The role of Real option in e-business Risk management: The case of E-treasury project

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ABSTRACT

Implementing information technology projects requires a calculated process to prevent failure. At the same time application of information technology in organizations faces various potential risks. Exploring information technology environment in organizations reveals the potential risks and provides a structure for comprehensive risk management. There are various methods available for risk management which the purpose of all these methods is proposing the most appropriate design for removing or minimizing the risk or reducing it to an acceptable level. One of these methods is real option approach. Real option theory is a right of decision making which potentially leads to value increase, although doesn't create any commitment to its owner. This theory, offers a new and more actual concept of opportunity evaluation and strategic risk evaluation which traditional evaluation methods usually ignore. The aim of this research, is explaining the role of real option in e-business risk management. The study is an applied research and is both qualitative and quantitative. The research method which was used is case study (e-treasury project). The target population includes managers and experts of the project which had managerial or practical experience of at least one e-business project (experience of transition from traditional mode to electronic mode). The findings suggest that a combination of various real options could be applied to financial, organizational, environmental, etc risks management. The results also indicate that real option to defer has the most application in projects' risk management.

Keywords

risk management, e-business, real option

1. Introduction

In today's world, electronic businesses are rapidly growing and have an increasing share in countries' economy. Because of cost and time savings of these kinds of businesses have grown recently. Iran with 23 million internet users and a great potential to increase capacity has a significant potential for e-businesses. Many factors affect the failure of these businesses including lack of basic business knowledge, inability to meet customer needs, lack of business plan or poor business plan, ineffective advertisement, insufficient procurement, inappropriate use of financial resources, and underestimate the e-business related risks and not leveraging suitable managerial tools for control and management.

E-businesses similar to traditional businesses also face various risks such as lack of profitability, weak strategy, inappropriate leadership, security defects, and privacy concerns, destroyed reputation, identity theft, losing intellectual property, over independence on sales person or other third party individuals, technology uncertainty and expertise unavailability. Such risks are considered a threat for e-businesses and much damage an organization's reputation and cause to losing of myriads of customers (Iwata, 2000). Due to damages of risks to e-businesses, risk management has become a research and application domain. Today there are various methods and tools for risk management which their aim is prioritizing and estimating the risk value and removing or minimizing the risk to an acceptable level (Vorster & Labuschagne, 2005). These tools and methods include risk avoidance, risk contracting, risk transfer, risk acceptance, risk planning and risk identifying. However, many authors have pointed out to the necessity of a comprehensive risk management method, which reduces the weaknesses of traditional methods (Saleh & Alfantookh, 2011). One of these

methods is real option theory which is a new and more actual concept of opportunity evaluation and strategic risk evaluation which traditional evaluation methods usually ignore. This theory contains environmental change and managers' authority for decision making in this changing environment. One framework among existing frameworks is option- based information technology risk management (OBIRM) which Benaroch (2006) has proposed for risk control and maximizing the value in information technology investments decisions. The basic logic of this framework is a set of mappings between risks and options. In this paper, after identifying the existing risks in e-treasury project, we corresponds them with real options based on this frameworks in order to control and manage them.

2. Theoretical foundations

2.1 Risk

There are diffelease definitions for risk; however, all contain a common concept. Risk is a deviation in outcomes. Risk in a general sense is the negative effect resulting from vulnerability considering probability of happening and its effect on a system's processes. For calculating the probability of an event (for example in an IT system), the existing and potential vulnerabilities of system are evaluated and analyzed. Its effect refers to the amount of damage that depends on sensitivity, accuracy and significance of system's elements and data (Stoneburner, Gogven, and Feringa, 2002).

2.2 Real option

Real option is like a roadmap in which guidelines and symbols have been embedded in it in diffelease locations which provide us the existing paths and options. Therefore it not only helps make appropriate decisions but also leads to individual's awareness increase and better learning. Decision making on investments in uncertain conditions is likely (Copeland, Keenan, 1998). For risk reduction, managers should be able to change their investment decision which requires new information about, prices, costs, etc. This implies managers' flexibility when encountering uncertainty. Managers' options and flexibility are underlying parts of real option theory. The real option theory, the right to make decisions that will potentially increase the value, but it does not create an obligation for the holder. When projects and decisions involving risk and a high level of uncertainty and also include opportunities for efficiency, the real power is used.

2.2.1 Various kinds of real options

Several t types of real options have been proposed by different authors:

- Option to defer: this option enables investor (manager) to achieve information about the uncertain results and outcomes, before investment and project onset (Benaroch & Kauffman, 2000).
- Option to prototype: refers to flexibility for partial investment in a prototype.
- Option to stage: refers to flexibility to stage an investment and divide it to diffelease phases and is important when there are complicated technical risks, user participation risks, architectural stability risk and project implementing risks (Benaroch et al., 2005).
- change Scale: refers to flexibility of expanding or contracting an investment and makes sense when one responds to technical and user participation risks. This flexibility has two dimensions:
  1) Project expansion which increases the project scale.
  2) Contracting the project which decreases the project scale (Gaynor & Bradner, 2001; Kulatilaka et al, 1999).
- Option to outsource: refers to flexibility of outsourcing the project development when the project development failure risk can be transferred to a third party which has required capabilities and experiences (Lammers & Lucke, 2004; Whang, 1992).
- Option to abandon: this flexibility leads to investment abandon and directing resources toward other alternatives and in fact secures the project from failure (Benaroch et al., 2005 and Brautigam at al., 2003).

Each real option should have required and sufficient conditions in order to play role in the project which these conditions have been completely described in Benaroch (2006) paper.

2.3 Risk management

Risk management is the process of identifying, evaluating and controlling potential accidental risks which its possible outcomes may cause damage or change in curlease situations. Risk management, managers risks by controlling them and funding the happened damages. There are various frameworks for risk management. One important framework is OBIRM (Option- based IT risk management).

2.4 OBIRM framework and risk reduction strategies

The basic logic of OBIRM framework is a set of fundamental mappings between risks and option which based on it provides a combination of options which creates the maximum value. Diffelease option types include: option to defer, option to abandon, option to stage, option to change scale, option to prototype, option to outsource and option to lease. The mapping between risks and option is done through

flexibility of real options and five risk reduction strategies which Boehm has proposed. These strategies are as follow:
1- Information requirement (purchase): this strategy helps to acquire information about strength of various risks by which the manager can accept or reject the investment. This strategy is implemented by using three types of real options:

- Option to defer: this option facilitates learning-by-waiting especially about monetary risk, organizational risk, competition risk, environmental risk and technological risk
- Option to prototype: this option is as an effective way to learn about the extent to which technical execution risk and technological risk can affect the system realization success.
- Option to explore (pilot): acquiring Information about how internal section (organizational units and users) and external section (competitors, suppliers …) respond to full scale investment.

2- Risk transfer: this strategy transfers risk from one part of project to another part and is implemented by using three types of real options:

- Option to stage: dividing a project into parts enables holding gateway reviews after each part in order to learn about project execution and technology maturity risks.
- Option to outsource: it has also been proposed that risk could be transferred to, or shared with, subcontractors and IT vendors via fee-based contracts (Benaroch, 2002).
- Option to lease (leaseing resources such as server, network and software). This option protects the project from risks emerging project development or implementation. Also it saves money through releasing the project resources.

3- Risk reduction: this strategy decreases the probability of risk and its outcomes this strategy is implemented by using two types of real options:

- Option to outsource
- Option to lease

4- Risk avoidance: this strategy avoids risk through changing the initial defined goals. This strategy is implemented by using two types of real options:

- Option to expand: this option with ability to expand initial planned goals, leads to reduction of consequences of infrastructural, organizational, environmental and functional risks.
- Option to contract: this option with ability to reduce initial planned goals, leads to reduction of consequences of technological, organizational, environmental, functional and executive risks.

5- Risk control: this strategy accepts the risks resulting from unmanageable factors and establishes more probabilistic plans in order to cover the realized risks. This strategy is implemented by using one type of real options:

- Option to abandon: this flexibility leads to investment abandon and directing resources toward other alternatives In particular for technology, environmental, organizational ,competitiveness and financial risks.

2.5 E-treasury

Based on SSM methodology and according to zero level of treasury and financial supervision process, e-treasury is defined as a system that:

- Performs payments and receipts of financial planning
- Supervises the government and governmental companies' revenues and centralizes them
- Allocates resources based on laws and regulations
- Supervises government's financial commitments and costs
- The expected features of e-treasury are as follow:
- A comprehensive system based on existing information technology infrastructure in Iran

Making the relationship among diffelease parts of e-treasury a systematic relationship

- Accounts coding
- The quality of inputs data
- Processes
- Reporting
- Interacting with economic environment
- Network security
- Information technology governance design
- Human capital training

3. Previous researches

Benaroch et al (2006) have studied the application of real option in IT projects risk management. Their results indicate that managers usually don't use real option theory in risk management although their natural intuition is significantly compatible with this theory. When various options are used in an investment project their combination can lead to risk reduction. Also results suggest that there is a clear relationship between IT projects risk management and the flexibility resulting from real option. Benaroch (2002) has studied risk management in IT projects based on real option approach. The results show that the real option is not inhelease in every IT investment; rather it should be planned and embedded deliberately.

Kochilla et al (2006) have studied risk management in supply chain based on real option approach. Results show

that one way for reducing the damages resulting from lack of cooperation, is increasing flexibility of supply chain and real option tools can be used to achieve this. By doing this, the manager can adapt his decisions with new conditions which no one can predict. Introducing the real option into supply chain may lead to more flexibility in the network for covering damages from market fluctuations.

Scott (2004) examined the measurement of dimensions of perceived risk in e-businesses. Results suggest that business owners can leverage some benefits by concentrating on their risks management in three dimensions: strategic risks, organizational risks and political risks.

Richardson et al. (2001) have studied the risk evaluation in e-commerce. Results show that companies' managers reveal potential electronic risks which are controllable which can lead to cost reductions.

4. Research method

This research is an applied one and is a combination of qualitative and quantitative research method. Due to the scientific nature of real option domain, the case study method was used. For data collection in qualitative section unstructured interview with e-treasury managers was used and two stages coding including open and pivotal coding was used for data analysis and the risks which e-treasury project faces with them were identified. Then these indicators of risks were corresponded with e-businesses risks in IT literature. During interviews planned reducing actions relevant to each risk were also identified. The data related to real options were acquired through library studies. In quantitative section in order to confirm the existence of risk indicators confirmatory factor analysis was used by SMART PLS software and these indicators were classified into 10 factors and were corresponded with classified risk factors in IT literature. To do this a questionnaire including 19 questions was distributed among managers and experts who were familiar with e-treasury project. In the next phase, the planned reducing actions for risk management were corresponded with 4 indicators including:

"Real option definitions", "risk reduction strategy", "previous researches about mapping IT projects risks and real options" and "required and sufficient conditions for presence of options". Finally a mapping between risks and real options was conducted. The target population included e-treasury project managers and experts which had at least one project managerial or executive experience (experience of transition from traditional mode to electronic mode). The sample size in qualitative section was enough for saturation. Therefore 6 persons were interviewed and the sample method was snowball purposeful sampling. The target population in quantitative section was 60 and the sample size based on Cochran's formula was calculated which was 52 persons.

5. Findings

5.1. Risks data

As table 1 show after analysis of interview, the risks existing in e-treasury project were identified.

Table1. Risk indicators of e-treasury project

risk indicators in e-treasury project	risk indicators in IT literature
lack of organizational support	organizational support
lack of timely contractors financial funding	organizational support
individuals resistance to change	resistance to change
change from cash accounting to commitment accounting	organization's environment instability
change in budgeting system	organization's environment instability
changes in law	organization's environment instability
difficulty of security dimensions management	security
balanced architecture	technical architecture stability
lack of plan for contractor selection	inappropriate/ lack of planning
lack of suitable plan for mc	inappropriate/ lack of planning
insufficient experience and skill of managers and contractors	team experience in client organization
management team's lack of integrity and coordination	project management experience and skill
IT technology maturity	novelty of IT/ new technology
treasury project size	project size
difficulty of curlease work processes	technical and tasks complexity
communication difficulty with large systems such as tax and customs systems	insufficient infrastructure for implementation
scope's lack of transparency	scope's lack of transparency
lack of supervision on system performance	perception of maintenance
ambiguity of project's benefits	unknown benefits

5.2 Data related to risk mitigations

These actions are described in table 2 which resulted from interviews

Table 2- Planned reducing actions for each risk

Risk indicators	Risk mitigations
lack of organizational support	- project abandon
lack of timely contractors financial funding	- negotiation with management - follow up through budgeting section - revising and changing the budget laws and computerizing them
individuals resistance	- justification meetings and workshops - change culture - project transparency
change from cash accounting to commitment accounting	- providing law attachments of change - providing a system based on both situation - the necessity of system's flexibility
change in budgeting system	- providing law attachments of change - providing flexible e-treasury system
changes in law	- finalizing all the laws changes - predicting the scope of changes in laws
difficulty of security dimensions management	- interaction with intelligence for security concerns - use of secured protocols - receiving advice from security companies - thinking on alternative platforms
balanced architecture	- the goals of e-treasury project should be approved - proposed operational processes which are aligned with goals should be approved - new structure based on e-treasury design should be approved - required laws should be approved
lack of plan for contractor selection	- classification and selection of contractor by unions
lack of suitable plan for mc	- no action identified
technical and managerial skills managers and contractors	- establishing the plan management system - necessity of presence of project manager - a contractual structure which an mc undertakes project implementation and management - financial guarantee and commitment - contractor change - serious reaction for management change
managements team's lack of integrity and coordination	- converging thoughts - justification sessions
IT technology maturity	- leveraging best performances in e-treasury design and implementation - linking treasury mission with e-treasury - considering processes alignment with individual by using IT
treasury project size	- dividing to stages for development and implementation - general design and implementing in phases - contracting the treasury scope
difficulty of curlease work processes	- processes reengineering before starting the project
communication difficulty with large system such as tax and customs systems	- interaction with entities for data base and shared systems - participation of institutions in e-treasury design and implementation - lack of dependence on communication platform
scope's lack of transparency	- interaction with top and down entities - considering the curlease scope - integration of scope
lack of supervision on system performance	- establishing integrated structure
ambiguity of project's benefits	- defining the measures of e-treasury profitability - providing key performance indicators for each subproject

5.3 The results of confirmatory factor analysis

19 risk indicators which were identified in the project are classified in 10 factors (table 3). Results show that all indicators have load factor greater than 0.4 which confirms the existence of risks. Then the risk factors resulting from this analysis are corresponded with risk factors in IT literature.

Table 3- The results of confirmatory factor analysis

risk factors (constructs)	risk indicator name	risk indicator (question)	load factors	risk factor in IT literature
support	lack of organizational support	a1	.867	organization support/organizational change
	lack of timely contractors financial funding	a2	.689	
	individuals resistance to change	k	.522	
environmental change	changing account system	b1	.791	organization's environment chaos
	changing budgeting system	b2	.796	
	changing general accounting law	b3	.667	
project security management	security dimensions management	C11	.926	security
		C12	.682	
planning	lack of plan for contractor selection	d1	.895	risk/project management
	lack of suitable plan for mc	d2	.905	
skill, experience and integrity	insufficient experience and skill of managers	e1	.847	expertise
	lack of integrity and coordination of management team	e3	.850	
architecture stability	balance architecture/ architecture stability	C21	.781	architecture instability
		C22	.854	
size, complexity and scope	project size	g1	.471	size/technical and task complexity/scope change
	difficulty of curlease work processes	g21	.755	
		g22	.737	
	scope's lack of transparency	i	.772	
technology maturity	IT technology maturity	f2	1	new technology
profitability	ambiguity of project's benefits	j	1	profitability
system monitoring and interorganizational communication	lack of supervision on system performance	h3	.739	
	communication difficulty with tax and customs organizations	h1	.758	

5.3.1 Comparing the amount of correlation between a construct indicators and that construct with correlation of those indicators with other constructs (cross loading)

Table 4 shows the results of factor analysis in which indicators of each construct have greater correlation with their construct than correlation with other construct

5.4 Corresponding risk reducing actions with real options in the project in final stage based on following four indicators:

1- Real options definitions 2- Risk reduction strategy 3- Previous researches about mapping IT projects risks and real options 4- Required and sufficient conditions for presence of options, a mapping between reducing actions and real options was done. For instance, regarding project size risk, according to table 2, the project managers can overcome risk by dividing the project to stages (option to stage).

Table 4- The results of correlation between constructs and indicators

	support	environmental change	architecture stability	planning	skill, experience and integrity	size, complexity and scope	system monitoring and interorganizational communication	project security management	profitability	technology maturity
a1	.867	.219	.361	.487	.587	.549	.465	.479	.474	.318
a2	.689	.270	.142	.293	.266	.240	.266	.324	.177	.287
h2	.522	-.106	-.097	.109	.379	.460	.181	.182	.046	.249
b1	.392	.791	.093	.169	.090	.312	.085	.363	.079	.089
b2	-.049	.796	.345	-.043	-.221	.172	-.074	.173	.013	-.004
b3	.01	.667	.235	.019	-.023	.277	.006	.289	-.103	-.014
C21	.258	.329	.781	.232	.158	.404	.184	.334	.211	.170
C22	.19	.124	.854	.457	.351	.240	.482	.264	.261	.012
d1	.444	.005	.412	.895	.594	.421	.625	.270	.474	.383
d2	.406	.159	.368	.905	.721	.523	.684	.287	.404	.315
e1	.478	-.099	.329	.577	.847	.462	.688	.263	.332	.246
e3	.556	.052	.216	.665	.850	.574	.531	.409	.260	.392
g1	.256	.389	.031	-.074	.065	.568	.012	.261	.145	-.01
g21	.361	.158	.444	.439	.574	.794	.517	.387	.335	.794
g22	.547	.360	.025	.280	.339	.696	.475	.379	.243	.696
I	.0481	.215	.380	.527	.506	.796	.563	.567	.373	.521
h1	.195	.091	.581	.595	.491	.436	.758	.260	.276	.126
h3	.511	-.05	.043	.492	.585	.549	.739	.151	.392	.469
C12	.316	.203	.209	.104	.306	.363	.159	.926	-.110	-.187
C11	.476	.394	.353	.342	.348	.5564	.271	.682	.357	.268
J	.401	.006	.290	.487	.349	.420	.445	.235	1	.469
f2	.396	.045	.102	.387	.376	.580	.394	.134	.469	1

On the other hand this kind of risk is classified as project implementation risks which based on OBIRM framework, the project implementation risks could be managed by option to stage which also is a kind of risk transfer. Also according to the results of researches conducted by Boehm (1988) and Trigeorgis Panayi (1998) and Erdogmus & Favaro (2002), there is a positive relationship between project implementation risk and option to stage. On the other hand, option to defer also exist in the project and can be used to manage this risk. Also according to table 2, project managers can overcome the risk by actions such as "contracting the scope of e-treasury" and "downsizing the project scale" which is correspondent with option to contract. On the other hand, this risk according to IT literature is classified as project implementation risk which based on OBIRM project, implementation risks can be managed by options to contract and the corresponding strategy is risk avoidance. Also according to researchers conducted by Kambil et al (1993), Boehm (1988), Sullivan et al. (1999), Erdogmus & Favaro (1999) and Kim & Saunders (2002), there is a positive relationship between project implementation risk and option to contract. On the other hand option to defer exists in the project and can be used to manage this risk. For risk of work processes difficulties, according to table 2, the managers can overcome this risk by actions such as "processes reengineering" before starting the project which corresponds to option to defer. This risk is classified as project implementation risk based on IT literature that implementation risks can be managed by option to defer based on OBIRM framework. That, by the delay before the start of the project management and doing these mitigations, access to information about the severity of the risk and decide

to invest or to reject it. In fact the strategy for risk reduction is access to information. The results of Boehm (1988) shows that there is a positive relationship between project implementation risk and option to defer. On the other side, according to the necessary and sufficient conditions for the presence of real options, presence this option in the project and can be used to manage this risk. About scope's lack of transparency risk, according to table 2, the managers can overcome this risk by actions such as "interaction with top and down entities and integration of scope" before starting the project which corresponds to option to defer. This risk is classified as project implementation risk based on IT literature that implementation risks can be managed by option to defer based on OBIRM framework. That, by the delay before the start of the project management and doing these mitigations, access to information about the severity of the risk and decide to invest or to reject it. In fact the strategy for risk reduction is access to information. The results of moran (2002) shows that there is a positive relationship between project implementation risk and option to defer. On the other side, according to the necessary and sufficient conditions for the presence of real options, presence this option in the project and can be used to manage this risk. Also according to table 2, managers can overcome this risk by actions such as "considering the current scope" which reduces project size and is correspondent with option to contract. This risk is classified as project implementation risk based on IT literature that implementation risks can be managed by option to contract based on OBIRM framework . Thus, taking into account the current scope of project, changes in project goals are defined and avoid the occurrence of these risks. The strategy for this risk is risk avoidance. According to Boehm(1988) and Erdogmus and Favaro(2002), there is a positive relationship between project implementation risk and option to contract. On the other side, according to the necessary and sufficient conditions for the presence of real options, presence this option in the project and can be used to manage this risk.

The three risk indicator classified as risk factor "size, complexity and scope of". For other risks, correspondence between the mitigations and real options in detail in a thesis entitled "The role of real option in risk management businesses, Treasury Electronic Case Study Project" is given (Hatami, 2015).

5-5 Final mapping between risk factors and real options

three indicators including: "project size", "work processes difficulties" and "scope's lack of transparency" were classified and integrated into a new factor named "size, complexity and scope" by confirmatory factor analysis which according to IT literature are classified as project implementation risks. This risk factor could be managed by three real option types including: option to defer, option to stage and option to contract.

6. Discussion and conclusion

The results of this study show that 19 risk indicators are classified in six general categories including: organizational, environmental, project implementation, exploitation, financial and technological. Results also indicate that organizational risks could be managed through option to defer and option to abandon. These findings are consistent with the results of Benaroch et al. (2005). Environmental risks category could be managed by option to defer, option to prototype, option to outsource, option to stage and option to contract. This finding is confirmed by the previous researches including: Clemons & Weber (1990), Whang (1992), Kambil et al. (1993), Sullivan et al. (1999), Gaynor & Brander (2001), Erdgomus (2002). Financial risks category are manageable by option to defer and is confirmed by Benaroch & Kauffman (200), Shwartz & Zozaya (2003). Technological risks category could be managed by option to defer and option to outsource and finally exploitation risks category are manageable by option to defer and option to prototype which is consistent with Moran (2002).The findings show that there is relationship between identified risk factors and real option combinations. With assigning 1 to option existence and 0 to lack of option, we are able to test the correspondence between risk factors and real options and prioritize the real options which are used to manage that risk. So we propose a future research on: designing a real options decision tree used for IT projects risk management. On the other hand, previous researches show that if profitability and costs of projects are measurable, we can calculate the quantitative value of each real option by calculating the net present value (NPV). Therefore we propose a research on modeling real options value in IT projects to be done. Organizations and businesses which are in transition stage from traditional mode to electronic mode can also use the results of this study. Also in it projects such as electronic purchasing, employees' automatic monitoring systems, electronic files management system and e-insurance development which encounter with organizational, environmental and technological risks, real option could be used to risks management. We propose a research be conducted on the role of real options in IT projects which considers each of the above examples as case study.

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