

Performance Evaluation of Project Management Implementation by BIM in Trans Sumatera Toll Road Case Study: Simpang Indralaya-Prabumulih Segment

Ni Putu Oki Wirastuti and Mursyid Hasan Basri

ABSTRACT

PT Hutama Karya (Persero) (PT HK), which one of the Indonesian State-Owned Company (SOE) that was assigned to operate the Trans Sumatera Toll Road (JTTS), has implemented Building Information Modeling (BIM) for construction control in terms of Cost, Quality, and Time since 2021. The Indralaya-Prabumulih intersection is one of the projects implementing BIM, which is expected to be a solution for completing this 65 km project. However, there are still inconsistencies in its implementation, as evidenced by the assessment carried out from January 2021 to October 2021, where achievements above 100% occurred in the first five months. However, starting from the sixth month, a decline of 83% began. This condition continued until the 10th month when the scores were below 100%, and some were even below 75%. It is necessary to evaluate the performance of BIM implementation at PT HK and find the alternative to improve performance of BIM Implementation. The cause of the implementation of BIM at PT HK, which has not reached the expected target, is due to several obstacles, namely the making of the DED 3D model image using BIM is slow, the 3D model shop image is not following the development schedule, and the BIM infrastructure cannot be implemented properly. Based on the analysis, several dominant problems must be resolved, namely standard procedures that are not following conditions in the field, a corporate culture that has not placed BIM as important and has not been able to adapt to technology quickly, and a new company has developed a KM system so that the transfer of BIM knowledge has not gone well. The proposed alternative solution is to eliminate Non Value Added Activity by making a Business Process Modeling Notation (BPMN) for making shop drawings, changing culture with the ADKAR concept and choosing a Knowledge Management System with the Analytic Hierarchy Process. The proposed alternative solution is expected to improve the performance of BIM implementation in PT HK.

Keywords: Building Information Modeling, BPMN, Culture Change, Knowledge Management.

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I. INTRODUCTION

BIM 360 is newly applied in the Simpang Indralaya-Prabumulih Toll Road project. Prior to the existence of BIM 360, all processes were carried out conventionally by project implementation parties. As previously stated, the HK Toll Road construction has the Project Director and Supervisory Consultant representatives who control the Contractor's work in project management. The entire activity process supports the implementation of work done in a silo that is not integrated between one data and another.

The implementation of BIM has been evaluated on a regular basis. However, some things have not met the target, resulting in an assessment score that is still fluctuating and unstable, indicating a lack of preparedness in implementing BIM. Whereas BIM implementation is expected to have an impact on the Indralaya-Prabumulih Toll Road project's production performance, both in terms of time and cost-efficiency.

All of HK's preparations have demonstrated maturity, from supporting infrastructure in the form of hardware and

software to regularly trained personnel. Before the implementation began, all relevant stakeholders were given the same perception so that if there were any issues that were still deemed irrelevant, they could be addressed in detail. Several discussion forums have also been held in order to anticipate things that may become obstacles, but this is not considered able to map the problems that occur.

This research was conducted with limitations due to BIM implementation on this project since the construction progress has been running (24%), and the data was taken in a very short period (less than 1 year). This limitation will be a strong recommendation for the organization and to be followed up. The scope of this research is limited to analyzing the performance evaluation on the Simpang Indralaya-Prabumulih Toll Road project. In addition, external factors due to delays in land acquisition are ignored in this study.

This study provides information to propose the alternatives solution for improving project management performance with BIM 360 on the Sp. Indralaya-Prabumulih Intersection Toll Road Project.

II. LITERATURE REVIEW

BIM has only been implemented in the construction world in the last 10 years. In its development, not all projects can adopt BIM properly. In general, the application of BIM, which is an IT tool, is greatly influenced by the ability of the company's resources to adapt. The following are some of the problems that have existed in implementing BIM from various aspects. Leadership Factor, Man Power and Capability, Policy Factors, Project Related Factors, Standard and Regulation in Industry, system infrastructure, and technical device interface problems.

The benefits of BIM in reviewing design and controlling costs and implementation time are benchmarks for the success of implementing a BIM. With a fairly broad scope of project management in the construction process, the direct application of BIM and elaborating it on the main aspects of project management becomes an obstacle. However, further studies on BIM are carried out to emphasize the sub-field of project management. Among the conventional construction project objectives, namely controlling time, cost, and quality, cost control is the most popular topic. Simulation of objects with ontologies (Lee *et al.*, 2014) and the use of technical specification standards with BIM allows a smart and fast approach in estimating the cost of construction.

Root causes analysis is a process used to define the cause of a problem to prevent repeated errors. Knowing the cause of a problem will be easy to determine the expected solution. Root causes analysis can be done with various techniques and methods to find the main causes, understand ways to overcome the causes, and apply the lessons learned systematically to avoid the same problems in the future.

There are several ways to perform root causes analysis: five whys, fishbone diagrams, and change/event analysis. The five whys method will be used in this paper. According to Tiara Oktarini's interview, BIM Manager at the Indralaya-Prabumulih segment, the current use of BIM has not been maximized, and the main thing is the process of making BIM 3D shop drawing which takes a long time. Due to the lack of human resources devoted to BIM, most of the personnel to make conventional drawings have a more significant portion. It was also stated that the portion for BIM special personnel was 1:5 when compared to traditional methods. In addition, there are repetitive activities that cause the output of the BIM to not keep up with the construction schedule. Compared to the output for making working drawings from conventional methods, it becomes faster.

III. METHODOLOGY

Using qualitative and quantitative methods where a direct study is carried out on the Indralaya-Prabumulih project of PT HK with the interview method and primary data collection. And measurements were also made through a short survey with quantitative data processing using Microsoft Excel to analyze the data obtained through the survey.

IV. FINDINGS AND ARGUMENT

By doing a root cause analysis, several things were found that became problems that affected the performance of BIM in the project. There are alternative solutions with a relatively high risk to the company and BIM implementation. In this writing, three alternatives are taken with high risk in this writing and are the root of the problem that dominantly affects the performance of BIM implementation at Sp Indralaya-Prabumulih, namely, the 3D shop drawing model is not completed on time. An alternative solution that will be investigated further is mapping the existing processes to identify activities in a BIM process that do not provide added value (NVA). Furthermore, recommendations for the concept of cultural change in companies to improve BIM implementation, as well as proposals for selecting a BIM Knowledge Management (KM) system that are relevant to current conditions, are provided.

A. Business Process Modeling Notation (BPMN) to Avoid Non-value-added Activity

BPMN is a way to describe business processes graphically and become a medium of communication to companies regarding standard procedures. Lean construction is an innovative approach to the construction process that has the same concept as in manufacturing with the principles of eliminating waste, constant improvement, value for money, focus on users or clients, efficient supply chain, and project management (Zahraee, SM, 2020, p. 1280).

To determine a non-value-added activity, you can use several verbs in the above category. In the Sp. Indralaya-Prabumulih project, a BPMN mapping of the existing condition of the drawing process as follow.

The supervision consultant will conduct repeated reviews to compare the 2D DED image and review according to the survey data. Once approved, the next process is making shop drawings with 2D image output which is currently not in digital condition, so it requires printouts and is directly approved by signature. The whole process from the 3D BIM model to the shop drawing takes 41-47 days for each category or field, be it highway, structure, and drainage. To be able to determine VA and NVA, analysis using 3 categories is needed as described in Table I.

To support the analysis of value-added and non-value-added data, a questionnaire method was also used to represent respondents in implementing BIM. The respondents are personnel who have direct involvement in the BIM implementation process in the project. Apart from the Indralaya-Prabumulih Sp Project, questionnaires were also given to other sections taken, including the Binjai-Pangkalan Brandan, Bengkulu-Taba Pananjung, Padang-Sicincin and Indrapura-Kisaran toll road projects. The questionnaire was given using the online google form method with 10 questions using a scale of 1-5 to determine activities that provide value and do not provide value. Based on the results of the answers to the questionnaires in the survey that has been carried out, the following results in Table II.

After the analysis is done, the BPMN diagram is obtained with those that have eliminated non-value-added activities as in Fig. 2.

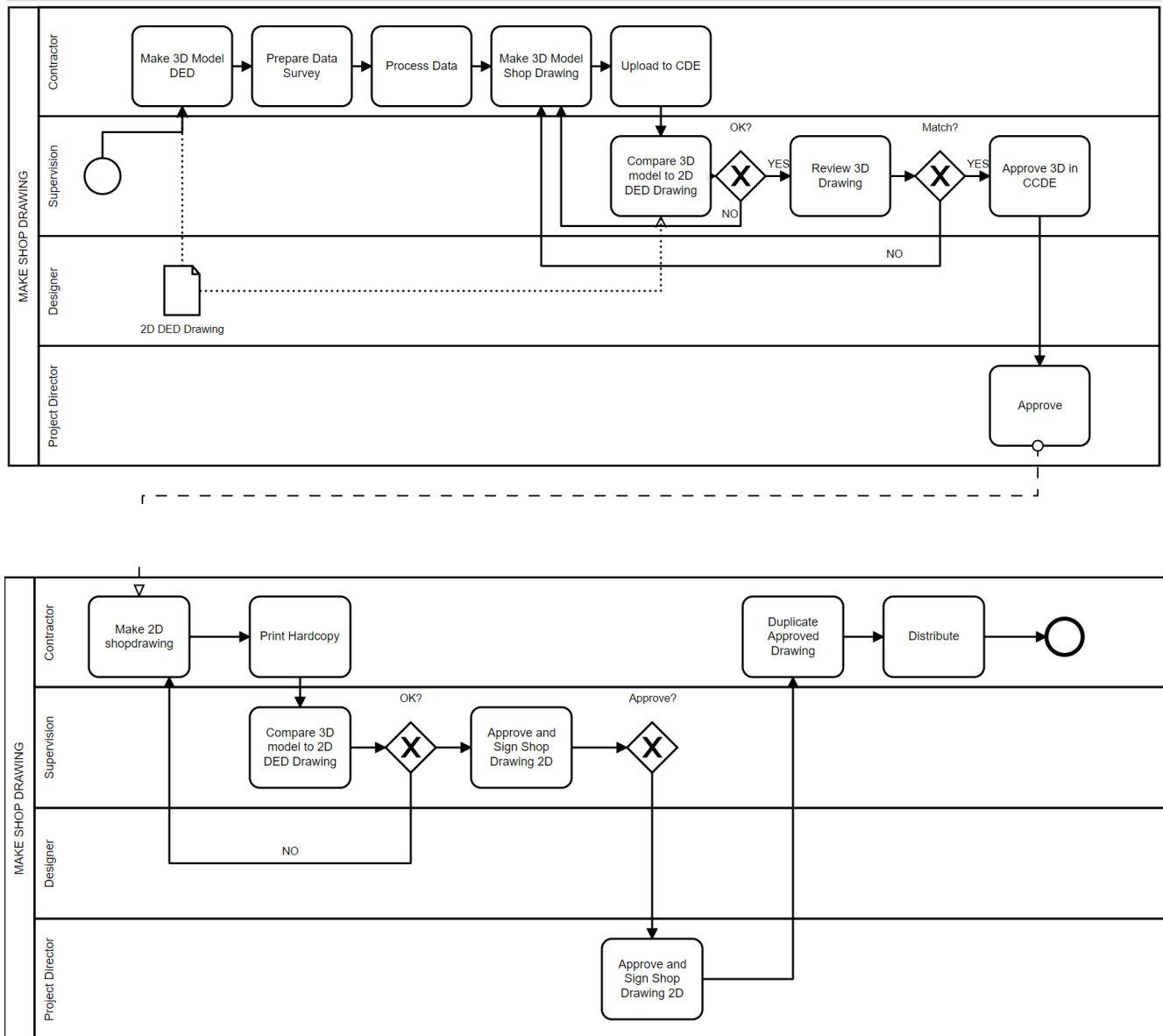


Fig. 1. Actual Workflow in Sp Indralaya-Prabumulih Segment.

TABLE I: DETERMINATION OF VA AND NVA USING 3 CRITERIA

No	Activity	Criteria			VA/NNVA/NVA
		Right at First Time	Transformation	Customer willing to pay	
1	Taking Field Survey Data	v	v	v	VA
2	Processing Survey Data	v	v	v	VA
3	Loading 3D Modeling based on Survey Data	v	v	v	VA
4	Upload 3D Images on CDE BIM 360	v	v	x	NNVA
5	Review Compare with 2D DED images	x	x	x	NVA
6	3D Modeling Reviews	x	x	x	NVA
7	Approve Image on CDE by Supervise	v	x	v	NNVA
8	Approve Image on CDE by Project Director	v	x	v	NNVA
9	Make Shop Drawing 2D	v	v	v	VA
10	Print Hard Copy	x	x	x	NVA
11	Review Compare Shop Drawing to 3D Model	x	x	x	NVA
12	Review of 2D Shop Drawing with 3D Model	x	x	x	NVA
13	Approve and sign Shop Drawing by Supervise	x	x	v	NNVA
14	Approve and sign Shop Drawing by Project Director	x	x	v	NNVA
15	Duplicate Hardcopy	x	x	x	NVA
16	Image Distribution	x	x	x	NVA

TABLE II: VALUE ADDED (VA) AND NON-VALUE ADDED (NVA) SURVEY RESULTS

No	Activity	VA/NVA	Reason
1	Taking Field Survey Data	VA	
2	Processing Survey Data	VA	
3	Loading 3D Modeling based on Survey Data	VA	
4	Upload 3D Images on CDE BIM 360	NVA	No Special 1 Day Required for This Not Required If DED Image Is Already 3D
5	Review Compare with 2D DED images	NVA	
6	3D Modeling Reviews	VA	
7	Approve Image on CDE by Supervise	VA	
8	Approve Image on CDE by Project Director	VA	
9	Make Shop Drawing 2D	VA	
10	Print Hard Copy	NVA	Digitization will be carried out Not Required If DED Image Is Already 3D
11	Review Compare Shop Drawing to 3D Model	NVA	
12	Review of 2D Shop Drawing with 3D Model	VA	
13	Approve and sign Shop Drawing by Supervise	VA	
14	Approve and sign Shop Drawing by Project Director	VA	
15	Duplicate Hardcopy	NVA	Digitization will be carried out
16	Image Distribution	NVA	Digitization will be carried out

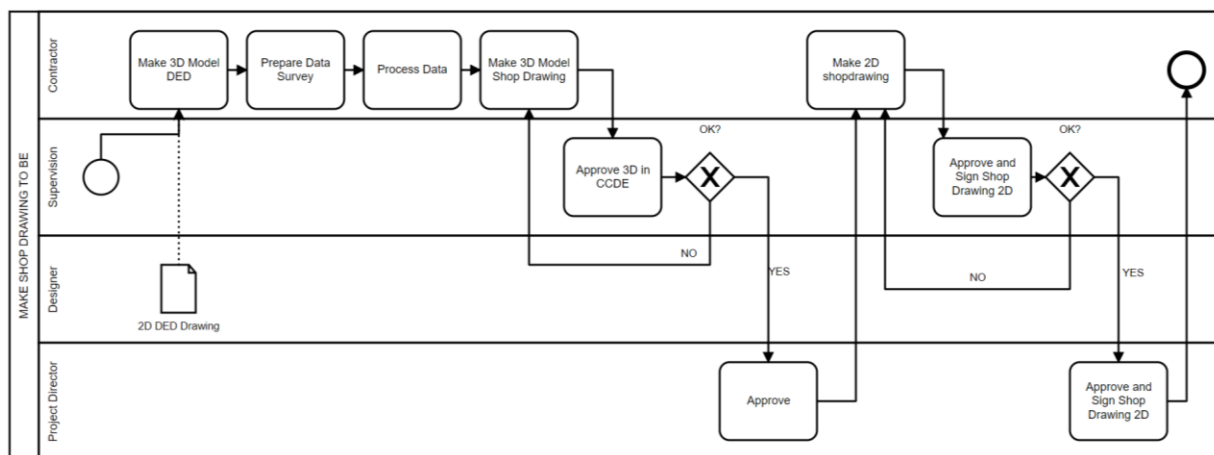


Fig. 2. BPMN for Shop Drawing Process to be.

B. Propose Change Management with the ADKAR Concept

The use of conventional methods is still tolerated so that the existence of BIM is only a complement and administrative fulfillment but is not used as a primary need. The author proposes to be able to apply the ADKAR concept model according to Jeffrey M. Hiatt (2006, Page 1) can provide an understanding of the concept of change for the individual level and the community level. Communities, companies, and government agencies. ADKAR stands for Awareness, Desire, Knowledge, Ability, and Reinforcement. The author describes the ADKAR concept in the implementation of BIM at PT HK as shown in Table III. Proposed Selection of Knowledge Management System with AHP.

Applying the knowledge management system (KMS) at PT HK is still in the development stage. A community of practitioners has been formed that can become a forum for capturing the knowledge possessed by experts owned by PT HK. Likewise, PT HK has a web-based data management

platform, but its use is minimal, and not all employees can easily access it. And the selection of KMS is still generalized for all types of knowledge without being separated according to their needs.

According to Jann Hidajat T (2017) (Page 101. Jann HT & Kristinawati D. Knowledge Management Implementation Strategy. ITB Publisher. Bandung: 2017), there is a KMS method for sharing knowledge, there are 19 methods that can be applied to the concept of BIM knowledge transfer which is expected to transfer tacit knowledge into explicit knowledge, then several methods are taken, namely Knowledge Café, Knowledge Portal, Document Libraries, Communities of Practice, and After Action Reviews (AAR).

The method used in making decisions is to use the Analytic Hierarchy Process (AHP) where this method, according to Saaty, TL (1980), is a method for solving complex decisions with a hierarchical structure based on goals, criteria and the sub-criteria and the chosen alternative. To perform AHP analysis, the author uses Super Decision software as shown in Fig. 3 AHP Framework using Super Decision.

TABLE III: ADKAR CONCEPT IN BIM IMPLEMENTATION

ADKAR Elements	Factor Influencing Success
Awareness	BIM is a project management tool to welcome industry 4.0
Desire	PT HK is a large state-owned enterprise that must create competitive advantages to compete with other companies.
Knowledge	BUMN company have used BIM as part of their services to customers
	Currently, PT HK already has human resources who have BIM competence, but they are few
Ability	More training is needed regarding the technical use of BIM software. Training is given at the officer level and the management level.
	The habit of using conventional methods will hinder the application
Reinforcement	Even though PT HK already owns the capabilities
	To be able to execute the application of BIM, Need to make the implementation program
	Quick win to find out the achievements to motivate the continuity of change.

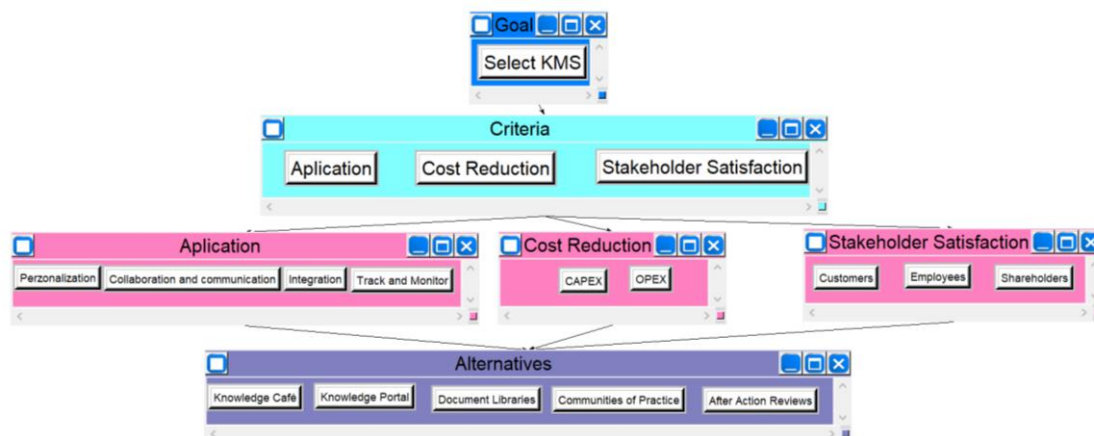


Fig. 3. AHP Framework using Super Decision.

From the results of the pairwise comparison and sensitivity analysis (Fig. 4), it was found that the alternative form of KMS that can be used in BIM KMS is After Action Review.

the Business process of making 3D shop drawing models to BPMN and eliminating Non-Value-Added Activity (NVA) can reduce the duration of making shop drawings from 41–47 days to 32–28 days in the Indralaya-Prabumulih Sp project. Thus, the assessment of parameter 2 BIM, which is experiencing a downward trend, can increase the achievement ratio by 100%. In writer opinion, this alternative is the best alternative because it is not only the best short-term alternative solution for the Indralaya-Prabumulih Sp Project so that it can improve the performance of the project but also affect the long-term implementation of BIM.

Similarly, analyzing cultural change with ADKAR and selecting the right KMS will impact the long-term goal of BIM implementation. The more consistently management implements these two alternatives, the easier it will be for PT HK's business in the future, particularly in competing with competitors. PT HK will compete on an international scale to achieve the company's vision of becoming the best toll road developer in Indonesia. As a result, PT HK requires a competitive advantage to remain competitive in the construction industry. PT HK will be able to compete and collaborate with other world-class companies by incorporating BIM into its culture and performance.

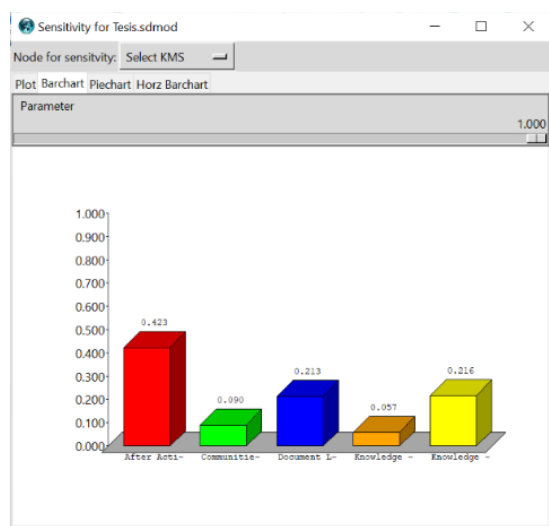
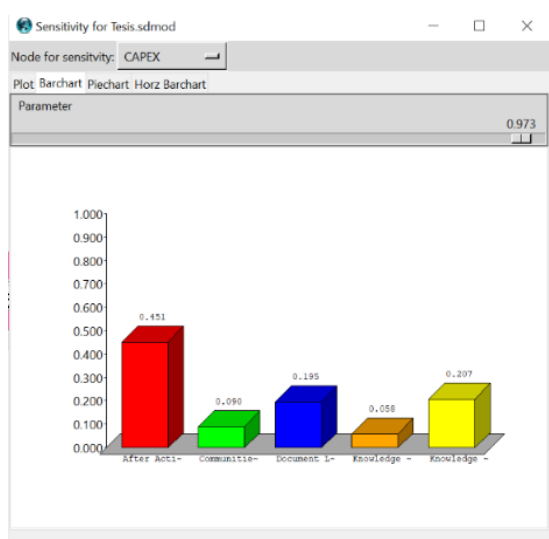


Fig. 4. Analysis Sensitivity Result.

V. CONCLUSION

Based on the analysis of the three alternative business solutions above, it is projected to accelerate the completion of shop drawings which is the most dominant problem affecting the performance of BIM implementation at PT HK. Mapping

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CONFLICT OF INTEREST

Authors declare that there is no conflict of interest.

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