes the integration of technical discipline efforts with a cross reference to the specific plan.

2.4 Computer-Aided Systems Engineering

Computer-Aided Systems Engineering Tool

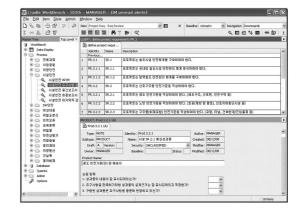


Fig.10. Project evaluation

(Cradle) is used to manage various programs more practical. Cradle is a beneficial and powerful for modification of requirements, verification assessment and validation management.

Outputs of this program are requirement table, VRTM (Verification Requirement Traceability Matrix), SEMP (System Engineering Management Plan).

3. Conclusion

Establishment of processes of railway safety management system in South Korea was attempted in this research. These processes were introduced with particular attention to Systems Engineering Management Plan (SEMP). For this purpose, railway safety management system in South Korea was briefly discussed and systematic management process was considered that ensures the success of national R&D projects. In this respect, detailed applying SEMP on railway safety management system of South Korea was discussed including Systems Engineering process and Verification and Validation procedure. In order to make the management process more easily controllable, a computer-aided systems engineering tool (Cradle) was used.

References

- Alexander Kossiakoff, William N.Sweet, "Systems Engineering Principle and Practice", pp31-33, Wiley-Interscience, 2003.
- [2] James, N., Martin, "Systems Engineering Guidebook", CRC press, pp21-22,1997.
- [3] Jeffrey O.Grandy, "System Integration", pp171-174, CRC press.