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An empirical analysis on the effects of investment assessment methods on IS/IT project success

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Abstract:
As organizations' investments on information systems/information technology (IS/IT) increase, the assessment methods used during IS/IT investment decision-making process holds more and more importance. Since successful IS/IT projects are key to the sustainability of an organization, identifying the factors which have effects on project success carries useful insights. In this study, 18 assessment methods are identified based on the literature. A novel classification method is proposed and assessment methods are classified into financial, strategic, and organizational categories. A novel rule-based method for determining the size of IS/IT projects is also proposed. Detailed information on project characteristics, employed IS/IT assessment methods, and project success is collected for 110 real-world IS/IT projects. The collected data is utilized in ANOVA and Regression tests to examine the factors which affect project success. Use of organization-related assessment methods, which is proposed in this study, is found to increase the success rate of the projects. Obligation towards the project and use of multi-criteria methodology have significant relationships with project success whereas project size, use of gut feeling during evaluation, and employed system development methodology do not have statistically significant impacts on project success.

Keywords:
IS/IT investments; assessment methodologies; project success; success criteria; project size.

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1. Introduction

Information systems/information technology (IS/IT) global spending is expected to reach the level of 2-3 trillion dollars by 2020, with sustained significant growth over the years [1]-[3]. IS/IT investments are also found to have a significant impact on economic growth and it is superior to other types of investments in terms of efficiency in growth output [4]. Moreover, a causal relationship exists between IT investments and productivity [5].

Various IS/IT investment assessment methods are available for evaluating projects prior to the final investment decision. Since investments are expected to provide benefits, financial or otherwise, to the company; the success of the invested projects carries uttermost importance. The purpose of this study is to explore IS/IT project characteristics and use of IS/IT investment assessment methods in actual IS/IT projects and finally determine their effects on the success of the projects. In achieving the stated purpose, an extensive survey is conducted on 110 IS/IT projects, descriptive statistics on those projects are analyzed, and Analysis of Variance (ANOVA) and Regression tests are carried out to examine factors affecting project success. The findings enable practitioners and researchers to gain insight into current practices in real-world IS/IT projects and provide prescriptions for conducting successful IS/IT projects.

The contribution of this paper includes, but is not limited to, the following:

- A novel categorization is developed for classifying IS/IT assessment methods;
- A real-world statistical data is provided on the characteristics and success rate of IS/IT projects;
- Use and importance of 18 IS/IT assessment methodologies are explored;
- The relationships between project success and employed assessment methods are examined.

This paper is structured as follows. In Section 2, the relevant literature which provides a background for the study is identified and briefly discussed. Subsequently, in Section 3, research aims are presented and hypotheses are developed. The methodology employed in this study is described in Section 4. Results and findings are presented in Section 5. Discussion on managerial implications, limitations of the study, and directions for future research are given in Section 6.

2. Background

This section provides a review of the literature on project characteristics, investment assessment methods, and project success with the purpose of providing a background on the effects of project characteristics and investment assessment methods on IS/IT project success.

Sauer et al. [6] study the impact of the project's size and volatility on its performance in terms of budget, schedule, and scope expectations. For classifying the projects based on size, they utilize budget, effort (average person months), duration, and team size. Aguilar et al. [7] survey 107 Mexican software development companies to investigate the size of projects built by these companies. They propose a rule-based method to classify projects as small, medium, and large-sized projects based on effort (work hours), duration, and full-time equivalent (FTE) staff of the project. However, project complicatedness measures such as problem and solution complexities, and interdependencies with other systems and projects are often overlooked while determining the size of the projects.

Joshi and Pant [8] classify IT projects in a discretionary-mandatory dimension. Purely discretionary projects indicate that the organization has complete flexibility in undertaking the project as well as in choosing the time frame for its execution. Purely mandatory projects, on the other hand, are the projects where the organization have no choice, but to undertake the project within a defined narrow time frame. Projects which fall between these two ends are either classified as mainly discretionary projects or mainly mandatory projects based on which end they are closer to. The relationship between project obligation and project success remains an open question for exploration.

In system development, agile and waterfall are considered as two competing approaches with more specific methodologies being the hybrid or derivations of the two. This view is almost universally accepted by both practitioners

and researchers. Accordingly, the current research in this field focuses on specific methodologies rather than challenging the widely-accepted two general approaches.

Ika [9] investigates the success criteria used in project management from the 1960s to the 21st century. As presented in Table 1, they suggested that in addition to the iron triangle which consists of time, cost, and quality; criteria such as user satisfaction and stakeholder satisfaction are also fundamental. Success measures for projects evolve over time and there is no universally accepted standard for all kinds of projects. Yet, a success measurement model which is generalizable for most projects and still relevant for individual projects is very useful.

Table 1. Project success criteria across time (adapted from Ika [9])

Research Focus	**Period 1** **1960s - 1980s**	**Period 2** **1980s - 2000s**	**Period 3** **21st Century**
Success criteria	"Iron triangle" (time, cost, quality)	Iron triangle Client satisfaction Benefits to organization End-user's satisfaction Benefits to stakeholders Benefits to project personnel	Iron triangle Strategic objective of client organizations and business success End-user's satisfaction Benefits to stakeholders Benefits to project personnel and symbolic and rhetoric evaluation of success and failure

Bacon [10] examines the criteria used for allocation of IS/IT resources to candidate projects. Senior executives from 80 organizations are asked to specify the most popular 15 assessment criteria along with the respective frequencies. The study also groups criteria under financial, management, and development categories. Rosacker and Olson [11] investigate the IT project selection and evaluation methodologies through a survey of IT project management practitioners working in U.S. state governments. They also assess the relationships between selected assessment methods and success of the project and find that utilization of financial assessment methods is important in achieving project success in terms of budget. Khakasa and Ateya [12] conducted a similar study. Their study provides an empirical analysis on IT investment assessment methods used in banks in Kenya. The findings show that sophisticated techniques which integrate strategic and financial methods are less frequent than the use of traditional assessment methods which focus mostly on financial returns.

Renkema et al. [13] provide a reference framework for the assessment methodologies in the literature. They discern four basic categories: financial, multi-criteria, ratio, and the portfolio approach. The reviewed methods are then classified under those categories. Irani [14] reviews the literature on IS/IT investment assessment methods in manufacturing resource planning and provides a taxonomy of the methods. Moreover, the study proposes a conceptual model for IS/IT investment evaluation. Stix and Reiner [15] provide a critical review on IT appraisal methods and their categorizations. They place IS/IT investment assessment methods inside a triangle whose three corners represent the three categories: financial, multi-criteria, and strategic. Although some methods fall between multiple categories, all can be assigned to their predominant category. Ozturan et al. [16] examine over 50 academic articles and classified IS/IT investment assessment methods used in those studies into three categories as financial, non-financial, and hybrid. They find that although financial methods are more frequently used than non-financial methods, there is an increasing trend in the use of non-financial methods due to a tendency towards strategic and intangible benefits of IT.

Andresen [17] proposes a framework for selecting evaluation methods for IT projects in the construction industry, particularly in Denmark. Their survey of Danish companies shows that formal evaluation methods are only rarely used. Since there does not exist a single evaluation method which is best for all cases, their framework helps to find the best IT evaluation methods matching the needs of the company. In order to do such a match, the nature of the company, use of IT, business objectives, and reasons for evaluation are weighted and taken into account. Similarly, Chou et al. [18] propose a fuzzy multi-criteria decision model approach which considers compatibility and ability to integrate with

existing IT portfolio. Their two-stage evaluation process uses weights given to 26 IS/IT investment criteria to score candidate projects.

Table 2 presents IS/IT investment assessment methods employed in this study along with appropriate references and original categorizations by the respective authors in the literature. As depicted, studies in the literature do not agree on a widely-accepted classification but rather employ different categorizations. An exception to that is the traditional finance-related criteria which are labeled as financial in all reviewed literature except for Khakasa and Ateya [12] and Irani [14] where they are labeled as economic. For the other criteria, the majority of the literature makes the distinction based on whether the criterion is numeric/analytic or non-numeric, which in our opinion is insufficient since most methods contain both quantitative and qualitative components especially with the advance of data collection and analysis capabilities.

Table 2. Assessment methods for IS/IT investments

Assessment Method	**Reference Category**	**References**
Cost Benefit Analysis	Financial	[11], [12], [15]-[17]
	Economic	[12], [14]
Payback Period	Financial	[10], [11], [13], [17]
	Economic	[12], [14]
Return on Investment	Financial	[10], [15]-[17]
	Economic	[12], [14]
Net Present Value	Financial	[10], [11], [13], [16], [17]
	Economic	[12], [14]
Internal Rate of Return	Financial	[10], [11], [13], [17]
	Economic	[12], [14]
Technical Importance Assessment	Strategic	[12], [14]
	Development	[10]
Competitive Advantage Analysis	Qualitative	[11], [12]
	Strategic	[14]
	Management	[10]
IT Portfolio Analysis	Non-financial	[16]
	Strategic	[12]
	Portfolio	[13]
	Multi-criteria	[15]
	Qualitative	[17]
SWOT Analysis	Strategic	[15]
Risk Analysis	Non-financial	[16]
	Analytic	[12], [14]
Value Analysis	Non-financial	[16],
	Analytic	[12], [14]
Opinions of Experts	Financial	[17] (as *Delphi Evidence*)
Human Resource Availability	-	[18]
Administrative Necessities	Management	[10]
Legal Necessities	Qualitative	[11]
	Management	[10]
Suitability for Development	Development	[10]
Operability after Deployment	Development	[10]
Gut Feeling	Qualitative	[11]
	Gut Feeling	[12]

3. Research aims and hypothesis building

This study has two main research aims. The first is to explore the characteristics, success, and employed assessment methods for IS/IT projects conducted in the industry. The second is to examine the effects of project characteristics and employed IS/IT investment assessment methods on project success.

Project characteristics, investment assessment methods, and project success. Understanding the problem setting and current practices is a prerequisite for most problems, particularly in IS/IT management field. Such information can yield useful practical insights and enables formulation of further sophisticated research questions. Accordingly, first research aim requires analysis of the project characteristics in terms of project size, the obligation towards the project, and employed system development methodology as well as the project success and the use of investment assessment methods. To the best of our knowledge, this is the first study which investigates mentioned characteristics simultaneously. Further to that, project size is measured by a novel, more comprehensive classification method which considers problem and solution complexities, and interdependencies in addition to the traditional metrics of budget, duration, and FTE staff. In accordance with the earlier discussion in the previous section, project success is also measured via a more contemporary approach rather than the traditional metrics of time, cost, and quality. For potentially hundreds of investment assessment methods, most frequently used methods are identified and presented with a novel categorization based on an analysis of the literature. A detailed discussion on the operationalization of the variables is given in the next section.

The second research aim investigates the factors affecting project success. Objectives under this aim are stated as formal hypotheses, which can be tested by conducting appropriate statistical tests. This research aim can further be divided into two subcategories based on whether the effects of project characteristics on project success are investigated or the effects of investment assessment methods on project success are investigated.

Effect of project characteristics on project success. As discussed earlier and as evident from the literature, the relationship between employed system development methodology and project success is a field of its own. Yet, an empirical comparison of agile and waterfall methodologies in terms of eventual project success is valuable for providing further evidence or counter-evidence for the literature. On the other hand, the relationship between project size and project success have only been explored using less sophisticated measurement models, and the relationship between obligation towards project and project success is not investigated at all. Therefore, investigating how projects with varying characteristics are likely to be successful is an obvious research direction. It carries not only scientific importance but very strong and immediate practical importance as well. To the best of our knowledge, this the first study which employs all of the listed project characteristics and examines their effects on project success. The formal hypotheses regarding the relationship between project characteristics and project success are given below.

- **H1.** There is a relationship between project size and project success.
- **H2.** There is a relationship between obligation towards project and project success.
- **H3.** There is a relationship between employed system development methodology and project success.

Effect of assessment methods on project success. As discussed earlier in this work, the existing studies on IS/IT investment assessment methods are very limited in number and scope, and mostly take interest in how to classify different assessment methods and how frequently those methods are used in actual IS/IT projects. As a result, a sufficient analysis of the relationship between the use of assessment methods and project success is lacking even though the ultimate goal of IS/IT investment assessments is choosing the projects with highest returns. Obviously, the success rate of projects would increase the return from investments. If project executives have the knowledge on which assessment methods would yield more accurate predictions on project success, then the success rate of projects can be improved through better assessment. Moreover, our study employs a novel classification of assessment methods since no agreed upon sufficient classification method exists in the literature, as discussed earlier in the previous section and will be detailed in the next section. On the other hand, the fact remains that the use of multi-criteria method might have an effect on project success since utilizing different types of assessment methods adds new perspectives and provides triangulation in assessing the investments. On that account, the existence and size of the effect of employing the multi-

criteria method is also an interesting problem for the IS/IT management community. The formal hypotheses regarding the relationship between IS/IT investment assessment methods and project success are given below.

- **H4.** There is a relationship between categories of employed IS/IT investment assessment methods and project success.
  - ***H4a.*** There is a relationship between use of financial assessment methods and project success.
  - ***H4b.*** There is a relationship between use of strategic assessment methods and project success.
  - ***H4c.*** There is a relationship between use of organizational assessment methods and project success.
  - ***H4d.*** There is a relationship between gut feeling and project success.
- **H5.** There is a relationship between multi-criteria method use and project success.

4. Methodology

This section begins with a description of the methodology used in the measurement and operationalization of variables employed in this study under project characteristics, assessment methodologies, and project success categories. The section concludes with the details of the data collection process.

4.1 Project characteristics

The methodology employed in determining project characteristics such as sector, project size, obligation towards project, and employed system development methodology is explained in this section.

Sector. List of sectors is taken from the list of supersectors in FTSE Russell Industry Classification Benchmark (ICB) [19]. ICB is a distinguished standard categorizing companies to subsectors which most closely represents the nature of their business, which is determined by its primary source of revenue and other publicly available information. In addition to those sectors, our study provides the *Other* option and allows respondents to specify the sector of their project. Among the responses which specified their sector as *Other*, the most popular sector was *Education*. List of sectors is presented in Table 3.

Table 3. List of sectors

Automobiles & Parts	Construction & Materials	Food, Beverage & Tobacco	Media	Technology
Banks	Consumer Products & Services	Healthcare	Personal Care, Drug & Grocery Stores	Telecommunications
Basic Resources	Energy	Industrial Goods & Services	Real Estate	Travel & Leisure
Chemicals	Financial Services	Insurance	Retail	Utilities

Project Size. Following the similar methods employed by Sauer et al. [6], Aguilar et al. [7], and several organizations such as universities and state departments [20]-[22] the following methodology is used to classify projects as small, medium, or large. Three levels are determined for each of full-time equivalent (FTE) staff, duration, number of departments involved, number of links to other systems and projects (interdependency), problem complexity, and solution complexity. Each project is then classified under one of the three levels for each criterion. Assuming that the third level signals larger projects whereas the first level signals smaller projects, each project is assigned a point based on its classifications under all criteria. The first level contributes zero points whereas the second and third level contributes 1 and 2 points respectively. Projects which have up to 4 points are categorized as small. Projects which have at least 10 points are categorized as large. The rest are classified as medium-sized projects. Table 4 summarizes the novel classification methodology employed in this study.

Table 4. IS/IT project size classification methodology

	0 pts.	1 pts.	2 pts.
Budget	Less than ₺50,000	₺50,000 - ₺250,000	More than ₺250,000
FTE staff	Less than 5 people	5 - 9 people	More than 10 people
Duration	Less than 4 months to reach operational status	4 - 12 months to reach operational status	More than 12 months to reach operational status
Departments Involved	1 - 2 departments	3 - 4 departments	More than 4 departments
Interdependency	No links or only a few links to other systems and projects	Several links to the other systems and projects	Many links to the other systems and projects
Problem Complexity	The problem is easy to understand and define.	The problem has medium difficulty for understanding and defining.	Problem is difficult to understand and define.
Solution Complexity	The solution is easily achievable.	The solution is achievable but not as easily.	The solution is unclear and difficult to achieve.
	Small	**Medium**	**Large**
Points	0 - 4 pts.	5 - 9 pts.	10 - 14 pts.

Obligation. The organization's obligation towards each IS/IT investment can be different and these differences might affect the project success. Therefore, all projects are classified as purely discretionary, mainly discretionary, mainly mandatory, or purely mandatory based on the work of Joshi and Pant [8].

System Development Methodology. Projects are categorized based on whether their employed system development methodology fits under *agile* or *waterfall* approaches. Waterfall approach is a sequential process where each phase is completed before moving to the next phase. Agile approach, on the other hand, is an incremental process where work is divided into multiple deliveries and an iterative methodology is employed. For projects where such distinction is not applicable or the system development methodology is unknown, a third option named *unclear/unknown* is also provided.

4.2 Investment assessment methodologies

After reviewing the literature for classifications of IS/IT investment assessment methodologies in Section 2, a novel set of categories is employed which classify the given assessment methods under financial, strategic, and organizational categories as shown in Table 5.

In the literature, there is a widely-accepted consensus regarding which methods belong to the financial category. For the nonfinancial methods, a sizable portion of the previous literature makes the distinction based on whether they are numeric or non-numeric (quantitative or qualitative, analytic or not). However, most methods often contain both numeric and non-numeric parts which make such classification less accurate. To overcome this problem, this study approaches the issue by introducing an organizational perspective and making the distinction between strategy- and organization-related methods. In this way, it becomes easier to classify assessment methods which contain both numeric and non-numeric information.

In addition to the data collected on the level of importance given to each assessment method during the IS/IT investment decision, a separate data is also collected on whether a multi-criteria evaluation method (e.g., scoring method) is employed or not.

Table 5. Classification of assessment methods for IS/IT investments

Financial	Strategic	Organizational	Gut feeling
Cost Benefit Analysis	Technical Importance Assessment	Human Resource Availability	Gut feeling
Payback Period	Competitive Advantage Analysis	Administrative Necessities	
Return on Investment	IT Portfolio Analysis	Legal Necessities	
Net Present Value	SWOT Analysis	Suitability for Development	
Internal Rate of Return	Risk Analysis	Operability after Deployment	
	Value Analysis		
	Opinions of Experts		

4.3 Project success

Adapting from Ika [9], this study measures success in five dimensions: whether the project is completed (i) within time, (ii) within budget; whether the project output meets (iii) technical requirements, (iv) functional requirements; and (iv) how the stakeholders rate the success of the project.

First four criteria correspond to the iron triangle where quality is measured in two dimensions as technical and functional. End-user satisfaction is not included as a separate dimension since the people who respond to the questionnaire might not accurately know the level of satisfaction that end-users have. The last dimension, stakeholder satisfaction, is expected to reflect end-user satisfaction up to a certain degree.

4.4 Data collection

An online questionnaire was prepared with the purpose of collecting information regarding the use of assessment methods for IS/IT projects in the real world along with sector of the project, project characteristics, and success metrics as explained previously in Section 4. The complete questionnaire can be found in Appendix A. The questionnaire was sent out to executives, managers, and project management professionals majority of whom works in Turkey. They were also encouraged to forward the questionnaire to other people who might have the information to respond to the questionnaire.

The data was collected over the first half of the year 2018. Total of 110 responses are obtained. Upon investigation, all responses are deemed as valid and no response is filtered out, resulting in a final sample size of 110. However, not all of the responses are for completed projects since information is collected also on projects which are not completed. The statistics are presented in the next section.

5. Results and findings

5.1 Project characteristics, investment assessment methods, and project success

In the real world, it is expected that the sectors like technology and banks to have a greater number of IS/IT projects and the sectors like chemicals and utilities to have a relatively lower number of IS/IT projects given the size of the sectors and relative importance of IS/IT in each sector. Table 6 shows the distribution of the projects by sectors in our sample. In line with our initial expectation, most of the projects (20%) are from the technology sector followed by the banks sector (%15). The sectors where IS/IT is not as crucial as other sectors and the smaller sectors have a lower number of projects. Therefore, we can conclude that our sample adequately reflects the population.

Table 6. Distribution of projects by sectors

	Complete	Incomplete	Total	
Sectors	N (70)	N (40)	N (110)	%
Technology	12	10	22	20%
Banks	12	4	16	15%
Retail	4	6	10	9%
Others	7	3	10	9%
Financial Services	3	4	7	6%
Automobiles & Parts	5	1	6	5%
Telecommunications	4	1	5	4%
Health Care	4	1	5	4%
Insurance	5	0	5	4%
Industrial Goods & Services	2	2	4	4%
Media	3	1	4	4%
Energy	1	2	3	3%
Utilities	3	0	3	3%
Construction & Materials	1	1	2	2%
Travel & Leisure	1	1	2	2%
Consumer Products & Services	1	1	2	2%
Food, Beverage & Tobacco	0	2	2	2%
Chemicals	1	0	1	1%
Personal Care, Drug & Grocery Stores	1	0	1	1%

Table 7 shows the number of complete and incomplete projects in terms of size, obligation, and system development methodology. According to the results, medium-sized projects constitute 42% of all projects. In terms of completion rate, small-sized projects have the highest rate with 77% which indicates that dividing larger scopes into smaller projects might increase the chance of completion. In terms of obligation, the projects which are at the two ends of the scale have a larger rate of completion. It is intuitive that purely mandatory projects to have higher completion since the organizations have no chance but to complete them. However, it is interesting that purely discretionary projects have a similar completion rate as well. The projects which are part mandatory and part discretionary have lower completion rates but constitute two-thirds of all projects. In system development, agile methods are used more frequently than the waterfall methods, reflecting the current trend towards the agile. Completion percentage of agile and waterfall methods are close to each other but projects which have no clear methodology (i.e., uncertain/unknown) have lower completion rates which hint the importance of employing a well-defined system development methodology.

Table 8 shows the number of complete and incomplete projects in terms of sub-items of the size criteria. According to results, while projects having more than 250.000 Turkish Liras budget is the highest percentage of all projects with 55%, projects having less than 50.000 Turkish Liras budget has the highest completion percentage with 79%. Projects lasting 4 – 12 months have the highest number of projects and completion percentage when comparing duration levels. Whereas the number of projects with less than five people is the highest among full-time equivalent staff levels with 38%, projects with more than 10 people have the highest completion percentage with 69%. When the number of involved departments increases, completion percentage decreases which signals possible communication and co-working issues prohibiting completion of such projects. In both problem and solution complexity, projects with medium

complexity constitute the largest level among complexity levels. Counterintuitively, the projects which have more complex problems do not have lower completion rates. Yet, the projects which have very complex solutions have a lower rate of completion, and therefore the solution complexity seems to be a more decisive issue rather than the hardness of the problem.

Table 9 shows descriptive statistics for investment assessment methods for the IS/IT projects. Organizational assessment methods have the highest mean scores among four assessment method categories whereas gut feeling is the lowest one, which contradicts the belief that gut feeling plays a significant role in project selection. Financial methods on average have the lowest score which challenges the traditional view that economic feasibility is the prominent determining criterion in project selection. Financial and organizational assessment methods consist of five items (respectively, Cronbach's $\alpha = .830$, Cronbach's $\alpha = .732$) whereas strategic assessment methods consist of seven items (Cronbach's $\alpha = .834$). Since Cronbach's α values are greater than 0.7 for all categories, internal consistencies within the categories are satisfied.

Furthermore, survey results show that 53% of projects use the multi-criteria method but the remaining 47% do not. Among projects which employ multi-criteria method, the completion rate is 62%. On the other hand, the completion rate for projects where the multi-criteria method is not used is 65%. Hence, there seems to be no substantial difference in project completion rate based on whether the multi-criteria method is used or not.

Table 10 shows descriptive statistics for IS/IT project success. Meeting stakeholders' requirements has the highest mean among five sub-success criteria which might indicate that projects are driven to satisfy stakeholders' requirements. Time goals have the lowest score which strengthens the common observation that projects often overrun their deadlines.

Table 7. Distribution of IS/IT projects by their characteristics

	Complete	**Incomplete**	**Completion Rate**	**Total**	
	N (70)	N (40)	%	N (110)	%
Size					
Small	20	6	77%	26	24%
Medium	27	19	59%	46	42%
Large	23	15	61%	38	34%
Obligation					
Purely Discretionary	9	3	75%	12	11%
Mainly Discretionary	16	10	62%	26	23%
Mainly Mandatory	27	20	57%	47	43%
Purely Mandatory	18	7	72%	25	23%
System Development Methodology					
Waterfall	24	13	65%	37	34%
Agile	35	18	66%	53	48%
Uncertain/Unknown	11	9	55%	20	18%

Table 8. Descriptive statistics for sub-items of the size of IS/IT projects

	Complete	Incomplete	Completion Rate	Total	
	N (70)	N (40)	%	N (110)	%
Budget (in Turkish Liras*)					
Less than 50.000	15	4	79%	19	17%
50.000 - 250.000	18	13	58%	31	28%
More than 250.000	37	23	62%	60	55%
Duration					
Less than 4 months	19	9	68%	28	25%
4 - 12 months	34	15	69%	49	45%
More than 12 months	17	16	52%	33	30%
Full-time Equivalent Staff					
Less than 5 people	27	15	64%	42	38%
5 - 9 people	16	13	55%	29	26%
More than 10 people	27	12	69%	39	36%
Number of Departments					
1 - 2 departments	27	14	66%	41	37%
3 - 4 departments	26	13	67%	39	36%
More than 4 departments	17	13	57%	30	27%
Number of Links					
No links	15	1	94%	16	15%
Several Links	18	13	58%	31	28%
Many Links	37	26	59%	63	57%
Problem Complexity					
Easy	22	12	65%	34	31%
Medium	33	21	61%	54	49%
Hard	15	7	68%	22	20%
Solution Complexity					
Easy	15	10	60%	25	23%
Medium	36	15	71%	51	46%
Hard	19	15	56%	34	31%

* *1 US Dollars ≈ 4 Turkish Liras* at the time of data collection

Table 9. Descriptive statistics for the investment assessment methods for the IS/IT projects

	Complete		Incomplete		Total	
	Mean	**Std. Deviation**	**Mean**	**Std. Deviation**	**Mean**	**Std. Deviation**
Financial Methods (Cronbach's α = .830 **)**	3.07	1.06	3.27	0.77	3.14	0.97
Cost Benefit Analysis	3.53	1.20	3.85	0.98	3.65	1.13
Payback Period	2.79	1.39	3.00	1.18	2.86	1.32
Return on Investment	2.96	1.36	3.38	1.15	3.11	1.29
Net Present Value	2.89	1.27	3.00	1.09	2.93	1.20
Internal Rate of Return	3.19	1.38	3.13	1.20	3.16	1.31
Strategic Methods (Cronbach's α = .834**)**	3.19	0.95	3.41	0.81	3.27	0.91
Technical Importance Assessment	3.33	1.20	3.73	1.01	3.47	1.15
Competitive Advantage Analysis	3.13	1.37	3.63	1.43	3.31	1.41
IT Portfolio Analysis	3.19	1.35	3.20	1.36	3.19	1.35
SWOT Analysis	2.91	1.25	3.05	1.32	2.96	1.27
Risk Analysis	3.04	1.35	3.30	1.29	3.14	1.32
Value Analysis	3.07	1.32	3.40	1.32	3.19	1.32
Opinions of Experts	3.64	1.09	3.58	1.15	3.62	1.11
Organizational Methods (Cronbach's α = .732**)**	3.51	0.94	3.39	0.67	3.46	0.85
Human Resource Availability	2.99	1.20	2.83	1.22	2.93	1.20
Administrative Necessities	3.51	1.25	2.98	1.25	3.32	1.27
Legal Necessities	3.47	1.49	3.75	1.21	3.57	1.40
Suitability for Development	3.67	1.14	3.90	0.90	3.75	1.06
Operability after Deployment	3.90	1.18	3.48	1.04	3.75	1.14
Gut Feeling	2.42	1.16	2.87	1.28	2.59	1.22

Table 10. Descriptive statistics for success of the IS/IT projects

	N	**Min.**	**Max.**	**Mean**	**Std. Deviation**
Meeting Project Budget Goals	70	1	5	3.73	0.93
Meeting Project Time Goals	70	1	5	3.54	0.91
Meeting Technical Requirements	70	1	5	3.89	0.89
Meeting Functional Requirements	70	1	5	3.79	0.87
Meeting Stakeholders Requirements	70	1	5	4.01	0.94
Average Success	70	1	5	3.79	0.75

5.2 Examining the effects on project success

The proposed hypotheses are tested and interpreted for the 70 completed IS/IT projects.

Hypothesis 1: There is a relationship between project size and project success.

An analysis of variance (ANOVA) is conducted to test Hypothesis 1. The one-way ANOVA test ($F(2, 67) = 0.468$, $p = .629$) revealed that there is not a statistically significant difference between the size of the projects in terms of success. Table 11 presents mean success, standard deviation, and number of projects for each project size.

Table 11. Project success by size

Size	**Mean**	***St. Dev.***	**N (70)**
Small	3.66	1.05	20
Medium	3.87	0.64	27
Large	3.81	0.56	23

p-value = .629

Hypothesis 2: There is a relationship between obligation towards project and project success.

An analysis of variance (ANOVA) is conducted to test Hypothesis 2. The one-way ANOVA test ($F(3, 66) = 5.018$, $p = .003$) revealed that there is a statistically significant difference between obligation of the projects in terms of success. A Tukey post hoc test revealed that purely discretionary projects ($M = 2.96$, $SD = 1.17$) have significantly lower mean success scores than mainly discretionary projects ($M = 3.95$, $SD = 0.68$), mainly mandatory projects ($M = 3.90$, $SD = 0.52$), and purely mandatory projects ($M = 3.90$, $SD = 0.63$). Table 12 presents mean success, standard deviation and number of projects for each level of obligation.

Table 12. Project success by obligation

Obligation	**Mean**	***St. Dev.***	**N (70)**
Purely Discretionary	2.96	1.17	9
Mainly Discretionary	3.95	0.68	16
Mainly Mandatory	3.90	0.52	27
Purely Mandatory	3.90	0.63	18

p-value = .003

Hypothesis 3: There is a relationship between employed system development methodology and project success.

An analysis of variance (ANOVA) is conducted to test Hypothesis 3. The one-way ANOVA test ($F(2, 67) = 1.292$, $p = .282$) revealed that there is not a statistically significant difference between system development methodology of the projects in terms of success. Table 13 presents mean success, standard deviation, and number of projects for each system development methodology.

Table 13. Project success by system development methodology

System Development Methodology	Mean	*St. Dev.*	N (70)
Waterfall	3.82	0.65	11
Agile	3.98	0.57	24
Uncertain/Unknown	3.66	0.87	35

p-value = .28

Hypothesis 4: There is a relationship between categories of employed IS/IT investment assessment methods and project success.

Simple regressions are performed to explain the relationship between success of projects and assessment method categories used in project evaluations: financial, strategic, organizational, and gut feeling. Table 14 provides the results for the four sub-hypotheses of Hypothesis 4 and each sub-hypothesis is examined in this section according to the results given in the table.

Table 14. Regression results for the relations between investment assessment method categories and project success

		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	R^2
		B	Std. Error	Beta			
H4a	(Constant)	3.151	.266		11.852	.000	.087
	Financial Methods	.209	.082	.295	2.548	.013	
H4b	(Constant)	3.042	.304		10.019	.000	.089
	Strategic Methods	.235	.091	.298	2.576	.012	
H4c	(Constant)	2.450	.311		7.887	.000	.227
	Organizational Methods	.382	.086	.476	4.468	.000	
H4d	(Constant)	3.606	.218		16.509	.000	.013
	Gut Feeling	.076	.081	.112	.930	.355	

Hypothesis 4a. This hypothesis is accepted ($p < 0.05$) and use of the financial assessment methods explain 8.7% of the variability in success.

Hypothesis 4b. This hypothesis is accepted ($p < 0.05$) and use of the strategic assessment methods explain 8.9% of the variability in success.

Hypothesis 4c. This hypothesis is accepted ($p < 0.001$) and use of the organizational assessment methods explain 22.7% of the variability in success.

Hypothesis 4d. This hypothesis is rejected ($p = 0.355$) and therefore use of gut feeling does not have a statistically significant effect on project success.

All three categories of assessment methods are found to have relations with project success. However, the variance explained by financial and strategic assessment methods are relatively low and each can only explain less than 10% of the variance in success separately. In contrast, use of organizational assessment methods alone can explain more than 20% of the variance in success. The direction of the relationship is positive for all assessment method categories. Use of gut feeling does not impact the project success either in a negative or in a positive way.

Hypothesis 5: There is a relationship between multi-criteria method use and project success.

An analysis of variance (ANOVA) is conducted to test Hypothesis 5. The one-way ANOVA test ($F(1, 68) = 6.460$, $p = .013$) revealed that there is a statistically significant difference between the projects where multi-criteria method is used and those which it is not used in terms of success. A Tukey post hoc test revealed that projects which have not used multi-criteria ($M = 4.02$, $SD = 0.64$) have significantly higher mean success scores than those which employ multi-criteria method ($M = 3.58$, $SD = 0.80$). Table 15 presents mean success, standard deviation, and number of projects for multi-criteria method.

Table 15. Project success by multi-criteria method

Multi-criteria Method	**Mean**	***St. Dev.***	**N (70)**
Not used	4.02	0.64	34
Used	3.58	0.80	36

p-value = .013

6. Conclusion

This study provides background on classifying IS/IT projects by their size and proposes a rule-based method for determining the size of a given IS/IT project as small, medium, or large. Existing approaches to measuring IS/IT project success are compared and a generalizable and relevant measurement model is presented. Moreover, categorizations for IS/IT investment assessment methods in the literature is analyzed and a new, more accurate categorization which consists of financial, strategic, and organizational categories is proposed. Statistical tests are then performed to analyze the extensive data collected for 110 IS/IT projects from different sectors with respect to the project characteristics, use of assessment methods, and their relationships with project success.

The findings indicate that employing more and variety of IS/IT investment assessment methods have a positive impact on the success of a project. Assessment methods falling under the proposed organizational category are shown to have a greater relationship with project success when compared with other method categories. Therefore, organizations should not rely only on traditional financial and strategic assessment methods but also consider organizational criteria in the pre-investment evaluation of IS/IT projects. Contrary to some findings in the literature [23], gut feeling is found as the least preferred method among all. Furthermore, it does not positively or negatively affect project success. Moreover, counter-intuitively, employing a multi-criteria method is found to have a negative impact on project success.

Project success is higher for mandatory projects. Although the reasons behind this must be explored in detail, presenting a project as mandatory within the organization might increase the chance of success. Other results show that small projects have the highest completion rate. Especially, the projects which have no links to other systems have a completion rate of 94%. However, it should be noted that incomplete projects do not necessarily mean canceled or

unsuccessful projects but might also be ongoing projects which will eventually be completed successfully. Yet, these results still carry useful insights for researchers and practitioners.

On the other hand, there exist certain limitations for the study. First, the size of the sample used in this study is 110. Information on project success is only available for 70 of them since only that number of the projects are completed. Findings can be more generalizable if hypotheses are tested with a larger sample size. Second, only 18 investment assessment methods are considered in the study. Even though the assessment methods are selected based on popularity in the literature and also professional views of the authors, other assessment methods can be added as well. Lastly, the data is collected via a self-reported questionnaire thus it is possible that respondents may give inaccurate/incomplete information.

Future research studies can test the extent of generalizability of our findings by collecting and analyzing survey data from various regions of the world, possibly with different cultures and levels of development. Moreover, less structured, rich, and useful information can be uncovered via conducting in-depth interviews, focus groups, and analyzing existing documents. A qualitative approach utilizing such data sources can be designed to provide methodological triangulation to further validate our findings. Additionally, an action research study can be conducted by implementing changes guided by the findings, and then collecting and analyzing evidence so that the findings are also validated in the real world.

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Appendix A. Questionnaire

Items for the questionnaire used in this study are listed below.

1. Which sector does your company fit the best?
   - List of supersectors from FTSE Russell [19]
2. If *Other*, please specify the sector of your company.
   - Free text input
3. What is the planned budget of the project?
   - Less than 50.000 TL
   - Between 50.000 TL and 250.000 TL
   - More than 250.000 TL
4. How many people work in the project, in terms of full-time equivalent staff?
   - Less than 5 people
   - Between 5 - 9 people
   - More than 10 people
5. What is the planned duration for the project?
   - Less than 4 months to reach operational status
   - 4 - 12 months to reach operational status
   - More than 12 months to reach operational status
6. How many departments are involved with the development of the project?
   - 1 - 2 departments
   - 3 - 4 departments
   - 5 or more departments
7. Which of the following statements best describes the proposed information system?
   - It has no link or only a few links to other systems and projects.
   - It has several links to the other systems and projects.
   - It has many links to the other systems and projects.
8. Which of the following statements best describes the problem that the project aims to solve?
   - The problem is easy to understand and define.
   - The problem has medium difficulty for understanding and defining.
   - Problem is difficult to understand and define.
9. Which of the following statements best describes the solution that the project aims to bring?
   - The solution is easily achievable.
   - The solution is achievable but not as easily.
   - The solution is unclear and difficult to achieve.
10. What type of system development methodology is employed in the project?
    - Agile
    - Waterfall
    - Unclear/Unknown
11. Which of the following statements best describes the organization's obligation towards the project?
    - Purely Discretionary: The organization have complete flexibility in undertaking the project as well as in choosing the time frame for its execution
    - Mainly Discretionary
    - Mainly Mandatory
    - Purely Mandatory: The organizations have no choice, but to undertake the project within a defined narrow time frame.
12. Please specify the degree of consideration for each of the following in decision-making process of the project investment. (5-point Likert scale: Not at all, Low, Moderate, High, Very high)

- Cost Benefit Analysis
- Payback Period
- Return on Investment
- Net Present Value
- Internal Rate of Return
- Technical Importance Assessment
- Competitive Advantage Analysis
- IT Portfolio Analysis
- SWOT Analysis
- Risk Analysis
- Value Analysis
- Human Resource Availability
- Administrative Necessities
- Legal Necessities
- Suitability for Development
- Operability after Deployment
- Opinions of Experts
- Gut Feeling

13. Have you applied an overall multi-criteria evaluation method (e.g., scoring models) using the investment assessment methods you considered?
    - Yes
    - No
14. Is the project completed?
    - Yes
    - No

The following questions are asked only if the project is completed. They use five-point likert scale: Very Poor, Poor, Acceptable, Good, Very Good

15. How did the project do in meeting project budget goals?
16. How did the project do in meeting project time goals?
17. How did the project do in meeting technical requirements?
18. How did the project do in meeting functional requirements?
19. How did the stakeholders of the project rate the success of the project?

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