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Implementation of Input-Process-Output Model for Measuring Information System Project Success

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Abstract

Measurement of the information system (IS) project success has become the interesting topic for researchers and practitioners since the Standish Group published their findings in 1994. Project success theory is the main concept in this topic, but this theory is still an ambiguous concept and lack in agreement among researchers and practitioners. They are also still tending to focus on single or partial dimension. Therefore, they did not get a clear picture of the system measurements. This study developed an alternative model of the project success measurement based on input-process-output (IPO) model. The development was conducted using comparison, adoption, adaptation, and combination the previous theories and models: Davis's IPO model, the project success theories, Delone and McLean' model, and the project classificatory framework. As indicated in most studies that most of models are developed using the previous theories and models rather than on empirical proofs. The result is a IS project success model consisting of 9 variables and 36 relationships among the variables. Although, the model is only a conceptual model, but it was developed completely and coherently considering three main aspects of project success measurement, namely: processional and causal models, project success theories, and the influence concept of project environment.

Keywords: *IS, project, success model, IPO*

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1. Introduction

Researchers and practitioners have been trying to successfully manage IS projects to attain the high project performance for many years. This topic has been the interest of both researchers and practitioners since the Standish Group [1] published their findings in 1994. These findings have become the most famous and widely cited industry benchmark in information technology (IT) [2]. However, several scholars [2-5] have criticized the validity of the findings, but they have been able to encourage awareness of both researchers and practitioners that software development is in a crisis. Meanwhile, numerous scholars such as [6-9] indicated that definition of the project success is still an ambiguous concept because it has been changed over times, discussed oftentimes, and still lack in agreement, particularly for which criteria to be used. Furthermore, in the context of the development of project success model, both researchers and practitioners still tend to focus on single or selected parts of the success dimension [10, 11]. Therefore, they did not get a clear picture of theirs systems and methods [10] or present a partial approach in their developments [11]. This represents invalidity and incompleteness in the development of success model.

This paper presents a development of processional and causal model for developing an alternative IS project success model through comparison, adoption, adaptation, and combination the prior studies. As described by Belout and Gauvreau [12] that most of models are developed using the previous theories rather than on empirical proofs. Based on this description, authors tried to make a logical sense for developing the relationship among four theories and models: Davis's IPO model [13], the project success theories [14-18], DeLone and McLean's (D&M) IS success model [19], and McLeod and MacDonell' s (M&M) classificatory framework [20]. However, four meta-analysis studies of the D&M model [10-11], [19, 21] indicated that this model has been the dominant basis of IS success measurement over two last

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decades, but they have also suggested to extend and re-specify this model as mentioned by its authors [19] for further development and validation of their models. Considering these suggestions, this study is aimed to develop a measurement model of IS project success in the context of continuous study for creating new possibilities in the enhancement of IS project success. The following sections describe literature review, research method, result and analysis, and lastly, this article is concluded with suggestion for the further studies.

2. Literature Review

2.1. The Meaning of Project Success

De Wit [14] mentioned that the most appropriate criteria for success are the degree to which a project meets its objectives. He also suggested for separating between the project success and the project management success [14]. Several scholars [14, 22] described that stakeholder's perceptions from technical to strategic aspects must be considered in the project measurement. Wateridge [15] extended this concept through decomposing project life cycle into the project management life cycle and the product life cycle. Atkinson [23] proposed a triangle measurement model using cost, time and quality; he has also described how to identify the cause of project failures by tracking where the errors occured. However, this model was criticized by Ika [24] because of its incapability to represent the comprehensive criteria, despite the fact that it had been the basis of understanding for further theories. Furthermore, Lim and Mohamed [16] distinguished clearly between success criteria and its success factors in term of project environmental aspects in line with the stakeholder's focuses, namely: macro and micro environments.

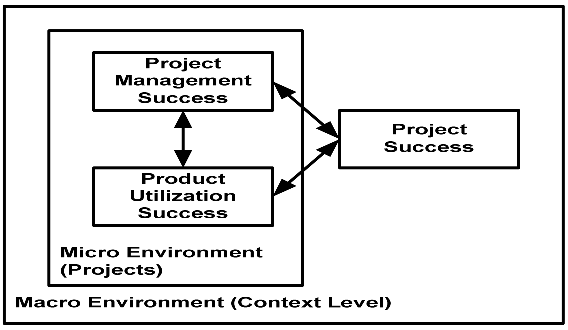

Figure 1. Project Success Concept (Adopted from [14-18])

Similarly, Howsawi et al. [18] proposed a model based on adoption of four environmental variables, including the project itself, its deliverable, business, and context levels. Judgev and Muller [17] who explained retrospectively development of the project success theories since over 45 years ago, they concluded that the theories began from the limited scope around the project life cycle into definition which it reflected strategically the product life cycle. Coherently, Subiyakto and Ahlan [25] developed a framework using systematic, managerial, directional, and environmental dimensions to understand information and communication technology (ICT) environment. However, several scholars such as [6-9] indicated that project success definition is an ambiguous concept, but authors concluded that project success consist of two main dimensions: the project management and the product utilization successes. This conclusion is in line with early theories [14-15], [17] and the placement of each dimension is based on environmental concepts [16, 18] as illustrated in Figure 1.

2.2. The Processional and Causal Models of IS Project

It is inevitable that stakeholder's perceptions are often used to develop a project success model as indicated by several scholars [14, 19, 23, 25] that perceptions from technical to strategic aspects during the project process, must be considered to measure the project success. In order to identify the causes of the project failure, Atkinson [23] has elucidated this concept by tracking where the error occurred.

Similarly, implementation of these processional and causal models were also adopted by DeLone and McLean to develop D&M IS success model. They accommodated the communication research of Shannon and Weaver [26] and the information “influence” theory of Mason [27]. These researchers [19] described that the adoption of both models is aimed to capture the multidimensional and interdependent nature of IS success [19]. The three dimensions of their models are the creation of a system, the use of the system, and the consequences (impact) of its system as illustrated by Figure 2.

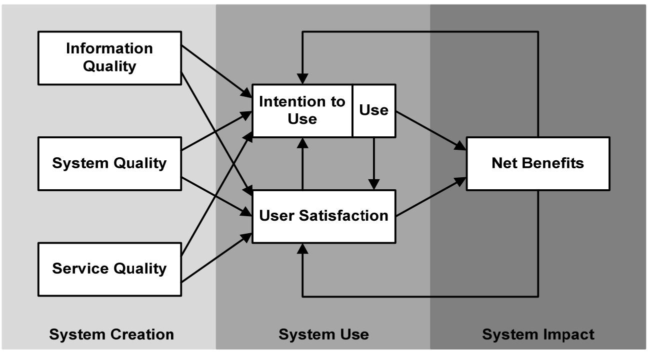

Figure 2. Processional and Causal Models of D&M IS Model (Adopted from [19])

This model has been the dominant basis of IS success measurement over two last decades, but a number of scholars [10-11], [19, 21] concluded that the wide popularity of the model is also strong indication of the need for its utilization in the further success measurement studies in the context for developing and validating this model. Specifically, Petter et al. [10] has shown that more studies are needed to understand the relationship between two variables in the system use dimension and their relationships towards variable of the system impact dimension. They also suggested both researchers and practitioners to use the overall dimensions of D&M success model in order to present the whole portrait of processional model [10]. Further, Urbach and Müller (11) found that most studies are conducted to date have only focused on the measurement and assessment of selected parts of the dimensions and described that utilization of the complete model will help researchers and practitioners to extend understanding of the overall validity.

Meanwhile, several researchers such as [28-30] had also adopted the processional and causal models using IPO logic. Although, these adoptions were conducted in different research fields, but the logic was implemented in the similar purpose for measuring quality of a system. Famously, this basic system theory is used to present a systematic concept of a system. For example, this model was used for conceptualizing, planning and/or documenting a computer program in particularly for graphically presenting the program’s control structure and set of IPO flaws [13]. Davis [13] presented the computer program as IPO logic and described that this systematic logic model can easily be understood by some stakeholders who are inexpert technically in the technical work [13]. However, the “text plus flowchart” nature of IPO charts often does not represent the current state of the real condition, but the logic can help designers to evaluate and refine the design, and correct the prior implementation flaws [13] as illustrated in Figure 3. In short, authors argue that the D&M IS success model can be combined with the IPO model in order to present comprehensively the processional and causal model of a project.

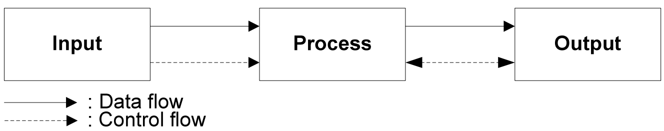

Figure 3. IPO Model (Adopted from [13])

3. Research Method

The research process followed is as shown in Figure 4. The research was carried out in the following four stages:

Stage 1: Literature review; this stage of research was performed through literature review of secondary sources such as books, journals, and conference proceedings that were held during February 2013 till May 2013. The theories and models of IS project success available from scholarly articles were identified and based on the nature of these theories/models, authors analyzed them into the IPO model [13] in order to capture a holistic approach as suggested by a number of scholars [13-19] (Figure 1, 2, and 3).

Stage 2: Research model design; based on the analysis results, authors combined and conceptualized the concepts into the proposed model (Figures 5). The semantics of the flow, dependencies between the construcs and dependencies among the constructs of model can be identified from the drawn model. The identified variables in each dimension were designed based on the processional and causal concepts of IPO model. The model consists of three main dimensions of IPO logic and two sub-dimensions based on the comparison, adoption, adaptation, and combination of the prior theories/models. These works were done from June 2013 till September 2013. At the end of this stage, authors found 36 relationships of 9 variables (Table 1).

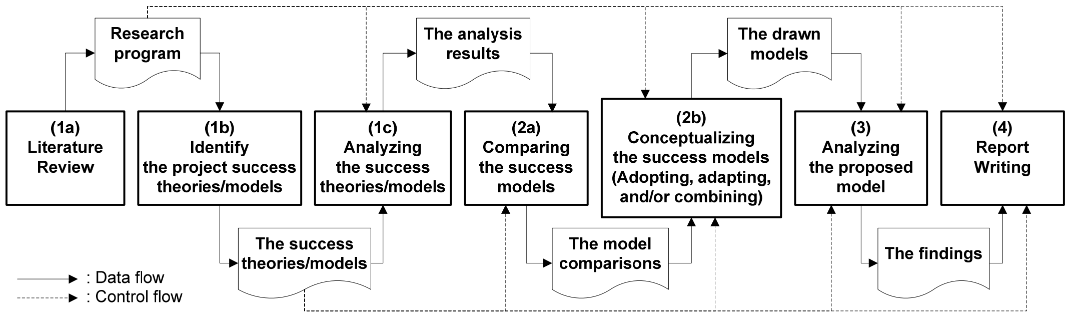

Figure 4. Research Process

Stage 3: Analyzing the proposed model; in order to ensure the feasibility of the model for further studies, authors identified indicators of each construct based on the nature of constructs from previous studies. This analysis was done from October 2013 till November 2013. In addition, authors had also discussed the model with a number of colleagues including at least 5 doctoral students in the different topics of IS field and 5 academicians who had experiences in the similar research field. At the end of this stage authors formulated 54 measurement indicators.

Stage 4: Report writing; finally documenting the findings of the research, report writing and finding opportunities for further empirical research was carried out from December 2013 till January 2014.

4. Result and Analysis

Belout and Gauvreau [12] described that most of models were developed using the previous theories rather than on empirical proofs. Considering this description, researchers developed a logical sense of the relationship among the several theories and models related to the research problem through comparison, adoption, adaptation, and combination the prior findings and suggestions.

First, authors compared two models: D&M model [19] and IPO model [13]. As indicated by a number of scholars [10-11], [19, 22], D&M model [19] were developed based on an assumption that IS as the information processing adapted the processional model of IS [26] and adopted the causal model of IS [27]. Similarly, authors assumed that a project is as a production process and adopted the IPO model [13] in order to capture the holistic process as indicated by [13-19]. This adoption is reasonable because the model in its nature represented comprehensively the processional and causal model. Based on comparison of these two models, authors found that the processional and causal model of D&M model is incomplete in term of IPO model of a project. As explained by several studies [10, 11] that the model was only focus on utilizations and services of the product. In the context of a project success measurement, this model was lack in particularly to explain the input dimension of the IPO model. Accordingly, the IPO model is more comprehensive than D&M model. In addition, authors argue that this model will be easly understood by some project stakeholders who are inexpert technically as described by Davis [13]. Specifically, this is related to the “key informant” role of the stakeholders in the project measurement studies. For instance, in the data collection phase; how to explain the research issues and get valid responses from them. The utilization of this model can also help researchers and practioners to evaluate and refine the model, and correct the prior implementation flaws. Moreover, IPO model can capture both processional and causal models of the project to get understanding of overall validity as suggested by Urbach and Muller [11].

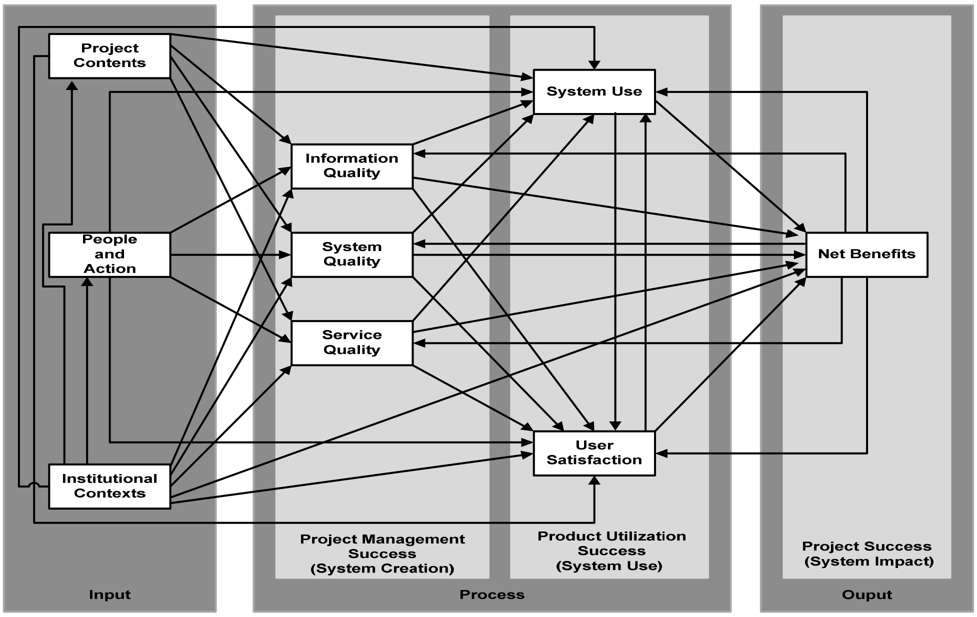

Figure 5. The Proposed IPO Model for Measuring IS Project Success

Second, researchers had also adopted the project success theories [14-18], D&M the IS success studies [19], and the project classificatory framework [20]. The adoption of project success theories was implemented to develop causality aspects of the model. Authors adopted all of D&M model and three of the project classificatory framework (Project content, People and action, and Institutional context) except Project process. It is because the project process was represented by process dimension.

Third, authors adapted placement of the variables in line with the IPO logic and the definition of project success used in this study. Three point adaptations are: (1) Placing together the two of D&M model dimensions (system creation and system utilization) into process dimension of the model as indicated by several scholars [15, 25], [17-18] that a project process is consisting of two sub-process: product production and its utilization. The placement of the system impact dimension of D&M model as output dimension of the model in line with definition of project success [15, 25], [17-18]. (2) Developing relationship between varibles of input dimension of the model towards its process dimension variables. In this point, each variable of the input dimension associated toward each variable of the process dimension in line with processional and causal model of IPO Model [13]. (3) Developing relationship between Institutional contexts towards all variables in the model based on concept of system environmental influences [16, 18, 20].

Table 1. Justification of the Relationships

Constructs	Relationships	References
Project contents	Project contents → Information quality	[13], [16], [18], [20]
	Project contents → System quality	[13], [16], [18], [20]
	Project contents → Service quality	[13], [16], [18], [20]
	Project contents → System use	[13], [16], [18], [20]
	Project contents → User Satisfaction	[13], [16], [18], [20]
People and actions	People and actions → Information quality	[13, 14], [16], [18], [20], [22]
	People and actions → System quality	[13, 14], [16], [18], [20], [22]
	People and actions → Service quality	[13, 14], [16], [18], [20], [22]
	People and actions → System use	[13, 14], [16], [18], [20], [22]
	People and actions → User Satisfaction	[13, 14], [16], [18], [20], [22]
Institutional contexts	Institutional contexts → Information quality	[13], [16], [18], [20]
	Institutional contexts → System Quality	[13], [16], [18], [20]
	Institutional contexts → Service quality	[13], [16], [18], [20]
	Institutional contexts → System use	[13], [16], [18], [20]
	Institutional contexts → User Satisfaction	[13], [16], [18], [20]
	Institutional contexts → People and actions	[13], [16], [18], [20]
	Institutional contexts → Project contents	[13], [16], [18], [20]
	Institutional contexts → Net benefits	[13], [16], [18], [20]
Information quality	Information quality → System use	[10, 11], [14, 15], [17], [19]
	Information quality → User satisfaction	[10, 11], [14, 15], [17], [19]
	Information quality → Net benefits	[10], [14, 15], [17]
System quality	System quality → System use	[10, 11], [14, 15], [17], [19]
	System quality → User satisfaction	[10, 11], [14, 15], [17], [19]
	System quality → Net benefits	[10], [14, 15], [17]
Service quality	Service quality → System use	[10, 11], [14, 15], [17], [19]
	Service quality → User satisfaction	[10, 11], [14, 15], [17], [19]
	Service quality → Net benefits	[10], [14], [15], [17]
System use	System use → User satisfaction	[10, 11], [14, 15], [17], [19]
	System use → Net benefits	[10, 11], [14, 15], [17], [19]
User satisfaction	User satisfaction → System use	[10, 11], [14, 15], [17], [19]
	User satisfaction → Net benefits	[10, 11], [14, 15], [17], [19]
Net Benefits	Net Benefits → Information quality	[10, 11], [14, 15], [17]
	Net Benefits → System quality	[10, 11], [14, 15], [17]
	Net Benefits → Service quality	[10, 11], [14, 15], [17]
	Net Benefits → System use	[10, 11], [14, 15], [17], [19]
	Net Benefits → User satisfaction	[10, 11], [14, 15], [17], [19]

Fourth, the model developed in this study is combination of four theories and models above mentioned. This combination was performed in order to respond two main issues around IS project success modeling, namely validity and comprehensiveness of the measurement model. The comprehensiveness of the model developed is means that the model was developed to cover overall dimension of a project in the context of its processional and causal aspects as indicated by conclusions of two meta-analysis studies [10, 11]. The validity is means that this model represented basis of project success theories. Three main dimensions of the developed model are input, process, and output dimensions. The process dimension is consisting two sub-dimensions: system creation and system use dimensions. The model is also consisting 9 variables and 36 relationships among the variables. Project contents, People and action, and Institutional contexts are three variables for the input dimension. Information quality, System quality, Service quality, System use, and User satisfaction are five variables in the process dimension, and Net benefits is the variable for output dimension.

In addition, in order to measure quantitatively and qualitatively the model, authors defined the variables and their indicators (Table 2). Most of the indicators were identified based on four meta-analysis studies of Petter et al. [10], Urbach and Muller [12], DeLone and Mclean [19], and McLeod and MacDonell [20]. There are the variables used in this study:

(1) *Project contents,* the degree related to the various factors that are considered as properties of the project itself which affect typically, strategically, technically, or materially the process of project [20].
(2) *People and actions,* the degree related to the people's characteristics, actions, interactions and relationships shape the development trajectory and project outcomes in multiple ways [20].
(3) *Institutional contexts,* the degree related to the both internal organizational properties and external environmental conditions that affect the project, often in unpredictable ways.

(4) *Information quality,* the degree to which information consistently meets the requirements and expectations of the users in performing their jobs [10].
(5) *System Quality,* the degree related to the perceived ease of use is the famous definition of this construct relating to the technology acceptance (TAM) model.
(6) *Service Quality,* the degree of the excellence of system services into users [19].
(7) *System Use,* the degree in which an IT is utilized by its users [19].
(8) *User satisfaction,* the degree of the user's level of satisfaction when utilizing an IT as the project output [14, 22].
(9) *Net Benefits,* the extent to which IS are contributing to the success of individuals, groups, organizations, industries, and nations [19].

Table 2. Justification of the Indicators

Constructs	Indicators	References
Project contents	Project size	[20]
	Project complexity	[20]
	Newness to organization	[20]
	Appropriateness of the strategic management	[20]
	Clarity of the project strategic management	[20]
	Resources availability	[20]
	Technology development	[20]
	Data quality	[20]
People and actions	Professionalism	[20]
	Integrity	[20]
	Norms	[20]
	Stakeholder's support	[20]
	Clarity of the project structure	[20]
	Conflict management	[20]
Institutional context	Organizational cultures	[16], [18], [20]
	Organizational Policies	[16], [18], [20]
	Organizational experiences	[16], [18], [20]
	Legacies system and infrastructure	[16], [18], [20]
	Business environment	[16], [18], [20]
	External context	[16], [18], [20]
Information quality	Accuracy	[19]
	Timeliness	[19]
	Completeness	[19]
	Relevance	[19]
	Consistency	[19]
System quality	Ease-of-use	[10, 11], [19]
	Reliability	[10, 11], [19]
	Flexibility	[19], [32]
	Functionality	[19]
	Maintainability	[10]
	Response time	[19], [32]
Service quality	Assurance	[19], [33]
	Empathy	[19], [33]
	Responsiveness	[19] ,[33]
	Flexibility	[34]
	Interpersonal quality	[34]
	Technological training	[34]
	Security	[35]
System use	Nature of use	[19]
	Extent of use	[19],[36]
	Intensity of use	[37], [38]
User satisfaction	Adequacy	[39-41]
	Effectiveness	[39-41]
	Efficiency	[39-41]
	Overall satisfaction	[31], [38-42]
Net benefit	Profitability Enhancement	[43]
	Job performance	[32], [37]
	Resources savings	[19], [31], [39], [44]
	Managerial effectiveness	[31], [39], [44], [45]
	Productivity improvement	[31, 32], [44, 45], [37]
	Product quality improvement	[46]
	Customer satisfaction	[46]
	Competitive advantage	[39], [46]
	Market expansions	[19]

Furthermore, based on discussions involved 12 doctoral students in the different topics of IS field and 6 academicians who had experiences in the domain, two main issues of their comments and suggestions are related to complexity of the proposed model and its validity. In order to respond these aspects, researchers proposed the use of case study to explore the complexity and to measure the validity as described by Runeson and Höst [47] that the study is originally used primarily for exploratory and confirmatory purposes in specific phenomenon, in particularly for testing validity of the combination between three variables of the input dimension that adopted from the project classificatory framework [20] and its relationships toward variables of the process dimension and the ouput dimension from the D&M IS success model [19].

5. Conclusion

Literature study shown that most studies in the IS/IT project management topics is still indicate a disagreement around definition of project success. Meanwhile, most researches and practitioners are still use single or partial dimension in modeling of project success.This study was conducted to respond these two main issues. Therefore, the developed model is the major contribution of this work. Although the result of the study is only a proposition model, but it has been developed to cover four basis theories and models of IS project success, namely: the IPO logic model, the project success theories, the D&M success model, and the project classificatory framework. The IPO model was implemented in order to represent a comprehensive view of project process. The project success theories were adopted in order to represent causalities of project success. The D&M IS success model was also adopted in line with its validities that been dominant used to date. Lastly, the project classificatory framework as the input variables was adopted based on the influence concept of project environment.

Representation of these theories and models is aimed to ensure validity and compresensiveness of the model. Comprehensive is means that the model was developed to cover overall dimension of project in the context of its processional and causal aspects as indicated by suggestion by four referred meta-analysis studies. Valid is means that this model represented basis of project success theories models. The model is consisting three main dimensions, namely: input, process, and output dimensions. The process dimension is consisting two sub-dimensions: system creation and system use dimensions. The model is also consisting 9 variables and 36 relationships among the variables. The coherent combination of dimensions, variables, and relationships is also another unique contribution of this work. In short, the model development of this study presented that the model was developed using the previous theories rather than on empirical proofs. Therefore, further researches can be conducted quantitatively and qualitatively to test validity of the variables particularly for three variables of the input dimension and its relationships toward variables of the process dimension and the ouput dimension.

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