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Perspective on Information Requirement Determination Practices in Kuwait: Familiarity, Usage and Perceived Value

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Abstract

Few studies have examined how Information Requirement Determination (IRD) is practiced in the Arab world. To lessen the gap, this empirical study reports on the perception of 19 IRD methods in Kuwait, an Arab country. Based on a sample of 87 software stakeholders, this study reports on the most known, widely used and highly valued IRD methods. Results show that Arab culture influences perception of IRD techniques in that: (i) the most used is the traditional technique (interview), followed by the formal analysis technique (DFD), and group elicitation technique (brainstorming); (ii) the most valued techniques from past projecst are external representation techniques (Decision trees), followed by unstructured elicitation techniques (goal oriented elicitation), and observation technique (prototyping); and (iii) the least known, used and valued techniques are UML, Ishikawa and cognitive technique (KJ- methods). In addition, the study reveals some additional factors that affect IRD practices such as the existence of a correlation between past IS project problems and the usage of three techniques (QFD, DFD and role playing), the existence of a correlation between two techniques (prototyping and decision trees) and the statement "obtaining the right requirements is essential to successful system development". Other correlations were also found between some IRD techniques and specific used information system development methodologies. This paper discusses findings which are relevant to theory and practice.

Keywords

Information requirements determination, empirical study, state of RE practice, Kuwait industry, requirement gathering, requirements elicitation, requirement presentation, system development.

INTRODUCTION

It has been often and convincingly argued that Information Requirements Determination (IRD) is the most critical phase of system development (SD) (Kotonya and Sommerville 1998; Browne and Ramesh 2002; Hickey and Davis 2003; Mathiassen et al., 2007). Poor IRD execution will almost guarantee that the final project is a complete failure. The Standish group survey reveals that inappropriate IRD or the absence of an appropriate technique is one of the main reasons for unsuccessful SD projects (Anonymous 2008). The study of Beecham et al. (2003) found that IRD determination is a major concern of system developers. IRD occurs early in SD in order to obtain requirements relevant to software stakeholders. The later in the SD life cycle that a software error is detected, the more expensive it will be to repair (Kotonya and Sommerville 1998). IRD is the process by which system analysts build an understanding of end-users' needs for an information system. This process is also termed " requirement engineering".

IRD process includes three stages: information gathering (elicitation), representation, and verification (Browne and Ramesh 2002). The quality of this process could be improved by the use of many techniques. During the information gathering stage, system requirements are determined based on the *problem* that needs to be solved, *system boundaries, stakeholders,* and system *goals*. System boundaries define where the final delivered system will fit into the current operational environment. Stakeholders are individuals or organizations who stand to gain or lose from the success of failure of a system, and those who may be affected by the development of a new system. Stakeholders include customers (who pay for the system), developers (who analyze, design, construct, and maintain the system), and en-users (who use and interact with the system to get the work done). Goals denote the objectives of a system that must be met. Outcome of information gathering is used as input to the second stage, "representation", in which different representational techniques may be used to document the elicited requirements. These representations are then typically used to help verify that the requirements elicited

are in fact correct. Users then sign a requirements document, and the diagrams representing the requirements are given to a systems designer.

Much has been written about IRD over the past thirty years. Many of these studies focused on several issues related to IRD techniques, including problems associated with IRD (Browne and Ramesh 2002); the process of IRD (Nuseibeh and Easterbrook 1998; Browne and Ramesh 2002), the selection of IRD elicitation techniques (Hickey and Davis 2003), the improvement of IRD techniques (Hickey and Davis 2003), proposing new IRD techniques (Hickey and Davis 2003), the effectiveness of requirements elicitation techniques (Davis et al., 2006), the conditions when specific techniques might or might not be applicable (Kotonya and Sommerville 1998), and literature review studies and perspectives for future research directions (Mathiassen et al., 2007).

Because the process deals with software stakeholders, several problems are associated with IRD (Byrd et al., 1992; Kotonya and Sommerville 1998; Browme and Ramesh 2002) including: (i) system analysts lack an understanding of the business; (ii) requirements don't reflect the real needs of the customers; (iii) requirements are inconsistent and/or incomplete; (iv) it is expensive to make changes to requirements after they have been agreed upon; and (v) there are misunderstandings between customers and developers. This miscommunication can cause mismatches between what end-users say and what requirements system analysts understand. Besides limits on human information processing and the heuristic nature of problem-solving, the attempt to build consistent and complete requirement models is futile. IRD in modern research on information system is more observed as a dynamic process associated with frequent requirement changes, negotiations to resolve conflicts, and search for consensus among software stakeholders without weakening satisfaction of each stakeholder's goals (Browne and Ramesh 2002).

While many IRD techniques were proposed by academia to overcome the above problems, existing studies provide limited insight into when a specific technique might or might not be applicable or used by analysts (Hickey and Davis 2003). This led some studies to notice the existence of a gap between academic and industrial practices (Matulevicius 2005). Kaindl et al., (2002) observed that "*past research results in IRD have been developed without much interaction with or impact on industrial practice*". They also added that "*there seemed to be little use of the concepts, techniques and tools developed by requirement engineering researchers which had been developed specifically to address the complex requirements of large-scale systems development*". The situation has since improved, but we advocate in this study that not all IRD techniques are accepted or adopted by practitioners, and academic suggestions seldom find applicability in practices. Therefore, additional empirical studies related to the perception of IRD techniques are encouraged.

In trying to approach this issue, this study finds very few empirical studies that show how proposed IRD techniques are perceived by practitioners (in term of knowledge, use and perceived value), and almost no study that shows whether such perceptions vary from one culture to another. Thus, empirical research is the first step to find out how organizations perceive IRD techniques proposed by academia and to gather knowledge about possible improvements.

In order to bridge the gap between academia and industry, this study focused mainly on IRD methods in Kuwait for the following five reasons. *First*, this study observes that most previous studies focused on IRD in developed countries (i.e. in western cultures) with very few exceptions in developing countries with non-western cultures. *Second,* The Arab world includes 22 countries which share a similar culture, values, language, history and geographic location. Kuwait is one of these countries, which is also a developing country, where no past study was dedicated to IRD. In the Arab world, little is known about how IRD is practiced. Also, most studies mainly focused on issues related to systems' acceptance and satisfaction; for a summary of past studies see Rouibah (2008). *Third*, most IRD techniques emerged in western developed countries and the transfer of these techniques to the Arab world may reveal differences in applications compared to the western developed world. The context in which IRD techniques take place is usually a human activity. Therefore, looking at the social practice of SD is an important research direction of current information systems. In addition, the selection of a requirement technique involves uncertainty in decision making. We, therefore, expect that the perception/value of IRD techniques may vary between countries that belong to different cultures. To strengthen this hypothesis, we refer to the work of Hofstede (2008) who characterized culture by four dimensions including the tendency of *uncertainty avoidance*. For comparison purposes, it does not need to measure these four dimensions of national culture, but rather to use the index of the country in the original work of Hofstede, where he gave every country an index of each dimensions. For example, the USA and Kuwait scored 46 and 68 respectively on uncertainty avoidance, leading to different perceptions on the propensity to take risk (i.e. Americans are more likely to take risk than Kuwaitis). In line with this statement, several cross cultural studies found that culture affects technology transfer in the Arab world (e.g. Loch et al., 2003; Rouibah 2008), and elsewhere (Martinsons and Davison 2007). Finally, authors of the study observed through their experience that many systems failed in Kuwait mainly because of problems related to the IRD (completeness, relevancy and miscommunication) process, which is also observed elsewhere (Anonymous 2008). Globalization creates a need to know how managers in different cultures make decisions and how computer based information systems can support

decision making. Understanding how IRD is perceived in Kuwait is a first step toward understanding the Kuwait environment.

In order to shed light on IRD in Kuwait, this study aims to answer the following questions: What are the most well-known IRD techniques? What are the most widely used IRD techniques? Of these techniques, which IRD technique is perceived to have the highest value from past SD projects? How is IRD practice different in Kuwait than in other countries?

In the next section, a summary of relevant literature related to above issues is discussed.

RELEVANT LITERATURE REVIEW

In order to address a literature review that touches some aspects of the research questions, the authors researched several online databases. We searched well-known databases such as Inspec, ScienceDirect and CiteSeer based on the descriptors "empirical studies", "requirement elicitation", "perception of elicitation techniques", "perception of requirement engineering techniques" and "requirement elicitation and developing countries". Results show very few research papers that deal with our research questions. With regard to the study objectives, our analysis of the current literature review highlights the four observations.

First, a variety of techniques have been proposed to assist the IRD process and decreasing communication problems between software stakeholders (e.g. Byrd et al., 1992; Kotonya and Sommerville 1998; Nuseibeh and Easterbrook 2000; Browne and Ramesh 2002; Mathiassen et al., 2007). Byrd et al., (1992) proposed many techniques in order to overcome communication obstacles that may be encountered during IRD. These techniques were grouped in five categories. To make the paper shorter, we only cited observation techniques, unstructured elicitation techniques, mapping techniques, formal analysis techniques, and structured elicitation techniques. Browne and Ramesh (2002) discussed an IRD process that includes three stages, determined a list of problems associated with this process, and proposed a list of IRD techniques to overcome these problems. These techniques were grouped into four categories: (i) pre-elicitation conditioning, (ii) direct prompting techniques, (iii) indirect prompting techniques, and (iv) external representation techniques. Nuseibeh and Easterbrook (2000) discussed an IRD process and proposed six categories of techniques. These are traditional techniques, group elicitation techniques, prototyping, model-driven techniques, cognitive techniques, and contextual techniques. Mathiassen et al., (2007) analysed 116 quality journal articles drawn from the requirements and software development literature. Authors classified 85 IRD requirement techniques into four categories: discovery, prioritization, experimentation, and specification techniques.

Second, there is an abundance of studies that focused on process view (how IRD could be improved) (e.g. Browne and Ramesh 2002; Byrd et al. 1992; Hickey and Davis 2003; Kaindl et al. 2002; Kotonya and Sommerville 1998; Mathiassen et al. 2007), but very few studies focused on empirical IRD techniques. Despite the availability of many techniques, Davis et al. (2006) observed little research that measured the effectiveness of various IRD techniques. Bostrom (1989) conducted an action research regarding the implementation of an integrated human resource system at a large American university. He used a model to improve communication between system developers and end-users that integrates several IRD techniques including interviews, Joint Application Design (JAD), prototyping, DFDs, and brainstorming. Karlsson et al. (2002) interviewed seven employees at five software development German companies. They found that simple techniques for basic needs were used. All the companies used natural languages to define their requirements. Two of the companies used Unified Modelling Language (UML) and one of these used flow charts. Verner et al. (2006) revealed additional findings with regard to the success of projects and practices of IRD. Based on 133 respondents who reported on 133 projects, the authors found that gathering requirements with a specific technique was not significantly associated with good IRD. Only 56% of projects had no defined requirements gathering techniques, 13% used only interviews, 4 projects used prototyping, 10 used JAD, and 7 projects used UML to document their requirement. Matulecvicius (2005) surveyed IRD process practices in a sample of 28 Lithuanian software development companies. Results indicated that many IRD techniques were used. Natural language was the most used technique, followed by flow charts, Data Flow Diagrams (DFD), use cases, and UML. Kontio et al. (2004) found that focus groups are cost effective and provide a quick empirical research approach for obtaining qualitative insights and feedback from practitioners. They also found that affinity diagrams (similar to the KJ method) are useful and effective.

Davis et al. (2006) made a systematic review of 26 published empirical studies concerning the effectiveness of elicitation techniques. They found that interviews appear to be one of the most effective elicitation techniques in a wide range of domains and situations. Also, they did not find the use of intermediate representations (e.g. DFD) to have a significantly positive effect during elicitation.

According to Hickey and Davis (2003), analysts' selection of a particular IRD technique encompasses any combination of four reasons: (1) it is the only technique that the analyst knows; (2) it is the analyst's favourite technique for all situations; (3) the analyst is following some explicit methodology, and that methodology

prescribes a particular technique at the current time; and (4) the analyst understands intuitively that the technique is effective in the current circumstance. Surprisingly, no empirical study investigates how analysts perceive existing IRD techniques.

Third, despite the number of IRD studies underlining the challenges of IRD for market-driven software products (Karlsson et al. 2002), little effort has been made to effectively establish a link between research and practice in the IRD field (Pinheiro et al. 2003). Several techniques have been proposed in IRD literature. However, the research results are not fully transferred into mainstream industrial practice (Kaindl et al. 2002). For example, Kaindl et al. (2002) investigated the difficulties of introducing IRD research results into practice. In an attempt to shed light on the issue, the authors described obstacles that researchers and practitioners encountered when they attempted technology transfer from academia to the industry. In addition, major incentives for using IRD techniques are discussed, along with ideas for improving current practices. Three obstacles faced during technology transfer efforts are: (a) cultural differences between universities and industrial organizations, (b) pressures to transfer poor research solutions and untested methods/prototypes, and (c) attempts to transfer research disconnected to the real problems faced in industry.

Fourth, as previously stated, there are very few studies related to IRD in developing countries (Arnott et al. 2007; Thanasankit and Corbitt 2000) compared to those in developed countries such as in North America and Europe. Thanasankit and Corbitt (2000) found that Thai culture does influence IRD elicitation techniques. In addition, the authors listed a number of techniques frequently used by Thai system analysts. These techniques include: interviews, goal-oriented elicitation, scenarios based requirement elicitations, form analysis, and tasks analysis. Arnott et al. (2007) examined SD in Thailand and identified several IRD techniques used to develop executive information systems. Among the frequently used ones, brainstorming was used by all four companies they studied. Interviews, flow charts, and DFDs were used by three companies. Prototyping, questionnaires, and decision trees were used by only two companies. Lastly, affinity diagram and rapid application development were used only by one company.

The question of which technique is the most well-known, among those suggested in the literature, most widely used, and allows software stakeholders to generate the highest value from past information system projects has not been appropriately addressed. This has led some authors (Bostrom 1989; Byrd et al. 1992) to criticize existing IRD techniques and considers them as designed based on common sense and intuition of the technique's designers (rather than being based on empirical evidence). Byrd et al. (1992, p. 133) called for further empirical IRD research, stating, "*empirical tests need to be done to determine which of these techniques are the most effective*".

The next section explains how this study answers the previous research questions with regard to the selection of a sample of selected IRD methods.

METHODOLOGY

This study develops a questionnaire instrument to assess the perception of 19 IRD techniques that support the IRD process, that is, gathering, representation, and verification (Hansen et al., 1998; Hoffer et al., 2005; Kontio et al., 2004; Mathiassen et al., 2007; www.skymaker.com). Of these techniques, 15 were cited in Mathiassen et al. (2007) and were grouped in seven categories. The first, *traditional techniques,* includes a broad class of generic requirement gathering techniques such as surveys, and interviews. The second, *group elicitation techniques,* aims to foster stakeholder agreement. They include brainstorming and focus groups, as well as JAD workshops. The third, *observation techniques,* aims to gather requirement by observing stakeholders doing a task. It includes observation and prototyping. The forth, *cognitive technique,* aims to gather knowledge of stakeholders which are complex to gather. It includes the KJ method. It has the name of its creator, Kawakita Jiro, and organizes and categorizes information, beliefs, and/or arguments or requirement through ideas associations flow. The fifth technique, *unstructured elicitation* techniques, aims to transform the investigator/ respondent relationship into a participatory relationship. This category includes goal-oriented elicitation, scenarios and role playing. The sixth, *formal analysis techniques, is* used to gather, represent, and verify system requirement. This category includes data flow diagram, use case, and UML. The seventh or last category, *external representation techniques,* includes five techniques (see Table 1). Ishikawa based on the Japanese professor who developed it. It is a graphical representation that helps identify, sort and display possible causes/consequences of a problem or quality characteristic of an IS. It is also known as a fishbone diagram because of its shape. *Fault Tree Analysis* is a logical, structured process than can help identity potential causes of an information system failure before the failure actually occurs. A *decision tree* is a graphical representation technique in which decision situation points (nodes) are connected together by arcs (one for each alternative on a decision) and terminate in ovals (the action that is the result of all the decision made on the path leading to that oval). It is used to increase communication between software stakeholders.

Table 1. Categories of IRD techniques, support for IRD process and theoretical support

Category	Technique	IRD phases
Traditional techniques	1. Interviews	Gathering
	2. Survey	Gathering
Group elicitation techniques	3. Brainstorming	Gathering, representation
	4. JAD workshop	Gathering, representation
	5. Focus group	Gathering, representation
Observation techniques	6. Prototyping	Gathering, representation, verification
	7. Observation	Gathering
Cognitive techniques	8. K.J. Method	Gathering, representation, verification
Unstructured elicitation techniques	9. Goal-Oriented Elicitation	Gathering, representation
	10. Scenarios	Gathering
	11. Role Playing	Gathering, representation, verification
Formal analysis techniques	12. Data Flow Diagram (DFD)	Gathering, representation, verification
	13. Use Cases	Gathering, representation, verification
	14. Unified Modelling Language (UML)	Gathering, representation, verification
External representation techniques	15. Quality Function Deployment (QFD)	Gathering, representation, verification
	16. Flow Charts	Gathering, representation, verification
	17. Fault Tree Analysis	Gathering, representation, verification
	18. Decision Trees	Gathering, representation
	19. Ishikawa	Gathering, representation, verification

A questionnaire was developed in three steps. In the first step, the authors and another two Kuwait University faculty members established a list of 33 techniques mostly cited in Mathiassen et al. (2007) as frequently used in previous studies. In the second step, the authors examined the feasibility of this list of techniques by a pilot study with 15 software stakeholders, from different companies, selected based on their expertise on the SD environment in Kuwait. Those participants were asked whether the 33 IRD techniques are known. Of these techniques, 17 techniques scored less 10% and thus were eliminated. In addition, *free text* questions were also included in order to suggest additional techniques. In the third step, three additional techniques "Fault tree analysis, decision trees, and Ishikawa" were added to the list, leading to the 19 techniques used in this study.

The questionnaire included many items related to four categories. The first one measured the demographic characteristics of the respondents. The second category contained items related to SD within the organization. The third category contained items related to the 19 IRD techniques. The subjects were provided with the list of techniques and were asked to: indicate whether: (i) they were familiar with the technique; (ii) they had used it; and, (iii) what their perception about its overall value derived from past projects the respondents were involved (i.e. which technique did the respondent believe it gave him the highest value/benefit based on past projects carried out [with a scale from "no value" (1) to "great value" (5)] if they had used it). The fourth category measures the perception of the respondents with regard to two critical success factors on a five-point Likert: "*obtaining the right requirements is a critical success factor for system development*" and "*We experienced problems during past system developments projects because of problems in IRD process*". The word "*right*" in this statement/ paper is used to refer to relevant requirement obtained by negotiation/consensus among involved software stakeholders.

In order to ensure that the variables (research constructs) were internally consistent, a reliability assessment was carried out using Cronbach's alpha. A low value (i.e. α close to 0) implies that the variables are not internally related in the manner expected. Reliability analyses show all variables exhibit Cronbach's alpha values between 0.95 and 0.96

A survey was designed and administrated to Kuwaiti organizations. The study used subjective and non-probability sampling methods to select participants. The sample included Kuwaiti organizations that had an IT department from different economic sectors (a total of 175 organizations were selected). An IT manager within each organization was personally contacted, and the questionnaire was delivered to him.

87 replies (out of 175) were received, resulting in a gross response rate of about 50 percent. The response rate was well within expectation (since the organizations were contacted personally).

RESULTS & DISCUSSION

The following sections contain the statistical analyses used in this study.

Demographical data

About 66.3% of respondents had less than 10 years experience with their organization. About 40% of the sampled respondents work in a public organization, and 60% work in the private sector. 59.3% of organizations had less than 500 employees, while 40.7% were considered large organizations (more than 500 employees). About 54% of respondents worked in the finance, banking, insurance, and IT consulting sectors.

Table 2 provides more insights about SD. 24% of the respondents reported in house SD; about 12.6% used outsourcing, while 63% use both in-house development and outsourcing. Table 2 also shows the methodologies used for system development by the respondents. Structured analysis and design, agile software development, and Object oriented analysis and design accounted for about 60% of the methodologies used.

Table 2. Behaviour toward SD methodologies

How IS are developed?	**Cited**	**%**
Company develops its own systems	21	24.13
Company outsources its IS development	11	12.6
Company develops and outsources	55	63.27
SD Methodology	**Cited**	**%**
Structured analysis and design	18	20.68
Agile software development	16	18.39
Object oriented analysis and design	15	17.24
Prototyping	8	9.19
Joint Application Design (JAD)	5	5.74
More than one methodology	25	28.73

According to Table 3, 94.25% of the respondents “strongly agree” and “agree” that obtaining the right requirement is a critical success factor (CSF1) for SD. In addition, 88.2% “strongly agree” and “agree” that they have experienced problems during their past SD projects because of problems in the IRD process (CSF2).

Table 3. Perception of IRD problems

	Obtaining the right IRD is a critical success factor for SD (CSF1)		**We experienced IRD problems during past SD projects (CSF 2)**	
	Cited	Frequencies	Cited	Frequencies
Strongly Agree	64	73.5	45	51.72
Agree	18	20.7	30	34.5
Neutral	4	4.6	10	11.5
Disagree	1	1.14	2	2.3
Strongly Disagree	0	0	0	0

Perception of familiarity, usage and value of IRD techniques

Table 4 below shows a listing of the most familiar IRD techniques. Table 5 shows a listing of the most used IRD techniques. And finally, Table 6 shows a listing of the techniques perceived to have the highest value for SD.

Table 4. Familiarity with IRD techniques

Techniques		Frequency	%	Techniques		Frequency	%
1.	Interviews	85	98	11.	JAD workshops	63	72
2.	Surveys	77	89	12.	Role Playing	54	62
3.	DFD	76	87	13.	QFD	50	57
4.	Brainstorming	75	86	14.	Fault Tree Analysis	44	51
5.	Decision Trees	70	80	15.	UML	42	48
6.	Scenarios	69	79	16.	Flow Charts	35	40
7.	Observations	69	79	17.	Goal-Oriented Elicitation	33	38
8.	Focus group	68	78	18.	K.J. Method	9	10
9.	Prototyping	66	76	19.	Ishikawa	6	7
10.	Use Cases	64	74				

The table above shows a listing of the most familiar IRD techniques. It can be seen that traditional techniques (interviews and surveys) are the most familiar and known, followed by formal analysis technique (DFD) and group elicitation technique (brainstorming). As can also be seen, external representation techniques (Ishikawa and KJ- methods) are the least known techniques.

From Table 5, we can note several observations: (i) half of the proposed techniques are being used in IRD process by more than 50% of respondents; (ii) interview, a traditional technique, is the most known and used, DFD as a formal analysis technique is the second used technique, even though it is ranked third among the most known techniques; (iii) surprisingly, survey, which is ranked the second known technique, moves to the fifth position of most used techniques; (iv) brainstorming, a group elicitation technique, is the third used technique while it is ranked fourth known technique; (v) observation, is ranked fourth used technique while it is ranked seventh most known technique; (vi) it is worthwhile to observe also, that half of proposed IRD techniques suggested by academia are used by a very small number of respondents. These are: role playing, QFD, fault tree analysis, flow charts, goal-oriented elicitation, UML, Ishikawa, and K.J. Method; (vii) UML is not widely used in Kuwait, since it is used only by one software stakeholder out of 5 (21%) and its rank is 18; and (viii) Ishikawa and KJ- methods are still the least used techniques, after all they were the least known techniques in Table 5.

Table 5. Most used IRD techniques in Kuwait

Techniques		Frequency	%	Techniques		Frequency	%
1.	Interviews	79	91	11.	Use Cases	44	51
2.	DFD	65	75	12.	Role Playing	38	44
3.	Brainstorming	64	74	13.	QFD	33	38
4.	Observations	59	68	14.	Fault Tree Analysis	23	26
5.	Surveys	59	68	15.	Flow Charts	21	24
6.	Prototyping	54	62	16.	Goal-Oriented Elicitation	18	21
7.	Scenarios	50	57	17.	UML	18	21
8.	Focus group	49	56	18.	Ishikawa	5	6
9.	JAD workshops	48	55	19.	K.J. Method	3	3
10.	Decision Trees	47	54				

Through Table 6, we can observe the following: (i) the five most highly valued techniques are: decision trees (which belongs to *external representation techniques*), goal oriented elicitation (which belongs to *unstructured elicitation techniques*), prototyping (which belongs to *observation technique*), DFD (which belongs to *formal analysis techniques*), and interview (from *traditional techniques);* (ii) among the five most widely used techniques, only two are still on the five most highly valued techniques. These are DFD and interview; (iii) while the value of DFD and interview is high, their rank retrograde respectively from first and second most widely *used* techniques to the fifth and fourth highly valued ones; and, (iv) *similarly*, *brainstorming*, *observation*, and *surveys* retrograde respectively to the 11th, 12th and 13th rank of highly valued IRD techniques. Surprisingly, it can be observed that not well *used* technique (e.g. decision tree and goal oriented elicitation) improve their rank. From the 10th and 16th used techniques they move to the1st and 2nd highly valued ones. Lastly, UML is on the bottom of the Table 6, leading to the conclusion that it is not perceived to generate high value from past SD projects.

Table 6. Most highly valued IRD techniques in Kuwait

	Technique	N	Mean	SD		Technique	N	Mean	SD
1.	Decision Trees	48	4.63	1.34	11.	Brainstorming	63	3.83	0.96
2.	Goal Oriented Elicitation	19	4.05	0.97	12.	Observations	60	3.78	0.99
3.	Prototyping	54	4.04	0.97	13.	Surveys	58	3.76	1.00
4.	DFD	65	4.00	0.90	14.	Fault Tree Analysis	24	3.75	1.07
5.	Interview	79	3.97	0.96	15.	Role Playing	39	3.72	0.86
6.	Scenarios	50	3.96	0.90	16.	UML	19	3.68	1.06
7.	QFD	33	3.94	0.79	17.	K.J. Method	3	3.67	0.58
8.	JAD workshops	46	3.93	1.00	18.	Flow Charts	22	3.45	0.91
9.	Focus group	49	3.92	0.91	19.	Ishikawa	5	3.20	1.48
10.	Use Cases	44	3.91	0.96					

Since this study has an exploratory dimension, we tested whether these techniques significantly correlated with SD success. To achieve this, we tested two critical success factors (CSF) for significant correlation with the 19 techniques. The first one deals with the statement "*obtaining the right requirements is essential to successful SD*" (referred to as CSF1). While the second one deals with the statement "*We experienced problems during past system developments projects because of problems in IRD* process" (referred to as CSF2). The Pearson Chi-square (χ^2) was used. Results (in Table 7) indicate that only five techniques exhibit correlations with CSF1 and CSF2. Two techniques (prototyping and decision trees) are highly correlated with CSF1, while other three used techniques (QFD, DFD and role playing) were significantly correlated with CSF2, leading to the conclusion that the use of QFD, DFD and role playing lead to problems in IRD process.

Table 7. Correlation IRD techniques and perceived problems

IRD techniques	**CSF1**		**CSF2**	
	$\chi 2$	P-value	χ 2	P-value
QFD	3.600	0.720	40.000	**0.001***
Prototyping	22.090	**0.050***	24.100	0.087
DFD	6.380	0.600	26.820	**0.043***
Role Playing	1.480	0.680	20.330	**0.016***
Decision Trees	24.100	**0.007***	27.040	0.130

Note: * Significant at p<0.05

In a further exploratory step, we tested whether the two critical success factors (CSF1 and CSF2) are correlated with the way companies develop/outsource their SD with the number of years spent by respondents in their companies and the type of companies (small ≤100 and large ≥100). Chi-square (χ^2) was used (see Table 8), and a significant relationship was found only between CSF1 and outsourcing SD (see Table 8). Such a new result indicates that only companies which outsource their SD perceived that obtaining the right requirement is a critical success factor for their SD.

Table 8. Other correlations between CSF, SD methodologies, experience of respondents, and type of enterprise

	Develop its IS		Outsourcing SD		Number of years		Type of company	
	χ2	P-value	χ2	P-value	χ 2	P-value	χ 2	P-value
CSF1	2.20	0.66	3.06	**0.04***	2.08	0.55	3.83	0.27
CSF2	4.30	0.77	2.10	0.55	0.23	0.97	0.77	0.85

Note: * Significant at p<0.05

In a last step, we tested the possible correlation between the 19 used techniques and the five types of SD methodologies: Agile software development (SD 1), structured analysis and design (SD 2), prototyping (SD 3), object-oriented analysis and design" (SD 4), JAD (SD 5). Table 9 shows only those that depict significant relationships. Significant correlations exist between the following: interviews is correlated with agile software development and JAD; use case is correlated with (agile software development, object-oriented analysis & design, and JAD); UML is correlated with prototyping, and object-oriented analysis & design; observation is correlated JAD; and finally goal oriented is correlated with prototyping.

Table 9. Correlation between IRD techniques and type of SD methodologies

IRD techniques	**SD1**		**SD2**		**SD3**		**SD4**		**SD5**	
	χ2	P	χ2	P	χ2	P	χ2	P	χ2	P
Interviews	11.30	**0.02***	2.26	0.68	1.69	0.79	1.12	0.88	1.95	**0.01***
Use Case	3.09	**0.03***	3.89	0.27	1.30	0.72	3.63	**0.03***	6.23	**0.01***
UML	2.34	0.50	4.89	0.17	9.71	**0.01***	2.23	**0.02***	1.70	0.63
Observation	0.90	0.92	4.99	0.28	8.47	0.07	10.95	0.10	5.74	**0.04***
Goal Oriented elicitation	1.29	0.73	2.20	0.53	8.47	**0.03***	4.03	0.25	4.13	0.24
Fault Tree Analysis	2.44	0.48	4.85	0.18	5.08	0.16	1.03	0.79	2.07	0.36
Flow Chart	0.46	0.92	2.15	0.54	7.07	0.07	7.80	0.68	3.17	0.36

Note: * Significant at p<0.05

DISCUSSION

Results indicate that the best valued techniques are Decision Trees, goal oriented elicitation, prototyping, DFD, and interviews. Such a result suggests numerous observations about IRD practices in Kuwait.

First, it can be observed that there is no single technique considered at the same time to be the most *well known*, widely *used* and most *highly valued* technique. Traditional technique in the form of *interview* is the most well known and widely used technique, but not the most highly valued one. This technique is used only to support requirement gathering during the IRD process. This technique puts the end-users at ease (if done properly). It also enables getting an overview of the tasks and for the discovering of appropriate IRD by confronting several views of software stakeholders. Findings of our study give additional clarification and another perspective to the findings of Davis et al. (2006). The systematic review of 26 published empirical studies done by Davis et al. (2006) concerning the effectiveness of elicitation techniques revealed that *interviews* is the most effective elicitation techniques in a wide range of domains and situations. While our study does not deal with techniques' effectiveness, it shows that interview is not the highly valued technique even though it is the most well known and used one. We advocate three possible explanations for such difference: (i) there is a cultural difference between the settings where the studies were carried out (Arab culture in our case, and western culture for studies reviewed in Davis et al. (2006); (ii) the second reason is related to the slightly different objectives of the two studies, unless we consider that effectiveness of an IRD technique also includes value of the technique derived from past carried project; and (iii) open interviews are not always appropriate for obtaining detailed requirement or operational models. This is because end-users' recall is often incomplete and unstructured. Another drawback to using interview is the need for the analyst to reconcile apparent contradictions in the collected requirement. A series of interviews may turn up inconsistent information about the current or prospective system, which requires an iterative process of requirement collection and validation among involved software stakeholders. This may prove to be a time consuming process.

Second, the most highly valued techniques are *external representation techniques* (Decision trees), followed by u*nstructured elicitation techniques (*goal oriented elicitation). This result is new and challenges those of Davis et al. (2006). Both techniques assist gathering and representations of requirement in IRD process. Two possible explanations can be advanced. First, goal oriented elicitation was included as an IRD technique; Mathiassen et al. (2007) did not include decision tree among the list of 85 techniques used to support IRD process. *Second*, a decision tree is a graphical representation technique, similar to an influence diagram. This mirrors one characteristic of the Arab culture. Specifically, convincing people with a visual form is better than thousands of speeches (Rouibah 2008). Also, decision trees are simple to understand and interpret. Software stakeholders are able to understand decision tree models after a brief explanation. Important insights can be generated based on experts describing a situation (its alternatives, probabilities, and costs) and their preferences for outcomes. Goal-oriented elicitation is ranked second because the main objective of this technique is to achieve overall goads of a specific system through negotiation of different software stakeholder. By suppressing details, the participants are able to construct a consensual model of the system to develop.

Third, it can be noted also that observation technique in the form of *prototyping* is perceived as the third highly valued technique. Prototyping is an analysis driven technique that involves the development of a pilot version of the desired system. It is used to support three phases of IRD: gathering, representation, and verification of system requirements. The aim is to clarify requirements by a visual prototype and to save time that might otherwise be wasted on efforts to meet system requirements. This result challenges those of Byrd et al. (1992), conducted in the western culture, who found that observation techniques are mainly used in SD. However, results of our study support those of Arnott et al. (2007) who found that *prototyping* is used by half of the sample respondents in Thailand; in our study, prototyping was found to be used by 62%. Similarities between the study of Arnott's et al. (2007) and ours could be explained by the culture proximity. Arab culture scores 68 on Hofstede uncertainty avoidance, while Thailand scores 64 and the USA 46.

Fourth, results of the study reveal that DFD as a formal analysis technique is ranked third in terms of the most highly valued techniques; while it is ranked the second most used technique, and the third among the most well known techniques. This result is not in line with previous research, suggestions and recommendations of past studies. For example, after reviewing past literature, Browne and Ramesh (2002) presented four factors that lead/push end-users to use informal representation (e.g. flow chart and brainstorming) rather than formal diagram (e.g., DFD). The four factors are: (i) difficulty to construct formal diagrams during end-users requirement elicitation; (ii) linked to previous, difficulty to record verbal interactions of system analysts with end-users; (iii) inability of end-users to understand formal representations leading to inappropriate and unreliable requirement documentation; and (iv) DFD is a poor technique to elicit requirements from end-users' view. Our findings also contrast with Bostrom (1989) who found that while DFD facilitates dialogue between system developers and end-users, technique alone is not effective. Our results also contrast with findings of Davis et al. (2006) who did not find the use of intermediate representations (DFD) during elicitation to have significant positive effects on IRD process.

Fifth, results of the study reveal that among group elicitation technique, JAD workshops (ranked 8th) is the most valued technique, followed by focus group (ranked 9th) and brainstorming (ranked 11th). These techniques are used to support only gathering and representation activities in the IRD process. Their low ranking reveals that software stakeholders in Kuwait don't perceive them as the best IRD techniques. This result contrasts with previous studies outside the Arab world. Kontio et al. (2004) found that the focus group is best used to study concepts that can be understood by participants within a limited time (less than 3 hours). The brainstorming technique is ranked the third most *used* technique and the fourth *known* technique, but low in term of derived value. Such findings question the value effectiveness of this technique in Kuwait since it proves its performance and efficiency outside the Arab world (Byrd et al., 1992; Kontio et al., 2004). Our finding contrasts with that of Arnott et al. (2007) in Thailand, who found that brainstorming is the most used technique in their study. An argument for the difference between the two studies could be attributed to the lack of skills needed to carry out this technique (brainstorming) in Kuwait. This technique requires the presence of an expert facilitator with leadership skills and experience to running brainstorming workshops. This person has to be trained in group management and facilitation as well as in system analysis. He needs to set agendas, and check that they are met. He needs to remain neutral and impartial on issues and does not contribute ideas or opinions but rather concentrates on keeping the group on the agenda, resolving conflict, disagreement, and soliciting ideas. If impartiality is not possible, the workshop probably will not achieve consensus, as attendees will feel they have been 'railroaded' into decisions. It could be suggested that system designers need to be trained on those skills.

Sixth, results of the study reveal that UML, Ishikawa and KJ method are among the least known, used or valued IRD techniques. While UML can be used to gather, represent and verify requirement during IRD process, it is not perceived to be known, used and valued in SD in Kuwait. Such results contrast with current trends in SD in western studies where UML is widely known and used (Agarwal and Sinha 2003; Matulecvicius 2005). Matulecvicius (2005) found the most important IRD techniques are flow chart, DFD, use cases, and UML.

Agarwal and Sinha (2003) studied perceptions of system analysts and designers in terms of usability of UML and what types of respondents' background lead to positive perceptions of UML usability. Each team in the study worked on a systems analysis and design project, which involved developing a requirements analysis model using UML during three months. The study found that novice developers, with prior experience in process-oriented modelling, had positive perceptions of UML and found it as easy to use. We can list two main reasons for the different results between this study and those of Agarwal and Sinha (2003): (i) respondents in Agarwal and Sinha (2003) have more experience with UML than in our study; and (ii) while Agarwal and Sinha's study included the perception of the four components of UML (use cases, class, state, and sequence interactions), our study focuses on general perception of UML. UML's usage and perceived value in Kuwait were strikingly low, an issue that needs to be addressed in future studies. Moreover, the low rank of the KJ method contrasts with the findings of Kontio et al. (2004), who found that affinity diagrams (similar to the KJ method) is a very useful and effective tool in obtaining input system developers and en-users.

Seventh, additional findings were highlighted using correlations between different variables. In particular, this study reveals the following: (i) existence of a correlation between problems of past information system projects and the usage of three techniques (QFD, DFD and role playing); (ii) the existence of correlation between the use of prototyping and decision trees and the statement "obtaining the right requirements is essential to successful SD"; and (iii) the existence of positive correlation between outsourcing and "*obtaining the right requirements is essential to successful SD*". Such a result indicates that only companies with outsourcing activities perceive that obtaining the right requirement is a critical success factor for their SD. This is why they outsource their SD in order to obtain more accurate and high quality systems. The three results are totally new and no past study found similar results, which calls for further studies in an attempt to replicate/validate these results.

In a last step, we tested the possible correlation between the 19 techniques and the five types of SD methodologies. Results indicate that interviews are best used with agile software development and JAD. Use case is best used in association with agile software development, object-oriented analysis & design, and JAD. UML is best used with prototyping, and object-oriented analysis & design. Observation is best used with JAD. Finally, goal oriented elicitation is best used with prototyping.

CONCLUSIONS

This study presents an initial step/overview toward understanding IRD practices in a lesser developed country in terms of commonly known, used, valued IRD techniques and other correlations between two IRD critical success factors and the selected IRD techniques.

This study has achieved three important contributions. *First*, this study reveals that Arab culture influences the IRD technique selection and that several techniques are known, used, and most valued in the IRD process. Such perceptions differ from those observed elsewhere. Most well known techniques are traditional techniques (interviews and surveys), followed by formal analysis technique (DFD) and group elicitation technique (brainstorming). The most widely used techniques are traditional technique (Interview), followed by formal analysis technique (DFD), and group elicitation technique (brainstorming). Most valued techniques from past projects are external representation techniques (Decision trees), followed by unstructured elicitation techniques (goal oriented elicitation), and observation technique *(*prototyping). Additionally, there is no single technique that is perceived to be the most widely used and has the most value at the same time. The least known, used and valued techniques are UML, Ishikawa and KJ- methods. *Second*, this study presents a novel empirical data on factors that affect IRD practices from a new region in developing countries where it has not been investigated before. It shows the existence of a correlation between past IS project problems and the usage of three techniques (QFD, DFD and role playing); the existence of correlation between the use of prototyping and decision trees and the statement "obtaining the right requirements is essential to successful SD"; and the existence of positive correlation between outsourcing and the statement "*obtaining the right requirements is essential to successful SD*". *Finally*, results reveal a gap between research and industrial practice, since IRD techniques are not all perceived in the same way between organizations in developed countries and developing countries. The case of UML is a striking example of this.

In spite of its contributions, the study suffers from three limitations. The sample size is somewhat small and is based on respondents' perceptions, which may introduce biased answers. More data is always desirable. Nevertheless, since the study has an exploratory character in a region where little is known about the subject, the sample isn't that small. Another limitation is related to the concepts "*method*" and "*technique"* and possible attributing of different interpretations and different degrees of use, which call for caution when interpreting those results. *Lastly*, while the study claims to investigate how IRD practices differ in Kuwait than in other countries, we did not include any cultural variable such as those used by Hofstede.

This study has several managerial and research perspectives. From a managerial perspective, this study proposes two suggestions - one related to students, another to software developers. The *first* one suggests re-

examining university curricula in order to familiarize students with techniques that have been proven effective. Important techniques that deserve more concern are group elicitation techniques (e.g. focus group, brainstorming, and JAD workshops), cognitive techniques (KJ methods), and formal analysis techniques (DFD and UML**)**. MIS curriculla should be updated to reflect the current trend in worldwide SD. With globalization, information systems are complex to design, which need to understand ill-structured requirement of different stakeholders. Group team techniques and cognitive mapping techniques are very important to design systems that meet a system's goals without compromising the requirements of each stakeholder. Object oriented techniques (e.g. UML) are also important to design reusable systems that are easy to maintain. Current students are potential system analysts and system designers of tomorrow. Therefore, it is important to teach students these techniques and give them more information system projects that encompass the use of these techniques. More teaching and practical training on different IRD techniques would lead to more knowledge and use, and consequently, to more perceived value. Such teaching will ensure knowledge transfer from university to practice and ensure long-term improvement of the practices. *Second*, IRD is the most critical phase in system development. It is consequently a must that practitioners employ a variety of IRD to improve these processes. Thus, this study suggests more training for system developers and system analysts on different IRD techniques in order to improve their skills and assimilate different IRD techniques. Also, results of the study call for more collaboration between academia and practitioners to ensure such knowledge transfer.

From a research perspective, this study suggests to carry out three research directions. *First*, we encourage future studies that replicate findings reported in this study, in particular to re-test whether there is a correlation between past IS project problems and the usage of three techniques (QFD, DFD and role playing). It is worthwhile to mention that results of this study are not absolute and need replication. *Second*, this study suggests to initiate cross-cultural comparative IRD related studies between developed (e.g. US and European companies) and developing countries (e.g. Arab countries). This study encourages researchers to consider the whole world as potential locations for research to test and enrich standard technology adoption theories. As mentioned in the literature review, empirical studies about perception of IRD techniques are lacking. Comparative studies will allow testing how western concepts/methods related to IRD are perceived across cultures, provides potential explanations, and suggests caution when applying theories or knowledge that come from developed to developing countries. In approaching this issue, future studies may include cultural variables such as those of Hofstede: Are there any significance differences in IRD practices/usage? If so,, which factors influence such differences? Does culture play a part in determining which IRD techniques work best? *Third*, perspective consists of going further in the way to assess the effectiveness of IRD technique. Besides, familiarity, usage, and value, this study encourages including an additional characteristics: how each IRD technique contributes to limiting the three communication problems during IRD which were discussed by previous researchers (Byrd et al., 1992). *Within obstacles* are caused by the cognitive limitation of human as information processor and problem solvers. *Between obstacles* are communication problems caused by miscommunication (lack of common language) between system analysts and end-users. *Among obstacles* are those caused/ associated with balancing the needs of multiple users (i.e. political ramification of using the new IS) which are often in conflict or in competition for limited system design resources.

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