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Success Factors for Web Application Development: Research Findings From The Initial Phase

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SUCCESS FACTORS FOR WEB APPLICATION DEVELOPMENT RESEARCH FINDINGS FROM THE INITIAL PHASE

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ABSTRACT

This paper reports the research findings from the initial phase of a research project for success factors of Web application development. From the initial sample data we collected, multiple regression analyses show that among the 100 independent variables, the following six factors significantly affect the success of Web application development: (1) computing infrastructure effectiveness, (2) end users' feedback about functionality, (3) creative brief or concept creation as a development phase, (4) operations and business process design as a development phase, (5) activity diagram as a development tool, and (6) political reasons. A preliminary path analysis indicates the following significant chain relationships: (1) "computing infrastructure effectiveness" affects "success of Web application development" via the moderator variable of "Web modeling language as a methodology", (2) "end users' feedback about functionality" influences "success" via "creative brief or concept creation as a development phase" and "operations and business process design as a development phase", and (3) "political reasons" determines "success" via "Web modeling language as a methodology" and "activity diagram as a development tool".

Keywords: Web application development, development methodologies, documentation tools and techniques

INTRODUCTION

This research project defines a Web application as a software system that relies on the Web as its interaction medium with the end users to create, exchange, and modify data for transaction requirements. This research project has three objectives. First, identify the methodologies, techniques, and tools being used by practitioners to develop Web applications. Second, identify the problems encountered by practitioners when they use existing methodologies, techniques, and tools for Web application development. Third, develop new methodologies, techniques, and tools to overcome the existing problems experienced by Web developers. Methodologies for application development are defined as the step-by-step procedures to carry out the development activities consisting of different phases in a system development life cycle. A methodology has its own assumptions about the reality, techniques to support working principles and enforce discipline, and tools to generate the deliverables for activities. In other words, there are a collection of techniques and tools for a certain development methodology. As Web application development is different from traditional information system development in terms of user recognition, user environment, communication control, testing requirements, and functionality design, existing methodologies for information system development may not well suit for Web applications. What are the methodologies being used by practitioners to develop their Web applications when there are no solid guidelines? Are practitioners using some heuristic methods developed by themselves, some modified methodologies from the literature, or not using any methodologies at all? It is the above question that provides the first objective for this research study. The second objective follows the first research question. If practitioners are using some methodologies for Web application development, are there any problems? What are those problems? How do those problems affect Web application development? What do practitioners need in order to solve those problems? The findings to the first two research objectives in this study will provide input to the last research objective, which is to develop a comprehensive methodology and its associated techniques and tools that can support an effective and efficient Web application development life cycle. This paper does not cover all the research questions but reports the findings from the initial sample data set we have collected.

LITERATURE REVIEW

There are four research directions in the literature for Web application development, namely, development life cycle, documentation tools, special issues such as security and accessibility, and Web services as imported components in a Web application. Table 1 (omitted) summarizes the research results from selected studies for the direction of development life cycle. Table 2 (omitted) summarizes the research results from selected studies for the directions of documentation tools, special issues, and Web services. The literature review indicates that practitioners and academia in Web application development are not exchanging their experience and ideas. While some studies recognize the importance of methodologies in Web application development, they have the following limitations. First, most research projects in the literature have conceptual model building as their objectives, which fall short of empirical verification. Second, all research projects with empirical evidence are case studies, which provide specific knowledge only for theory building. Third, the discussion on methodologies is on the conceptual level rather than the implementation level that incorporates the utilization of techniques and tools. Findings from this research project can fill the above knowledge gap in the literature.

THEORETICAL RESEARCH MODEL

Figure 1 depicts the theoretical model for this research project. We hypothesize that company characteristics, evaluation factors for Web application development, adoption factors for methodologies/tools/techniques, and failure factors for Web

application development affect the importance of different methodologies, development phases, tools, and techniques for Web application development, which further determine how successful Web application development is in a company. Methodologies, development phases, tools, and techniques are considered as moderator variables in our research model. The ultimate dependent variable is SR, the successful rate of Web application development. The definitions of all variables for each factor group can be found in the questionnaire in Appendix I. For example, there are seven variables AF1 – AF7 for the adoption factors for methodologies, tools, and techniques including improve overall quality of applications (AF1), improve maintainability of applications (AF2), improve management of development process (AF3), improve team member communication (AF4), improve communication with end users (AF5), reduce cost (AF6), and reduce development time (AF7). In this paper, because of the sample size, we cannot test the full structural equation model. Instead, we select some significant variables from each factor group to test the path analysis model as shown in Figure 2. The purpose of carrying out the initial analyses in this paper using the preliminary sample is to test the validity of the research model and also to fine tune the questionnaire based on the preliminary findings.

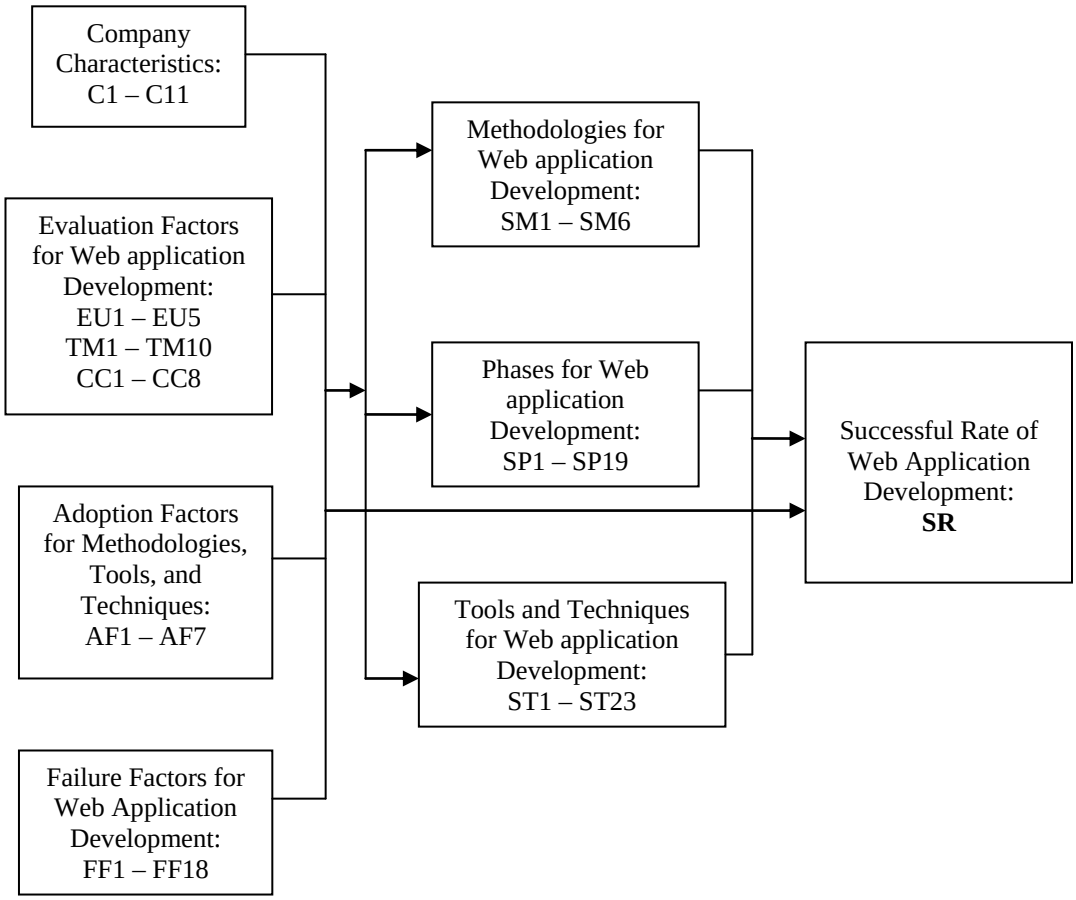

Figure 1. Theoretical Research Model

RESEARCH METHODOLOGY

We developed a preliminary questionnaire based on the research model. The preliminary questionnaire was submitted to 10 Web developers for pretest. Feedback from pretest was used to revise the questionnaire in terms of meaning clarification, format change, re-ordering questions, and question addition. The final questionnaire is given in Appendix I. A sample of about 5000 potential respondent contacts was collected from several Internet database brokers. The sample includes Chief Computing Architect, CIO, VP for eBiz/Internet, VP for IT, VP for Network, VP for Quality Assurance, VP for Software Development, Director for eBiz/Internet, Director for IT, Director for Network, Director for Software Development, Manager for Quality Assurance, and Chief Technology Officer. Basically, we included contacts who involve in any phases of Web application development. The questionnaire was delivered via an Internet survey company.

During the initial phase of data collection, we sent out email invitations to 1500 contacts in our sample requesting their participations in the survey. To provide incentive for participation, the invitation email mentioned that $10.00 will be donated to charity organization for each of the first 100 completed surveys. We received 116 responses out of which 51 are completed and usable. The response rate for usable surveys out of the 1500 invitations is 3.4%. One objective of carrying out the initial phase is to determine the response rate. If it is low, we will try to revise the questionnaire according to the response patterns as well as initial analysis results for correlation and significance. The response rate of 3.4% is lower than our expectation of 5% - 10%. We noticed that about half of the respondents who did not finish the survey completed about 1/3 of the survey, and the other half completed about 2/3 of the survey. There was a higher response rate from "Officer" and "VP" contacts than from

"Director" or "Manager" contacts. About 80% of the completed surveys are from small to medium companies. In order to obtain a higher response rate and a more balanced sample in terms of company size and respondents' job positions, we will do the following for the next phase of data collection: (1) obtain more contacts from large companies; (2) move critical questions such as successful rate of Web application development, importance of methodologies, tools, and techniques toward the beginning of the survey; and move descriptive questions such as company revenue toward the end of the survey; and (3) delete questions which are highly correlated with others such as number of employees, annual sales, annual profit in your company; average cost for developing a Web application, the total number of Web applications developed, and the total number of Web application being used.

For the initial sample of 51 completed cases, we used four pairs of variables to check the reliability of respondents' answers, including TM1 (development team members' feedback about functionality) and TM8 (development team members' feedback about how well the system performs required tasks), CC6 (whether the application is maintainable) and AF2 (improve maintainability of application), CC5 (whether the application delivers the overall quality as expected) and AF1 (improve overall quality of applications), and CC3 (whether the application is delivered within the approved timeline) and CC8 (whether different deliverables are on time). We first checked the difference along the seven-point Likert scale for the two variables in each pair. Any difference of 3 points or more will be flagged. If a respondent has 2 or more flagged pairs out of the 4 pairs, we deleted that respondent from our sample. Using the above procedure of reliability checking, we deleted one respondent from the initial sample yielding a total of 50 respondents in the final sample.

In order to carry out the full structural equation modeling, according to the rule of thumb of having 10 respondents for each variable in a factor, we will need at least 230 respondents since the "largest" factor is "Tools and Techniques for Web Application Development" that has 23 variables of ST1 – ST23. Though we cannot perform the full structural equation modeling for our initial sample of 50 cases, we adopted a multi-step analysis procedure as follows.

Step 1: We used multiple regression analysis with the backward method to identify significant predictors in each factor group (as shown in Figure 1) for the dependent variable of Web application development success.

Step 2: All significant variables identified from Step 1 were entered into a final regression model. This step generated the final list of significant predictors.

Step 3: Using the most significant variables we obtained from Step 2 above to represent factor groups respectively, we developed a path analysis model as shown in Figure 2. Though SM4, importance of Web modeling language as a methodology, is not a significant predictor from Step 2, we added that to the path model to check its moderating effect. To specify the model, we assigned the regression weight of 1 to the error terms e1 – e5 for SM4, SP1, SP7, ST9, and SR in the path analysis model.

Table 3. Multiple Regression Results for Predicting Success Rate for Web Application Development (SR) Using the Backward Analysis Method

All Predictors for Analysis	Predictors in Final Model	Standardized Coefficients	Beta Sig.	Model Sig. for F	Adj. R^2
C7 – C10	C10	0.3	0.034	0.034	0.071
EU1-EU5, TM1-TM10, CC1-CC8	EU1	0.385	0.006	0.006	0.13
SM1-SM6	SM4	-0.302	0.033	0.033	0.072
SP1-SP19	SP1	0.387	0.005	0.001	0.243
	SP7	-0.263	0.059		
	SP18	0.379	0.006		
ST1-ST23	ST1	-0.339	0.034	0.036	0.144
	ST9	0.316	0.038		
	ST16	-0.25	0.087		
	ST21	-0.262	0.089		
	ST23	0.292	0.063		
FF1 – FF18	FF12	-0.282	0.047	0.047	0.06
AF1 – AF7	No AF variables are significant in predicting SR.				
C10, EU1, SM4, SP1, SP7, SP18, ST1, ST9, ST16, ST21, ST23, FF12	C10	0.248	0.037	0	0.369
	EU1	0.381	0.005		
	SP1	0.259	0.044		
	SP7	-0.267	0.04		
	ST9	0.24	0.055		
	FF12	-0.332	0.01		

INITIAL RESEARCH FINDINGS

The research results for Step 1 are given in Table 3. There are no significant variables from the adoption factor group (AF). In the final regression model, C10, EU1, SP1, SP7 (-), ST9, and FF12 (-) are significant predictors. The final model is highly significant at the p-level of 0 and adjusted R square of 0.369. C10 is an organization's computing infrastructure effectiveness, which has a coefficient of 0.248 in the regression model affecting Web application development success. EU1 is the importance of end users' feedback about functionality, which has the largest coefficient of 0.381. SP1 has a coefficient of 0.259 representing the importance of the development phase creative brief/concept creation. ST9, with the coefficient of 0.24, is the importance of activity diagram as a development tool. SP7, the importance of operations and business process design as a development phase, has a negative coefficient of -0.267. FF12, the importance of political reasons as a failure factor for Web application development, has a negative coefficient of -0.332.

Figure 3 shows the analysis results from Step 3 using AMOS, revealing the significant paths for the path analysis model in Figure 2. The path analysis statistics for regression weights and model fitness are provided in Table 4. The CMIN, NFI, CFI, and RMSEA all indicate that the path analysis model is highly significant and has good model fit. The standardized direct effects, standardized indirect effects, and standardized total effects of variables are also shown in Table 4. The path model reveals that C10, EU1, and FF12 all have direct and indirect effects on SR.

The effect chain for C10 is: the higher the computing infrastructure effectiveness, the less important the Web Modeling Language as a methodology; the more important the Web Modeling Language as a methodology, the less success for Web application development; and the higher the computing infrastructure effectiveness, the more success. Computing infrastructure effectiveness stands out among all company computing characteristics as a significant variable for Web application development success. Its negative relationship to Web Modeling Language as a methodology is interesting. It may imply that if a company has effective computing infrastructure, formal methodology does not have much a role in successful Web application development. That echoes how practitioners do not use formal methodologies advocated by academia. Instead, practitioners may rely on effective computing infrastructure to facilitate their Web application development activities.

The effect chain for EU1 is: the more important end users' feedback about functionality for evaluation of Web application development success, the more important the creative brief/concept creation and operations/business process design as development phases; the more important the creative brief/concept creation, the more success; the more important the operations/business process design, the less success; and the more important end user's feedback about functionality, the more success. The positive association of end users' feedback about functionality to creative brief/concept creation and operations/business process design as development phases are intriguing. Creative brief/concept creation, as a unique phase in Web application development, certainly claims its importance in Web application development success. There seems to be the following message: when we start to develop a Web application, its unique presence on the Web as a concept or idea must be defined or created for its enduring success. The negative relationship between operations/business process design and success is puzzling. It can be due to the fact that our sample consists mainly of small or medium companies. Since small or medium companies do not have great deal of complicated business processes to handle, they do not show their importance in our initial sample. We will check whether this negative relationship persists in the full model from the complete data set in the future.

The effect chain for FF12 is: the more important the political reasons as a failure factor for Web application development, the more important the Web Modeling Language as a methodology and the more important the activity diagram as a development tool; the more important the Web Modeling Language, the less success; the more important the activity diagram, the more success; and the more important the political reasons, the less success. The phenomenon of political reasons as an important failure factor being associated with Web Modeling Language as a methodology as well as activity diagram as a development tool may have significant practical meaning. It may mean that methodologies and development tools are more used to deflect or solve political problems during Web application development process in organizations rather than because of their real practical values. This speculation has to be confirmed in the full data set we will collect in the next stage.

CONCLUSION

This paper reports the research findings from the initial phase of a research project. From the initial sample, we identified a significant path model showing computing infrastructure effectiveness, end user's feedback about functionality, and political reasons as the exogenous variables influencing Web application development success through the moderator variables of Web Modeling Language as methodology, creative brief/concept creation and operations/business process design as development phases, and activity diagram as a development tool. The most influential variables are end users' feedback about functionality and political reasons, which have path coefficients of greater than 0.3. The initial findings alert academia to pay attention to the relevance of methodologies and tools. Among all the UML diagrams developed by academia, it seems that only activity diagram has gained a foothold in practice. Web Modeling Language, the only significant one among all formal methodologies proposed by academia, actually has a negative impact on Web application success. Though the findings are based on a small

sample, they may carry significant meanings. The next phase of collecting the full data set for a complete structural equation model will provide further evidence for analyses.

Table 4. Statistics for Path Analysis

Regression Weights: (Group number 1 - Default model)

			Standardized Estimate	Estimate	S.E.	C.R.	P
sm4	**<---**	**c10**	**-.228**	**-.393**	**.231**	**-1.700**	**.089**
sp1	<---	c10	.094	.125	.177	.708	.479
sp7	<---	c10	.085	.133	.206	.644	.519
st9	<---	c10	.001	.001	.265	.004	.996
sm4	<---	eu1	-.121	-.316	.349	-.906	.365
sp1	**<---**	**eu1**	**.348**	**.703**	**.267**	**2.632**	**.008**
sp7	**<---**	**eu1**	**.359**	**.844**	**.310**	**2.718**	**.007**
st9	<---	eu1	.036	.107	.399	.269	.788
sm4	**<---**	**ff12**	**.236**	**.244**	**.138**	**1.767**	**.077**
sp1	<---	ff12	-.115	-.092	.106	-.869	.385
sp7	<---	ff12	.097	.090	.123	.737	.461
st9	**<---**	**ff12**	**.342**	**.403**	**.158**	**2.552**	**.011**
sr	**<---**	**sm4**	**-.195**	**-.110**	**.060**	**-1.818**	**.069**
sr	**<---**	**sp1**	**.280**	**.203**	**.079**	**2.581**	**.010**
sr	**<---**	**sp7**	**-.261**	**-.162**	**.068**	**-2.396**	**.017**
sr	**<---**	**st9**	**.256**	**.126**	**.053**	**2.389**	**.017**
sr	**<---**	**c10**	**.195**	**.189**	**.101**	**1.867**	**.062**
sr	**<---**	**eu1**	**.338**	**.495**	**.168**	**2.939**	**.003**
sr	**<---**	**ff12**	**-.282**	**-.163**	**.064**	**-2.533**	**.011**

Chi-Square Measure Fit

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	27	**4.847**	9	**.847**	.539
Saturated model	36	.000	0		
Independence model	8	65.691	28	.000	2.346

NFI and CFI Measure Fit

Model	**NFI Delta1**	RFI rho1	IFI Delta2	TLI rho2	**CFI**
Default model	**.926**	.770	1.073	1.343	**1.000**
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

RMSEA Measure Fit

Model	**RMSEA**	LO 90	HI 90	PCLOSE
Default model	**.000**	.000	.091	.890
Independence model	.166	.114	.218	.001

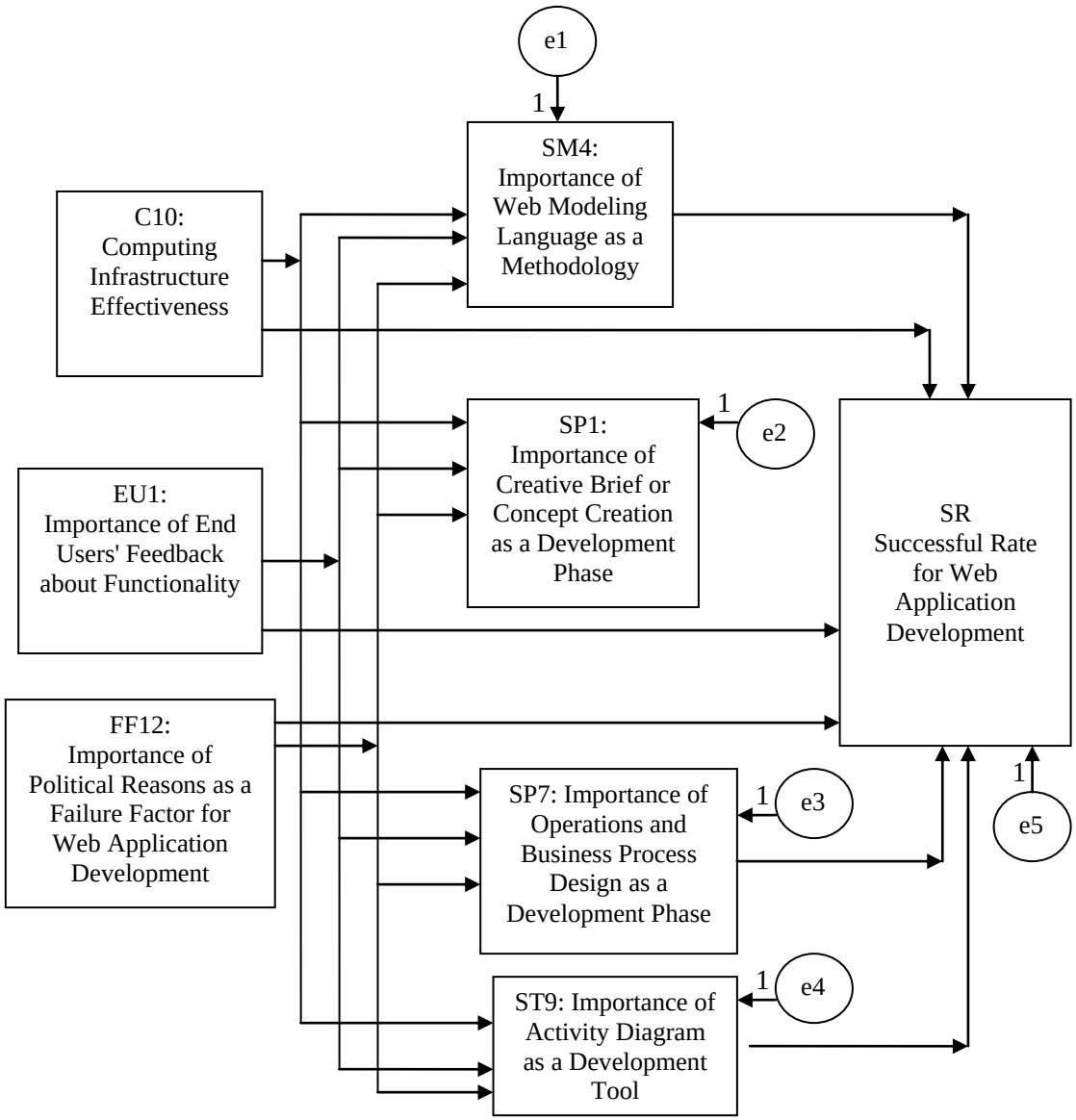

Figure 2. Path Analysis Model for Web Application Development Success

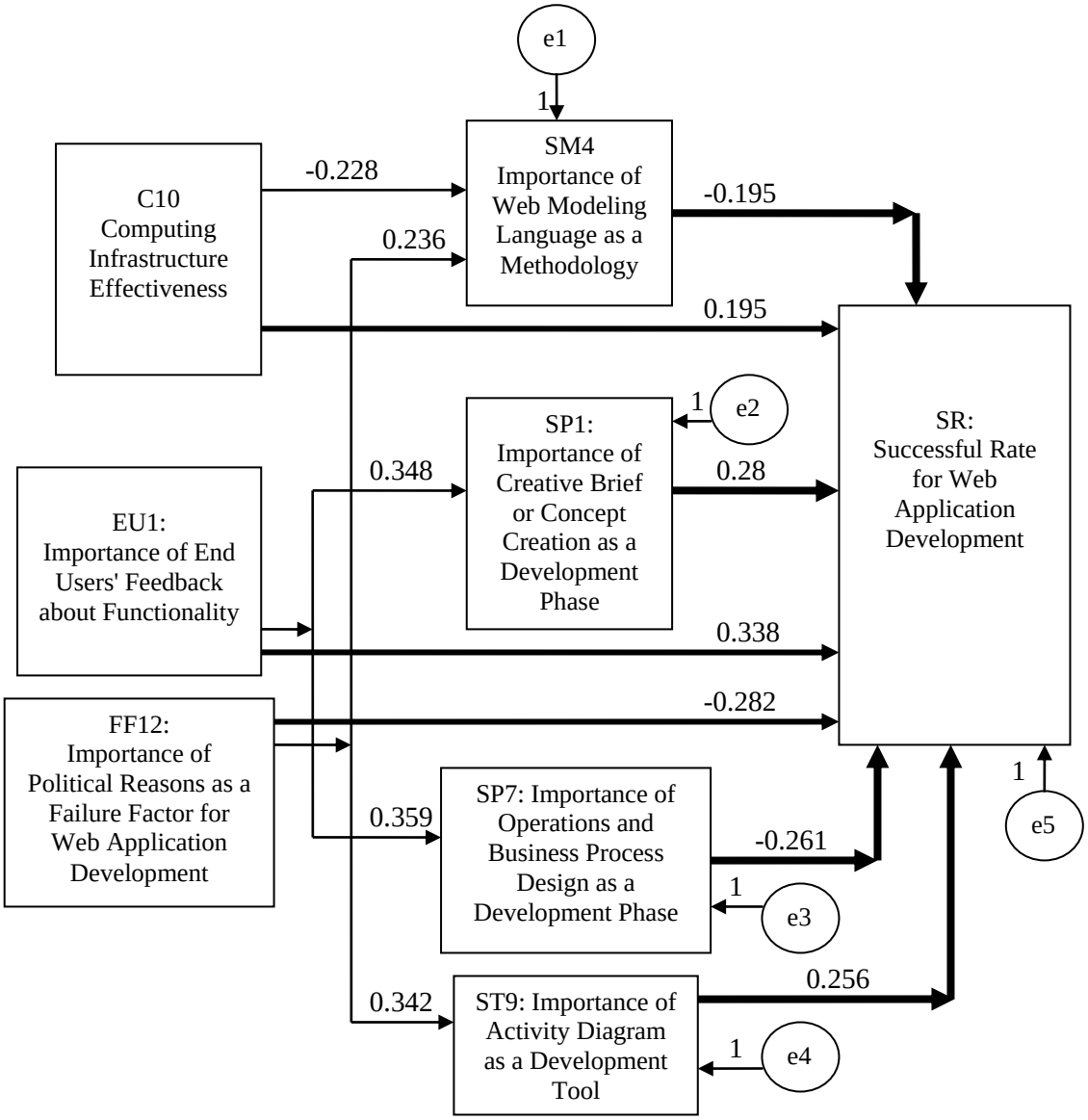

Figure 3. Significant Paths for Web Application Development Success

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