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Developing an ISDM Adoption Decision Model Using Delphi and AHP

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Abstract Research on information systems development methodologies (ISDM) adoption has been widely undertaken to highlight the experience of developed countries. Studies concerned with the status of ISDM in developing economies including the factors that influence and motivate their use, current trends, difficulties, and barriers to adoption are lacking. This paper explores these issues in a developing economy, namely Oman, and proposes an ISDM adoption decision model using analytical hierarchy process analysis informed by a survey and Delphi consultation. The findings from the survey reveal a lack of knowledge of ISDM amongst Omani Information Systems developers and the reliance on ad-hoc software development methods. Conversely, analyzed data reveals a trend whereby a majority of Omani organizations are gradually moving towards increased ISDM adoption and deployment. This has motivated the development of an adoption decision model to assist software companies to select the right ISDM adapted to their organizational needs in Oman. This model has a generic dimension and can be adapted to other socio-organizational contexts.

Keywords IS · ISDM · Delphi · AHP

الخلاصة

إن البحث في اعتماد منهجيات تطوير نظم المعلومات (ISDM) قد اضطلع به على نطاق واسع لتسليط الضوء على تجارب الدول المتقدمة. ولابد من الإشارة إلى أن هناك نقصاً في الدراسات المعنية بوضع منهجيات تطوير نظم المعلومات في الاقتصادات النامية بما في ذلك العوامل التي تؤثر وتحفز استخدامها، والاتجاهات الحالية، والصعوبات، والعوائق التي تحول دون اعتمادها. وتستكشف هذه الورقة العلمية هذه القضايا في اقتصاد نام، وهو اقتصاد عمان، وتقترح نموذج قرار اعتماد منهجيات تطوير نظم المعلومات باستخدام تحليل عملية التسلسل الهرمي التحليلي (AHP) المبلغ من خلال المسح وتشاور دلفي. وتكشف النتائج المستخلصة من المسح وجود نقص في المعرفة حول منهجيات تطوير نظم المعلومات بين مطوري نظم المعلومات العمانية وطرق تطوير برمجيات الاعتماد على المخصص. وعلى العكس من ذلك، فإن تحليل البيانات يكشف اتجاها بحيث إن غالبية المنظمات العمانية تتجه تدريجيا نحو زيادة اعتماد ونشر منهجيات تطوير نظم المعلومات. وقد حفز هذا على تطوير نموذج اعتماد قرار لمساعدة شركات البرمجيات لتحديد منهجيات تطوير نظم المعلومات الصحيحة والمتكيفة مع احتياجات المنظمة في عمان. إن هذا النموذج له عمر من عام واحد، ويمكن تكييفه مع السياقات الاجتماعية والتنظيمية الأخرى.

1 Introduction

Information systems development methodologies (ISDM) are considered as instruments for changing and enhancing the information system development process as well as one of the valuable assets in the organization [1]. Therefore, the decision to make such investments in adopting and deploying ISDM within organizations requires careful planning [2].

ISDM adoption has been recognized as a critical issue in Information Systems (IS) research due to the fact that ISDM are continuously developed and altered in response to technical changes, new practices, and varying requirements of different IS project situations [2–4]. ISDM have formed one of the most intensive research topics in information systems. Reference [5] estimated the number of ISDM to be over 1,000, and since then this number has continuously evolved in

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response to various environmental and technical challenges [6]. Reference [7] states that "information system development is still at the core of the IS field, and will be so for a long time". They added that "in recent time, the focus of IS research has shifted somewhat, as researchers have pursued more attractive but perhaps more ephemeral topics". Despite the argument about the usefulness of ISDM, they are expected to be largely used in the current era more than ever before [1].

A review of literature shows that there is insufficient empirical research on ISDM adoption. For instance, [8] state that there are "few studies that were conducted in order to identify how ISDM are selected or adopted, or how they are used". The same view has been reported by the studies of [6,9]. A survey of prior studies of ISDM adoption shows clear differences between the number of studies of ISDM adoption that have been undertaken in developed and developing economies [10].

Previous research highlights the idea that technology adaptations in developed countries occur constantly in reaction to misalignments, gradually leading to a successful alignment [11,12]. This is in contrast to developing countries, which tend to rapidly adopt technology created by developed countries, often in an ad hoc way [13]. In 2002, the National Science Foundation reported that more than 84 percent of the world's scientific and technological production is concentrated in developed countries. Developing countries have only marginally increased their participation, which emphasizes the scientific and technological gap that exists with the developed world. Also, in several of the information technology installations that were created and adapted for organizations in developing countries, local (regional and national) factors were not taken into account. This has resulted in outcomes that do not fit the needs of the direct beneficiaries in the developing nations [14]. While the above is applicable to ISDM, the crucial issue might not relate only to technology but also include other factors, such as cultural-based resistance: "technology, designed and produced in developed countries, is likely culturally-biased in favor of industrialized socio-cultural systems, technology transferred to developing countries meets cultural resistance" [15].

The objective of this research is to investigate ISDM adoption in a developing country, namely the Sultanate of Oman, and to develop an appropriate ISDM adoption model for Omani organizations. An empirical study was conducted by means of a survey, using a questionnaire and a number of face-to-face interviews with Information Systems (IS) managers in Omani organizations, to empirically examine ISDM practices and ascertain the extent to which there was a need for an ISDM adoption model. The survey was also intended to enable the testing of hypotheses formulated at an early stage of the research. The Delphi and AHP methods were undertaken to generate a confirmed list of ISDM adoption variables for decision making. Finally, a case study is selected to test the practicality and validity of the proposed ISDM adoption decision model and to adapt the developed theoretical model to reality.

Oman is an interesting example of a developing country that is investing in Information Technology (IT) to diversify its economy. Omani software companies succeeded in exporting Information System (IS) products to the Middle East, Africa and Asia and are now increasingly looking to the European and US markets [16,17]. However, there is a lack of studies and research on how information systems are currently being developed across the country.

The research contributes to the body of knowledge in ISDM by providing insights into ISDM adoption practices in a developing country across different types of Omani organizations. In addition, it identifies and analyzes the variables which contribute to effective evaluation and selection of ISDM, and investigates the usefulness of combining Delphi and AHP techniques to develop an ISDM adoption decision model. The following section introduces literature related to this study, followed by the research methodology. The results from the three research phases are introduced in Sects. 4 (survey), 5 (Delphi consultation), and 6 (AHP analysis), respectively, followed by discussion and concluding remarks in Sects. 7 and 8.

2 Related Work

The most recent definition of ISDM identified from the literature, introduced by [1,3,18] describe ISDM as a combination of the following:

- A systems development approach: the philosophical background upon which the ISDM is based, including objectives, principles, guidelines, and beliefs.
- A systems development process model: a representation of phases or stages of information system development. Reference [1] described a system development process model as an abstraction and the basis of the ISDM view of the development process.
- A systems development method: according to [9], system development method is a way of doing something, a procedure, or a means to accomplish an objective of at least one complete phase of systems development. System development method comprises tasks and activities as well as guidelines on how to use techniques and tools to develop information systems.
- A systems development technique: ISDM techniques are utilized during the system development process as an aid to perform a development activity.

Previous research in the field of ISDM ranged from studies of the application of methodologies [19], movement of methodologies [20], the use of methodologies [21], application of in-house software development methodologies (SDM's) and commercial SDM's [22], and issues in methodologies [23]. In addition, some of the research conducted was concerning the methodology itself and the changes in methodology [9]. However, although literature may be available for the selection and comparison of methodologies, methodologies are still extensively untested, despite their growth [7]. Nevertheless, there is a handful of research, which consolidate on the empirical study of the use of methodologies in specific countries [24,25]. However most of these researches tend to focus on the usage of methodologies in developed countries [26]. Only few papers have been published in premier journals such as *MIS Quarterly and Information Systems Research*. However, there are signs that this is changing. There are now specialist journals devoted to the topic (e.g., IT for Development) and some journals have focused on the area (e.g., *The Information Society*, Volume 18, Number 2, 2002) [27].

ISDM adoption remains a controversial issue among many organizations [1,24]. On the one hand, many practitioners view ISDM as the means for improving the quality of the information system development process. There are significant pressures to use ISDM as a requirement to obtain ISO certification or adhere to standards required by some governments. On the other hand, there are also considerable arguments against the use of ISDM, including (a) mismatches with organizational or Information Systems (IS) projects requirements, (b) ISDM vendor dependency, (c) system development delay, (d) system development stagnation [24]. Current research shows that there may not be one optimal methodology that can be universally applied to every project [28]. However, the adoption of ISDM does not guarantee a better ISDM process and system quality. The problem is the inappropriate use of the ISDM [29]. A review of the literature shows that while many organizations claim that they use ISDM successfully with positive results and view them as an essential approach to improve the quality and to increase the productivity of the software development process, others argue about the benefit of using these methodologies and affirm that they do not use any ISDM in practice [1,24]. Moreover, while various researchers argue that ISDM are an important resource in business and industry and have a critical potential impact on performance [8], concerns arise when an organization attempts to adopt and deploy ISDM. In fact, the issue remains open of whether or not the organization will acquire a quality information system as a result of adopting and deploying a particular ISDM [2].

Developing countries account for the majority of the world's population, and are important for this reason alone [27]. In developing countries, Information Systems are becoming an important tool for achieving rapid economic growth and improving operational efficiency, both at the public and private sectors [27]. However, achievement of these objectives is often difficult because of the existing rules and organizational structures. The harsh socio-economic and infrastructural context makes the sustainability of information systems a major issue [30]. Improvements can only be expected when there is a sound institutional, operational, and technical base. Technology transfer to developing countries has been too reliant on external factors, like international aid, and emphasized on technology itself. There is a need for locally developed, appropriate information systems, and appropriate development methodologies, which are based on local needs and structures [30]. Therefore, IT planning in developing countries presents a challenge that is significantly different from that encountered by developed countries [31]. In terms of research, studies concerned with the use of ISDM in developing countries are needed [6,9,23]. None to the knowledge of the authors has been conducted in Oman or the greater Middle East region. Table 1 shows some of the key ISDM studies conducted in developed and developing countries. In the recent year, globalization has resulted in software development being outsourced to developing nations [18]. A range of services and processes are being delivered by global vendors [32]. In 2006, the total spending on IT outsourcing was estimated at over USD 170 billion, with an above average growth at 7.3 % [32]. As a result, software development has moved away from on-site development, to the offshoring model [18] in which global virtual teams collaborate across national borders [33]. The recent years have also witnessed growth of the agile software development approach. The flexibility and responsiveness of the agile approach makes it attractive for adaptation in globally distributed software work [34]. According to a study conducted by [35], teams engaged in virtual software development teamwork might develop their own informal control mechanisms and even bypass the forced control mechanisms necessitated by the standard operating procedures while doing their projects.

3 Methodology

The scope of this research is defined as an investigation into ISDM adoption within the context of a developing country, namely the Sultanate of Oman. Therefore, the study is limited to that context. The research involves three empirical stages:

- The first empirical stage of this study investigated ISDM practices in Omani organizations. In this stage, a questionnaire was targeted at IS managers/heads of departments.

Table 1 Prior studies of ISDM adoption

Authors	Description
Developed country	
Fitzgerald et al. (1999)	Investigated systems development and maintenance in the UK. 57 % respondents claim to be using ISDM
Holt (1997)	Examined software engineering practice in 50 UK organizations. About 31 % of the surveyed organizations did not use any structured ISDM
Chatzoglou and Macaulay (1996)	Surveyed the use of ISDM in 72 IS projects in the UK. Reported that 47 % do not use any ISDM in IS development
Hardy et al. [22]	Studied ISDM customization across 102 UK organizations. Found that 88 % of the organizations customize their ISDM
Wastell and Sewards (1995)	Studied ISDM usage in 92 UK manufacturing companies. Found a positive relationship between organization size and ISDM usage
Beynon-Davies and Williams [8]	Examined the adaption of ISDM in two organizations in UK. The study utilized Dynamic Systems Development Method (DSDM) to explain some of the key features of the ISDM adoption processes
Venable and Lim (2002)	Surveyed consulting organizations in Austria that develop web information systems (WIS). 67 % use a type of methodology and about 10 % use WISDM to guide their WIS development activities
Dawson and Gibson (2007)	The study assessed the state of Information Systems Development Methodologies (ISDM) research in Australia
Palvia and Nosek (1993)	Surveyed the use of ISDM, tools and techniques in 65 US organizations. The study identified many ISDM, tools, and techniques that are in use and concluded that there is a need for an ISDM selecting method
Rouse et al. (1995)	Presented a comparison of ISDM adoption between Australian and US organizations. The adoption rate among Australian organizations found to be slower than that of US organizations
Iivari and Maansaari [23]	Investigated the use of ISDM in 44 CASE user organizations in Finland. Results indicate considerable problems in adopting the Object-Oriented methodologies
Fitzgerald [24]	Examined ISDM usage across organizations in Ireland. Only 6 % of the respondent reported using ISDM rigorously
Developing country	
Huisman and Iivari (2001, 2002a, b, 2003a, b, c, 2006)	Conducted a comprehensive analysis of ISDM adoption and deployment in South Africa involving 83 organizations, 234 developers, and 73 IS managers
Rahim et al. (1998)	Investigated ISDM adoption in public and private sectors in Brunei Darussalam. Nine different ISDM reported to be used by the surveyed organizations
Selamat et al. (1994) (cited from Rahim et al. 1998)	Studied CASE tools usage and associated ISDM in 40 Malaysian organizations. SSADM reported to be used by 8 % of the surveyed organizations

Thus, this stage focused on examining ISDM experiences of Omani organizations based on the primary data obtained from senior IS professionals in charge of an IS department.

- The second stage employed the Delphi method. Delphi is a method which facilitates communication among a group of experts with the objective of obtaining opinions on a particular issue [23]. Generally, the technique seeks for consensus and convergence of opinion and can be used to deal with complex problems. The responses from a group of experts are considered more accurate than those of a limited number of experts [36]. The second stage of was conducted in the UK. The rationale behind this stage relates to the availability of experts in the ISDM field in the UK compared with Oman where the number of ISDM experts is very limited. Another reason is that experts in the UK were chosen to help in developing and analyzing general variables that can be used for decision-making for ISDM adoption regardless of the context, which was also the rationale for employing the Delphi method. The variables obtained from this stage represent experts' viewpoints towards the critical variables which assist in evaluating and selecting ISDM.
- The third empirical stage aimed to apply an ISDM adoption model in a particular organization. The largest bank in Oman was chosen as the case study in order to gain an in-depth knowledge of the real word situation and to tailor the models' variables to this specific case domain as well as to verify and to test the validity of the proposed ISDM adoption model. The primary data were collected within the context of this organization, which represents the viewpoint of its personnel towards the adoption model variables. Analytical Hierarchy Process (AHP) was utilized. AHP is a type of multiple criteria decision making and is the most widely used decision making tool [37]. AHP enables decision makers to model a complex problem in a hierarchical structure showing the relationship between factors. AHP helps decision makers deal with both rational and intuitive judgment to select the best from several

alternatives with respect to a number of conflicting factors [38,39].

The research is exploratory in nature, adopts a positivist philosophical stance, and addresses the following independent three main research questions:

- RQ1: What is the current status of ISDM practices in the Sultanate of Oman?
- RQ2: What are the critical variables and their level of importance in evaluating and selecting the most suitable ISDM?
- RQ3: What is the requisite model for ISDM adoption to assist organizations to evaluate and select the most appropriate ISDM for their software development activities?

The hypotheses that underpin the research have been formulated based on previous literature and one of the author's knowledge of information system development in Oman. As no research has been carried out, to the best of the researchers' knowledge, to investigate ISDM adoption the Sultanate of Oman, the approach was mainly exploratory in nature taking into account the following hypotheses:

Organization type: In Oman, organizations are classified as public or private; [10] and [25] report that the use of ISDM in the public sector is higher than that in the private sector. This is due to the fact that the private sector works under immense pressures and time constrains to meet customers' demands. Therefore, IS developers in this sector are less likely to use ISDM. In contrast, public organizations face less pressure and thus are more likely to adopt ISDM. Thus, the first hypothesis is:*"H1: ISDM adoption patterns differ from public to private organizations"*.

Business category: There is a variation on ISDM adoption across business sectors. This view is supported by several studies [40,41]. Furthermore, [18] and [38] confirm that ISDM use differs significantly between IS departments in different business areas. Reference [25] found that the majority of ISDM adopters are administrative services and finance organizations. Reference [24] states that the relationship between ISDM usage and business type is significant and reports that ISDM are more frequently used in finance/insurance/real estate business categories, while the usage of ISDM in the construction/ manufacturing/ distribution category is reported to be very low. This leads to the formulation of the second hypotheses: *"H2: ISDM adoption is different across business categories"*.

Organizational and IS department size: Before choosing an ISDM, organizations' characteristics must be understood [41]. It is widely accepted that organization and IS department size are important factors that influence innovation (ISDM) adoption [42]; Reference [42] and [25] found that ISDM usage is significantly more likely in larger organizations and in larger IS departments. This leads to the following two hypotheses: *"H3: There is a positive relationship between organizational size and ISDM adoption H4: There is a positive relationship between IS department size and ISDM adoption"*.

Experience of IT/IS department: It is argued that the experience of IT/IS department in IS functions is important in the adoption of IS practices within an organization. This view is supported by [41], as well as by [40] who suggested that the more experienced the IS department, the more useful are the information systems developed. This issue is further empirically investigated by the study of [25] who reported that the age of IS function of an organization is statistically significant with ISDM use. Recent literature confirms these views. For instance, the study of [18,41] found a significant positive relationship between ISDM use and the experience of IS departments. Thus, it is fair to assume that organizations with a high level of experience in IS functions are more likely to adopt and implement ISDM more effectively. This leads to the next hypothesis: *"H5: There is a positive relationship between experiences of IT/IS department and organizational adoption of ISDM"*.

Relative advantage: According to [42] relative advantage is the extent to which an innovation is perceived to be useful. Reference [43] argues that the greater the perceived benefits before use, the more likely the innovation will lead to successful adoption. This study will follow [42] Diffusion of Innovation (DOI) theory. Thus, the next hypothesis is: *"H6: There is a positive relationship between relative advantage and organizational adoption of ISDM"*.

Complexity: Reference [42] defines complexity as the degree to which an innovation is perceived as relatively difficult to understand and use. Reference [40] believes that there is a negative relationship between the complexity of the innovation and its successful implementation. Generally, it is assumed that complex innovations are less likely to be adopted to simpler ones. Complex innovations require new and high level skills [18]. This study will support theoretical backgrounds of [42]. Therefore, the next hypothesis is: *"H7: There is a negative relationship between ISDM complexity and organizational adoption of ISDM"*.

Compatibility: Reference [42] defines compatibility as the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters. Reference [23] reports that there is a positive relationship between CASE tool usage and compatibility. Thus, the next hypothesis is: *"H8: There is a positive relationship between compatibility and organizational adoption of ISDM"*.

Knowledge barriers: Reference [41] believes that the lack of understanding of a new technology (ISDM) and its implications is an important barrier to successful adoption.

However, they also argue that knowledge is not always the barrier for new IS/IT adoption but makes implementation of the technology more problematic, because the organization needs the necessary skills and knowledge to integrated it in the organization context. Thus, the final hypothesis is: *"H9: There is a negative relationship between knowledge barrier and organizational adoption of ISDM"*.

4 Results from ISDM Consultation

This stage of the study utilized both quantitative and qualitative data gathering methods (i.e. postal questionnaires and semi-structured interviews). The total sample size was 532 organizations (one IS manager per organization), and the response rate was 70.86 %, which resulted in a population of 377 IS managers from both private and public organizations involved in information systems development in Oman. The data were coded and analyzed using descriptive statistical analysis including mean, percentage, and frequency. The qualitative data gathering methods for the study utilized 28 semi-structured interviews. A number of open-ended questions were used in the interviews to allow respondents to express their own opinions and give them an opportunity to elaborate on points they think are important. The semi-structured interviews were analyzed using content analysis to identify issues related to ISDM practices.

Table 2 presents ISDM usage versus respondents' background which was driven from participants' responses.

Table 2 Breakdown of ISDM usage by respondent (IS manager) background

	Using ISDM (N = 46)		Not using ISDM (N = 331)	
	N	%	*N*	%
Level of education				
Secondary and less	0	0	11	100
College	0	0	53	100
University degree	33	12.50	231	87.5
Masters and above	13	18.84	56	81.16
Experience in IS development				
1–5 years	4	9.09	40	90.09
6–10 years	11	8.53	118	91.47
11–15 years	9	10.98	73	89.03
16–20 years	12	12.25	86	87.76
More than 20 years	10	41.67	14	58.33
Studied or attended ISDM course				
Yes	46	32.17	97	67.83
No	0	0	234	100
Gender				
Male	36	12.41	254	87.59
Female	10	11.49	77	88.51
Nationality				
Omani	17	7.33	215	92.67
Expatriate	29	20.0	116	80.0

The profile of the respondents' level of education shows that none of the surveyed respondents using ISDM had an educational level below a university degree. The majority, 264 out of 377 (70.02 %), had a university level education. The respondents with a Masters and above level of education represented 18.3 %. The majority of IS managers had at least 5 years of experience (88.33 %). In terms of the respondents' awareness of ISDM, 46 (100.00 %) of those using ISDM had studied or attended some sort of ISDM training. 97 out of 331 (29 %) respondents not using ISDM attended ISDM training. The majority of respondents were male, as they represented 76.92 % of the total sample. Many of which were Omani nationals (232 versus 145 non-nationals).

Table 3 presents the breakdown of ISDM Usage by Organization Background. The profile of the respondents' organizations shows that only 31 (8.22 %) were government employees; 3 of which (9.68 %) use ISDM. It is interesting to see that the highest percentage of responses were from three industries, namely finance/banking/insurance/investment, manufacturing/mining/petroleum/energy, and wholesale/retail trade (29.97, 22.55, and 19.10 %, respectively). The organizations participating in the survey were involved in a variety of business activities, including consultants/software houses/IT vendors (14.32 %), wholesale/retail trade (19.10 %), travel/transportation (1.86 %), ministries/administration and public services (10.08 %), and telecommunications/networking (2.12 %). The size of the participating organizations varied considerably. Almost half (47.21 %) of the questionnaires came from organizations that employed 101–1,000 employees. However, organizations with above 1,000 employees also participated in the survey (6.63 %). All surveyed organizations had a separate IT/IS department. Only 14 (3.71 %) of the respondent organizations had a new IS department, 51 (13.71 %) had 6–10 years experience, and 48 (12.73 %) had 11–15 years experience. Matured organizations with over 15 years of IS usage represent the majority (70.03 %) of the respondent organizations.

In reference to Software/Development Languages, the average number of Software/Development languages used is 2.5 per organization. The majority (i.e. 324, representing 85.94 %) adopted Oracle development suite of products in their IS department, followed by MS Access, which is used in 263 (69.76 %) of the organizations, Visual Basic 118 (31.30 %), Java 106 (28.08 %), C++ 87 (23.08 %), and Visual Fox Pro in 38 (10.08 %) of the sample. A very small percentage of respondents (8, or 0.02 %) adopted other Software/Development languages. 44.3 % of the IS departments' efforts are dedicated to system support and main-

Table 3 Breakdown of ISDM usage by organization background

	Using ISDM (N = 46)		Not using ISDM (N = 331)	
	N	%	N	%
Type of organization				
Government	3	9.68	28	90.32
Private	43	12.43	303	87.57
Business activity				
Consultants/software houses/IT vendors	18	33.33	36	66.66
Wholesale/retail trade	3	4.17	69	95.83
Manufacturing/mining/petroleum/energy	11	12.9	74	87.06
Travel/transportation	0	0	7	100
Ministries/admin. and public services	4	4	34	89.47
Finance/banking/insurance/investment	10	10	103	91.15
Telecommunications/networking	0	0	8	100
No. of employees in the organization				
1–10	1	4.76	20	95.24
11–50	3	6.82	41	93.18
51–100	6	5.5	103	94.5
101–1,000	17	9.55	161	90.45
More than 1,000	19	76	6	24
No. of employees in IT/IS department				
1–5	3	0.92	108	99.08
6–20	12	7.14	143	92.86
21–100	31	26.32	84	73.68
More than 100	0	0	0	0
Experience of IT/IS department				
1–10	4	6.15	61	93.85
11–20	21	9.81	193	90.19
More than 20	21	21.43	77	78.57

tenance, 30.7 % on IS project outsourcing, 13.9 % on the development of new IS in-house, and 11.1 % on Commercial packages customization and integration. Collected data reveal that 46 out of 377 respondent organizations adopted ISDM to develop their information systems (12.2 %); out of those 46 organizations that adopted ISDM in their system development, 3 were from government organizations and 43 were from the private sector. The vast majority in both government and private organizations were non-users of ISDM (90.32 %) and (87.57 %), respectively. This is due to the fact that most IS departments in the surveyed organizations were not involved in information system development activities.

In terms of ISDM usage across business activities, it can be observed that the highest percentage of the ISDM adopters were Consultants/Software Houses/IT vendors (33.33 %) and Manufacturing/Mining/Petroleum/Energy (12.9 %). Interestingly, two business sectors (Travel/Transportation and Telecommunications/Networking) were found not to be using any ISDM. Moreover, ISDM adopters were large organizations, 76 % in organizations with more than 1,000 employees. Following the ISDM usage across business activities and organization size, the data shows that larger IS departments are more likely to adopt ISDM: IS departments that comprised 21–100 employees (26.32 %), 6–20 (7.14 %), and 1–5 (0.92 %).

Table 4 Popularity of ISDM

Information system development methodologies (ISDM)	Number	Rank
In-house methodology	21	1
Oracle development methodology	14	2
Structured systems analysis and design method (SSADM)	10	3
Rapid development method	9	4
Dynamic systems development method (DSDM)	8	5
Rational unified process (RUP)	6	6
Internet-speed development (ISD)	2	7
Information engineering methodology (IEM)	2	8

The analyzed data revealed that the adoption of ISDM increased with the experience of the IS department. That is, the older the IS department, the more likely it is to use ISDM for IS development: only 4 (6.15 %) of the organizations using ISDM for IS development had 1–10 years experience, 21 (9.81 %) had 11–20 years experience, and 21 (21.43 %) had 20 years of experience or more. The data indicate that the IS managers who adopted ISDM for IS development had a university degree (12.50 %) or masters and above (18.84 %). None of the IS managers with a college or less level of education use ISDM. In terms of ISDM usage versus IS managers' experiences in IS development, the data shows that 4 (9.09 %) of the IS managers using ISDM for IS development had 1–5 years experience, 11 (8.5 %) had 6–10 years experience, 9 (10.98 %) had 11–15 years experience, 12 (12.25 %) had 16–20 years experience, and interestingly the highest percentage (41.67 %) had more than 20 years experience.

Table 4 shows the rank of the most popular ISDM by the surveyed organizations. The analyzed data indicates that eight different ISDM were found to be used by the surveyed organizations. Several important observations can be made on the basis of Table 2; first, many ISDM presented in our comprehensive questionnaire were never used by Omani organizations. Second, in-house methodologies were found to be quite common compared with third

Table 5 Level of ISDM usage

Information system development methodologies (ISDM)	Mean ($N = 46$)	Below Average use	Average Use	Above Average use
Internet-speed development (ISD)	5	0	0	2
Rapid development method	4.3	0	7	2
Information engineering methodology (IEM)	4	0	1	1
Oracle development methodology	3.9	3	5	6
Rational unified process (RUP)	3.8	2	1	3
In-house methodology	3.7	5	9	7
Dynamic systems development method (DSDM)	3.6	2	3	3
Structured systems analysis and design method (SSADM)	3.6	3	5	2

party methodologies. Third, Oracle Development Methodology seems to be the most popular third-party ISDM in Oman. Fourth, SSADM (Structured systems analysis and design method) still represents an acceptable level of usage. Lastly, important ISDM such as Checkland's Soft System Methodology (SSM) [44], Multiview [19], and Extreme Programming (XP) [45] are not used at all in practice in Oman.

Table 5 shows the extent to which the identified ISDM is being practiced (i.e. the level of ISDM usage). The respondents indicated their level of ISDM usage by rating each ISDM on a likert scale as 1 = never used, 2 = seldom used, 3 = frequently used, 4 = very frequently used, or 5 = always used. The responses were aggregated and reclassified as "below average use", "average use", or "above average use". The average number of ISDM reported per organization is 1.6. The data shows that Internet-Speed Development (ISD) is the most intensively used in the IS departments. This is followed by Rapid Development Method and Information Engineering Methodology (IEM).

The data findings also show that the decision to adopt ISDM is largely undertaken by IS managers (80.43 %), only (13.04 %) by committee, and (6.53 %) by project leaders. According to the data, IS managers believe there are associated benefits with the use of IDSM, but the degree of benefit slightly varied across organizations. Out of 11 benefits listed in the questionnaire, only 3 benefits received a low rating with a mean of 2 and above including better system documentation, improved productivity, deliver the system within approved budget, and users' acceptance. Interestingly, a slight majority (58.70 %) of ISDM adopters are not sure whether or not ISDM can help in getting users' acceptance. The respondents were also questioned about associated problems with the use of ISDM. The results show that the majority of the respondents disagreed with the statement that ISDM is very complex to use (71.74 %), very difficult to learn (76.09 %), increases the IS project duration (82.61 %), increases the cost of IS development (67.39 %), or not flexible and assume all IS project are the same (58.70 %). A relatively small percentage of the respondents agreed with these statements with ratings of 21.74 %, 13.04 %, 13.04 %, 10.87 %, and 15.22 %, respectively.

Slightly higher than one third (39.13 %) of the surveyed organizations provide on-the-job training on ISDM by in-house trainers. 8 (17.39 %) of the surveyed organizations provide on-the-job training on ISDM by external trainers. 11 (23.91 %) of the surveyed organizations provide training on ISDM by attending courses in external institutes. 13 (28.26 %) of the surveyed organizations provide training as self-study supported by books, Computer Based Training and/or videos. Only 4 (8.70 %) of the respondents do not provide any formal training.

The data indicates that the most popular techniques among ISDM users are Data modeling/Entity relation diagrams (97.83 %), Data Flow Diagrams (91.3 %), and Object orientation (e.g. Object, class, object relation model, etc.) (51.17 %). The case is similar for respondents not using ISDM. The interesting finding is that ISD techniques are widely used compared with ISDM and that non-users of ISDM still adopt ISD technique in their IS development process without following any methodology framework to co-ordinate the application of these techniques. The examined data reveals that all (100 %) respondents claim that they either partially or fully understand ISDM. However, 224 (67.67 %) out of 331 of respondents not using ISDM had never heard about SSADM, 77 (23.26 %) were aware of SSADM, and a small percentage (9.06 %) were of the opinion that they have partial or full understanding of SSADM.

Table 6 Statistical analysis of variables related to ISDM relative advantages

Variables	Q1	MD	Q3	IQR
Better end product	3	3	4	1
Better development process	3	3	4	1
Standardizing (provide standard development process)	3	4	4	1
Productivity (improve system development productivity)	3	3	4	1
Quality (produce better quality of information systems)	3	3	4	1
Documentation (produce better system documentation)	3	3	3	0
Speed of development (ability to produce the system within short time and according to user priority)	4	4	4	0
Schedule and budget (helps to deliver the system on time and within approved budget)	4	4	4	0
Speed of development (ability to produce the system within short time and according to user priority)	4	4	4	0
Maintainable (produce more maintainable information system)	4	4	4	0
Learning (provides useful means of learning from past experience)	3	4	4	1
Acceptance (helps to get users' acceptance)	4	4	4	0
Requirements (helps to meet users' requirements)	4	4	4	0
Configuration control (helps for controlling changes to the software requirements, software design, and code)	4	4	4	0
ISO compliance (as a means of achieving ISO certification)	3	4	4	1
Reduce risk (helps to develop more visible and transparent system by facilitating project management and control, thus reducing risk and uncertainty)	4	4	4	0

5 Results from the Delphi Consultation

The overall aim of the second empirical stage was to determine and analyze the variables that contribute to effective ISDM adoption. Judgments were solicited from a group of experts in a sequence of successive rounds [43]. A questionnaire containing 30 variables obtained from the literature regarding the ISDM adoption (evaluation and selection) was sent to 370 prospective panel members. The potential members were IT/IS managers. In the first round of Delphi method, potential members were asked to rate the level of importance of each of the ISDM adoption variables, and identify more variables that they think are important for the study. The received responses were compiled and consolidated, and a final list of 40 variables was produced. The same procedure was followed for each successive round. Three rounds of Delphi surveys were performed to achieve consensus. Data from the three iterations of the questionnaire were collected during July through September 2009. The analyses of each of the 40 variables were accomplished employing SPSS software. The statistical Median (MD), Quartile One (Q1), Quartile Three (Q3), and Interquartile Range (IQR) were employed to identify the critical ISDM adoption variable, measure level of importance of these variables, and to assess group consensus about these variables. The Delphi process provided three important categories of information about ISDM adoption variables including assent, consensus, and level of importance. A group rating of assent for each of the 40 ISDM adoption variables was driven using a Likert five-value scale (0, 1, 2, 3, 4). That is, to eliminate variables considered not applicable or not important, a median criterion of less than 2.0 was selected. All remaining variables with a 2.0 median or higher were therefore included in the list of accepted variables (i.e. 4 = Very Important, 3 = Moderately Important, 2 = Somewhat Important). The results obtained indicate that the median of the 40 variables included in the Delphi research questionnaire revealed that none of the variables fell below the criterion of 2.0. Therefore, the Delphi study provided a confirmed group of 40 ISDM adoption variables that can be used for ISDM evaluation and selection. The following is a summary description of the research findings from this stage of the study.

5.1 Perceived Relative Advantage

This is the key variable that drives an organization to adopt ISDM or any technology. Relative advantages are perceived benefits gained from ISDM usage. In general, expected advantages from ISDM use may include better end product, better development process, standardizing system development process, increasing productivity and quality, better system documentation, etc. [18,24,42].

Table 6 displays the statistical analysis (with some descriptions) of the variables driven from final round of the Delphi

Table 7 Statistical analysis of variables related to ISDM features

Variables	Q1	MD	Q3	IRQ
Cost of ISDM (including training, hardware and software, and continuous consultancy)	4	4	4	0
Customizable (the ability of the ISDM to be adjusted to meet a particular requirement of the IS project)	4	4	4	0
Compatibility (relevance to organization and practitioner in terms of technical knowledge experience, and social and communication skills	4	4	4	0
Techniques (those are used within the methodology such as DFD, UML, etc.)	4	4	4	0
Rules (guidelines for how to use techniques, tasks, etc)	4	4	4	0
Scope (the stages covered by the ISDM in the system life cycle)	4	4	4	0
Problem analysis (ability to express problem and objectives of an organization)	4	4	4	0
IS project management (ability to provide a suitable means of project planning, control, and estimation)	4	4	4	0
Communication (ability to provide effective communication media across development team)	3	4	4	1
Simplicity (simple to understand and use, and to teach to others)	3	3	4	1
Development model (a representation of phases or stages of information system development such as traditional 'waterfall', iteration, etc.)	4	4	4	0
Observability (ability to see if it works before using)	4	4	4	0
Trialability (ability to test it before using)	4	4	4	0
Reductionist (decompose the system development to be developed in workable modules)	3	4	4	1
Flexibility (ability to utilize structured techniques, object oriented techniques, or both)	3	4	4	1
Supplier support (availability of training and technical support from ISDM supplier)	3	3	4	1
Tools support (e.g. configuration, repository, etc. as well as the ability for extension to incorporate new tools)	3	4	4	1

method, including Median (MD), Quartile One (Q1), Quartile Three (Q3), and Interquartile Range (IQR).

5.2 ISDM Properties and Features

This variable directly influences new ISDM adoption. ISDM feature variables include: ISDM costs, ability to customize ISDM on a project-by-project basis, simple to understand and teach, compatibility with existing systems, techniques utilized within ISDM, observability, trialability, and flexibility [18,24,42]. Table 7 illustrates the statistical analysis of variables related to ISDM properties and features.

5.3 Organizational Environment

These should be suitable for accommodating new ISDM in order to obtain advantages from ISDM use. Organizational issues include: sufficient resources and facilities, management support, developer acceptance, developer experience, and developer skill and knowledge [6]. Customer behavior is related to customer acceptance and satisfaction which is the main concern for any organization considering adopting new ISDM for commercial purposes. In relation to customer behavior, [24] stated that some government organizations during the 1980s and 1990s determined certain ISDM to be used for their system development, for instance, SSADM in the UK, Merise in France, Dafne in Italy, and NIAM in the Netherlands [41]. This demand from customers puts significant pressure on an organization to adopt a particular ISDM. Table 8 presents a summary of ISDM variables related to organizational and customer issues.

6 Analytical Hierarchy Processing Analysis and ISDM Adoption Model

This section discusses the process of using AHP to assist decision-makers in selecting the best ISDM by prioritizing ISDM alternatives. The model development presented provides the answer to the third research question (RQ3).

Table 8 Statistical analysis of organizational and customer variables

Variables	Q1	MD	Q3	IRQ
Resources (sufficient resources and facilities)	4	4	4	0
Management support	4	4	4	0
Developer acceptance	3	3	4	1
Developer experience (the experience of the developer in using the ISDM)	3	4	4	1
Developer skill and knowledge	3	4	4	1
Customer acceptance (as standard ISDM specified by customer for their system development)	4	4	4	0
Customer satisfaction (helps to make users more satisfied)	4	4	4	0

This section describes the process of structuring the generic model for ISDM adoption utilizing the concept of AHP and based on the primary data (i.e. variables) driven from the Delphi method. AHP was developed at the Wharton School of Business by Thomas Saaty (Forman and Selly 2002). It is used for structuring of ill-defined problems and its aim is to assist decision makers in selecting the best option from a number of alternatives based on his/her information, knowledge and experience, by conducting a pairwise comparison of the important variables. This approach of decision-making includes both quantitative and qualitative variables in hierarchical structure, encompassing mainly three levels:

- Goal (the purpose of the AHP decision model).
- Variables / criteria (may extended to several levels of sub-variables).
- Alternatives.

AHP starts by defining the problem and the goal of the solution to that problem. In addition, the decision model needs the identification of variables that must be considered in the model to achieve that goal. These variables are then arranged in a hierarchy, from general variables to sub-variables and so on. Finally, the decision model requires the determination of the alternatives or the possible outcomes of the model and these outcomes are largely dependent on the interpretation of the decision makers for the problem based on their information, knowledge and experience. Once the hierarchy structure of the model is completed, the decision-maker begins to conduct a pairwise comparison to derive weights known as 'priorities' for each variable in the AHP hierarchy structure model. The alternatives are then judged by rating each alternative to each variable in order to develop the overall priorities for all alternatives in the model (Saaty and Vargas 2001; Saaty 1999). Descriptions of the general ISDM adoption decision model as well as the process of adjusting and quantifying the model now follow.

This stage of the study used interviews and questionnaires as methods of data collection in the context of the selected case study, the IT department of the largest bank in Oman. The purpose of the data gathering instruments is to obtain data for the suggested ISDM adoption model. The data was gathered from the case study to examine the reliability, validity, and practicality of the proposed model and to adjust and quantify it.

The case study was conducted with the assistance of the IT department. ExpertChoices software solution is chosen to develop the ISDM decision adoption model. This approach of decision-making includes both quantitative and qualitative variables in a hierarchical structure, encompassing mainly three levels:

- Goal (the purpose of the AHP decision model).
- Variables/criteria (may extended to several levels of sub-variables).
- Alternatives.

AHP starts by defining the problem and the goal of the solution to that problem. In addition, the decision model needs the identification of variables that must be considered in the model to achieve that goal. These variables are then arranged in a hierarchy, from general variables to sub-variables and so on. Finally, the decision model requires the determination of the alternatives or the possible outcomes of the model and these outcomes are largely dependent on the interpretation of the decision makers for the problem based on their information, knowledge and experience. Once the hierarchy structure of the model is completed, the decision-maker begins to conduct a pairwise comparison to derive weights known as 'priorities' for each variable in the AHP hierarchy structure model. The alternatives are then judged by rating each alternative to each variable in order to develop the overall priorities for all alternatives in the model [39,46].

All model variables were obtained from the second empirical stage of this study using the Delphi technique. The main variables consist of (a) relative advantages, (b) ISDM features, (c) organizational environments, (d) customer behaviors. Each main variable is comprised of several sub-variables. For example, relative advantages were further elaborated as better end product, better development process, standardizing system development process, improve system development productivity, etc.

The alternatives of the model are all possible outcomes of the ISDM adoption decision model. The choices of the ISDM alternatives are to some extent dependent on the decision makers' explanation of the problem situation based on their opinion, perception, information, knowledge and experience. The alternatives for the proposed model can be any ISDM that the decision makers perceive as a potential solution that

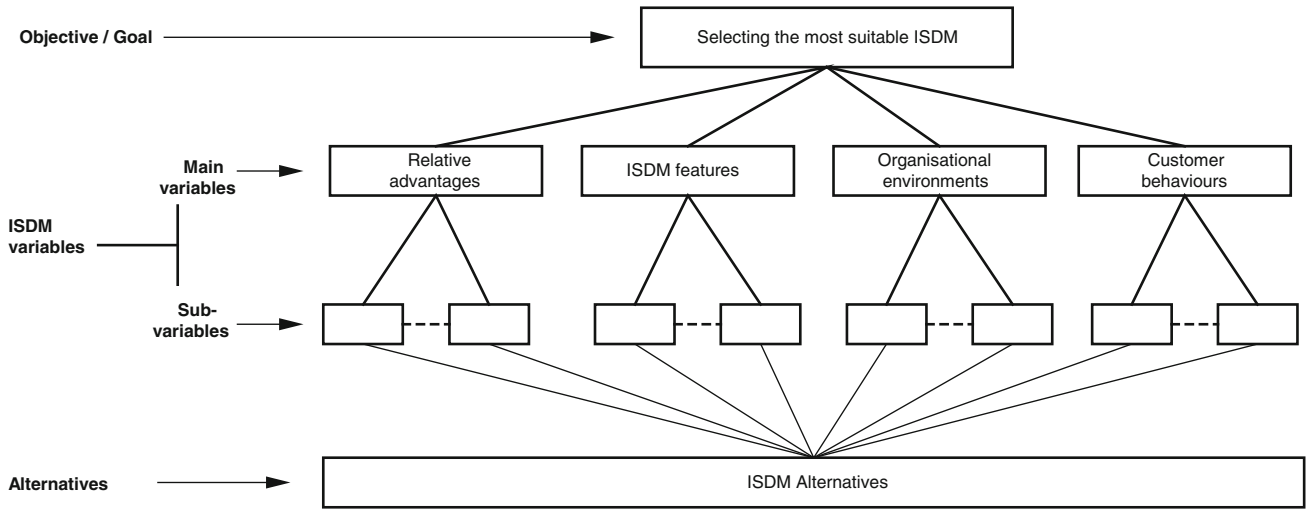

Fig. 1 The conceptual models for ISDM adoption

would fulfill the IS department's objectives in their organization in term of information system development. According to [47], two constraints must be considered in determining the alternatives:

- The number of alternatives must be less than nine for two reasons: (i) a simpler evaluation from the expert who gives judgments, and (ii) computational efficiency.
- The alternatives must represent real cases.

As Fig. 1 illustrates, the proposed model for ISDM adoption comprises four levels. The first level is the objective (i.e. the goal) of the model, which is to choose the most preferred and appropriate ISDM in accordance with the organization's objectives. The second and the third levels are the main variables and sub-variables respectively. These variables have great importance since a deeper level of analysis allows identification of all the variables and sub-variables that could be relevant for the choice.

The fourth and final level of the ISDM adoption decision model includes the alternative solutions (i.e. the possible outcomes or the preferred ISDM).

The proposed model for ISDM evaluation and selection facilitates the reduction of the complexity of ISDM adoption decisions to a series of pairwise comparisons and helps decision-makers to obtain the best decision as well as providing a clear rationale for that decision. The model development comprises three stages: structuring a problem; eliciting information and values; and evaluation. The "eliciting information stage" identified the potential ISDM alternatives to be: Dynamic Systems Development Method (DSDM), Extreme Programming (XP), in-house methodology, Structured System Analysis and Design Methodology (SSADM) and Rational Unified Process (RUP). These alternatives were evaluated based on the high and low level variables (i.e. main variables and sub-variables) such as relative advantages, features of ISDM, and organizational environment.

The pairwise comparison technique process was conducted for all possible pairs of variables on the high and low level variable in order to determine the relative weights of each variable in the model. The evaluation was also conducted to evaluate the specified alternatives and conduct sensitivity analysis using the ExpertChoice software. The model analysis revealed that the most suitable and preferred ISDM were the in-house methodology and RUP, respectively.

7 Discussion

The first part of this section discusses the research hypotheses. This is followed by a discussion of each of the three research questions that underpin our study.

7.1 Discussion of the Research Hypothesis

The fieldwork described in the paper was performed to investigate the impact of nine variables on ISDM adoption using two statistical techniques; chi-square and regression analysis. These two techniques were widely used by social researchers to test research hypotheses [48]. This is also the case for testing research hypotheses related to ISDM [18,24,25]. The chi-square was used to identify the relationship between ISDM adoption and several aspects related to organizational and ISDM features including type of organization, business activity, organizational size, IS department size, experience of IS department, and knowledge barrier. The results of the chi-square are presented in Table 9. Only statistically significant variables were further analyzed using regression analysis,

Table 9 The results of Chi-square testing for research hypotheses

Research hypothesis	Chi-square values (χ^2)		Remark
	Calculated	Critical	
Type of organization ISDM adoption patterns differ from public to private organizations df = 1, $\alpha = 0.01$	$\chi^2 = 0.3$	$\chi^2 = 6.63$, at	Insignificant
Business activity ISDM adoption is different across business categories df = 4, $\alpha = 0.01$	$\chi^2 = 20.4$	$\chi^2 = 13.28$, at	Significant
Organizational size there is a positive relationship between organizational size and ISDM adoption df = 3, $\alpha = 0.01$	$\chi^2 = 50.7$	$\chi^2 = 11.34$, at	Significant
IS department size there is a positive relationship between IS department size and ISDM adoption df = 2, $\alpha = 0.01$	$\chi^2 = 34.9$	$\chi^2 = 9.21$, at	Significant
Experience of IT/IS department there is a positive relationship between experiences of IT/IS department and organizational adoption of ISDM. df = 2, $\alpha = 0.01$	$\chi^2 = 11.1$	$\chi^2 = 9.21$, at	Significant
Knowledge barrier there is a negative relationship between knowledge barrier and organizational adoption of ISDM. df = 1, $\alpha = 0.01$	$\chi^2 = 79.2$	$\chi^2 = 6.63$, at	Significant

Table 10 The regression analysis results for research hypotheses

	ISDM adoption (R)	P-value
Business activity	0.21	$P \leq 0.05$
Organizational size	0.33	$P \leq 0.05$
IT/IS department size	0.43	$P \leq 0.01$
Experience of IT/IS department	0.26	$P \leq 0.05$
Relative advantage	0.71	$P \leq 0.001$
Compatibility	0.57	$P \leq 0.001$
Knowledge barrier	−0.79	$P \leq 0.001$

employed to examine how these variables are interrelated and associated with ISDM adoption. Regression analysis is a method for detecting and describing associations between a pair of categorical variables [48]. The results of the regression analysis are presented in Table 10. The degree of ISDM use was examined between the public and private organizations.

Based on the results presented in Table 9, the chi-square tests found no significant relationship between ISDM adoption and type of organization ($\chi^2 = 0.3$, df = 1, $\alpha = 0.01$). In order to determine if ISDM adoption differs significantly between IS department in different business areas, a chi-square analysis was performed. Consultants/Software Houses/IT vendors firms report the highest percentage of ISDM adoption. They are followed by IS departments in the Manufacturing/Mining/Petroleum/Energy, who reported the second highest percentage. The results indicate that methodology use differs significantly between IS departments in different business activities ($\chi^2 = 20.4$, df = 4, $\alpha = 0.01$).

In order to assess the impact of organization size on ISDM adoption, the surveyed sample was divided in two broad groups: a small organization group (includes two subgroups as 1–50 and 51–100 employees) and a large organization group (includes two subgroups as 101–1,000 and more than 1,000 employees). The analysis of ISDM adoption across small and large organizational size using chi-square tests shows that there is a significant relationship between size of organizations and ISDM use ($\chi^2 = 50.7$, df = 3, $\alpha = 0.01$) and that ISDM adoption is significantly more likely in larger organizations (with employees of 101–1,000 and more than 1,000). Furthermore, the impact of IS department size within an organization on ISDM adoption was examined using chi-square tests. The chi-square tests indicated that there is a significant relationship between size of IS department and ISDM adoption ($\chi^2 = 34.9$, df = 2, $\alpha = 0.01$).

The surveyed organizations were grouped into three categories as novice (1–10 years), matured (11–20 years), and very experienced (more than 20 years), to investigate the impact of age of IS department of an organization on ISDM adoption.

The largest percentage of ISDM adopters comes from very experienced organizations (21.43 %) compared to that of novice organizations (6.15 %). The chi-square tests found the difference in the degree of ISDM adoption between these variables ($\chi^2 = 34.9$, df = 2, $\alpha = 0.01$) to be statistically significant. Interestingly, only 143 (37.93 %) of IS managers of the surveyed organizations have studied or attended ISDM courses. Out of these, 46 (100 %) adopted ISDM for information system development, while, the majority (62.07 %) of IS managers from the surveyed organizations did not study or attend any course in ISDM. To investigate the impact of knowledge barrier on ISDM adoption, the IS managers from the surveyed sample were grouped into two categories, those who have studied or attended ISDM courses (i.e. they have knowledge and understanding of ISDM) versus those who have not (i.e. they do not know much about ISDM). The chi-square test found a significant relationship between these two variables ($\chi^2 = 79.2$, df = 2, $\alpha = 0.01$). These two variables were further analyzed using regression analysis to investigate the degree of association and the effect of change of

one variable to the value of the other. The regression analysis was employed to measure the strength of the relationship between ISDM features (i.e. relative advantage, complexity, and compatibility) and ISDM adoption. In addition, the five different aspects of ISDM adoption identified as statistically significant (i.e. by chi-square test) were further examined using regression analysis. Table 10 shows the results of the regression analysis.

The values shown in the second column of Table 10 are called correlation coefficient (R). R is a measurement of the strength between two variables and its value must fall between -1 and $+1$. The closer the value of R is to $+1$, the stronger the positive relation between the two variables, and the closer the value of R to -1, the stronger the negative relation between the two variables. However, if the value of R is close to 0, then this means that there is either a week relation or no relation at all.

In order to use business area in the regression analysis, it was ranked on an ordinal scale from 1 (lowest adopter) to 5 (highest adopter) as follows: Ministries/Admin. and Public services (1), Wholesale/Retail Trade (2), Finance/Banking/Insurance/Investment (3), Manufacturing/Mining/Petroleum/Energy (4), and Consultants/Software Houses/IT vendors (5). The results indicate that the business area of an IS department is related to the ISDM adoption.

More specifically, adoption of ISDM is highest in IS departments in Consultants/Software Houses/IT organizations.

In accordance with the research hypothesis where it is postulated that there is a positive relationship between the size of an IS department and organization with ISDM adoption, the results of regression analysis confirm that both the size of an IS department and organization were positively related to the use of ISDM. This is an expected result, since ISDM are perceived as mechanisms devised especially for large organizations. Furthermore, the experience of IT/IS departments is significantly related to ISDM use. This is consistent with many empirical studies findings such as [18,25].

To investigate the effect of perceived relative advantage on ISDM adoption, the IS managers from the surveyed sample were presented with several statements related to the advantages of ISDM use such as quality of developed IS, IS documentation, IS development productivity, etc. The IS managers were then asked to rate each statement based on five-point likert scale, where 1 = totally agree and 5 = totally disagree. Regression analysis shows that there is a strong positive relationship between relative advantage and ISDM adoption. This indicates that relative advantage reflects the perceived support provided by ISDM and their impact on the quality of the IS development and IS project control.

The case is similar for the variable compatibility, as the data analysis obtained from regression analysis shows that there is a strong positive relationship between compatibility and ISDM adoption. However, in contrast to the research hypothesis where it is postulated that there is a negative relationship between ISDM complexity and ISDM adoption, the results of regression analysis indicate that there is no relation between these two variables. One explanation might be that the majority of the respondents are not using ISDM; therefore, they might not have a clear picture of ISDM complexity. Finally, the results of this study indicate that lack of knowledge is the main barrier for not using ISDM in system development. Regression analysis shows that there is a strong negative relationship between knowledge barrier and ISDM adoption.

7.1.1 Current Status of ISDM Practices (Research Question 1)

Section 4 provided a comprehensive review of the consultation with a view of understanding the status of ISDM practices in Oman. The empirical survey tested a number of variables to examine the extent to which these variables affect ISDM adoption.

Nine variables were empirically tested including type of organization, business activity, organization size, IS department size, age of IS department, knowledge barrier, relative advantage, complexity, and compatibility. The findings of the survey reveal that a significant relationship is lacking between type of organization and ISDM adoption, and between complexity and ISDM adoption. However, the remaining seven variables were found to have some relationship with ISDM adoption and the degree of the impact of these variables varies from one variable to other.

7.1.2 Variables and their Level of Importance (Research Question 2)

The purpose of the second empirical stage of this study was to identify and analyze ISDM adoption variables that contribute to effective evaluation and selection of ISDM. In order to achieve this purpose, the study utilized Delphi technique to establish a communication medium between a group of IS experts in order to elicit their opinion about ISDM adoption variables.

As a result, a final list of 40 ISDM variables with their statistical descriptions was generated. The data analysis of the third questionnaire produced three important types of information for each variable in the questionnaire as follows:

- Rating of assent: used to determine the applicable ISDM variables for decision making. The level of assent was extremely high. As the results show that all variables received a high level of assent.

- Degree of consensus: the interquartile range (IQR) was employed to determine the level of consensus for each variable identified from the Delphi study. In relation to this study, the data analysis revealed that 24 variables received the highest degree of consensus, 16 variables received the average degree of consensus, and no variables received the lowest degree of consensus.
- Level of importance: identified by using the statistical median for each variable. In relation to this study, the findings of the research revealed that all 40 ISDM adoption variables were rated at a level of importance of moderately important or very important).

7.1.3 Requisite Model of ISDM Adoption (Research Question 3)

The third empirical stage of this study focused on developing a general ISDM adoption decision model based on the variables obtained from the Delphi technique. In addition, this stage concentrated on adjusting and quantifying the general ISDM model based on the selected organization employees' perspective in order to examine the practicality of the model.

The first stage was to identify the objectives that the case study is aiming to achieve. Then, all potential ISDM alternatives were identified for evaluation under a set of specific variables. The five ISDM alternatives perceived to fulfill the needs of the IS department of the case study objective are: Dynamic Systems Development Method (DSDM), Extreme Programming (XP), in-house methodology, Structured System Analysis and Design Methodology (SSADM) and Rational Unified Process (RUP). Each of these ISDM alternatives was evaluated using the same variables. High level variables consisted of relative advantages, features of ISDM, and case study environments. Each high level variable was sub-divided into low level variables, including specific issues detailed from the main variables. During the second stage, respondents were asked to weigh the level of importance (i.e. a pair-wise comparison judgment) of each criterion and then score all the alternatives against the specified criteria. The last stage evaluated the alternatives and conducted sensitivity analysis using the ExpertChoice software. Results from the AHP analysis revealed that the preferred ISDM was in-house methodology and the second alternative was RUP.

On reflection, the proposed model of ISDM adoption helps decision-makers increase their level of understanding and solving of problems, compares the rational results with their intuition, detects possible relevant reasons behind objective results, and allows them to improve their decision-making by adjusting weighting and scoring, and conducting sensitivity analyses. This model can be used and adapted in other socio-organizational contexts, including in developed economies.

8 Conclusion

In addition to exploring the status of ISDM in Oman and reporting important information for both the research community and to practitioner, the research examined a systematic way of assessing ISDM alternatives with a view of developing an ISDM adoption model. The study has endorsed the idea that good decision-making should focus on objectives and not on alternatives. Nine variables were empirically tested including type of organization, business activity, organization size, IS department size, age of IS department, knowledge barrier, relative advantage, complexity, and compatibility. The findings of the survey reveal that a significant relationship is lacking between type of organization and ISDM adoption, and between complexity and ISDM adoption. However, the remaining seven variables were found to have some relationship with ISDM adoption and the degree of the impact of these variables varies from one variable to other. Finally, Delphi and AHP were combined in a model and used in evaluating ISDM alternatives in a complex decision-making process. Both techniques have not been used before to evaluate and facilitate ISDM adoption.

In terms of limitations, this research investigated ISDM adoption based on the views of senior IS managers in charge of IT/IS departments within the surveyed organizations in a developing country, namely, the Sultanate of Oman. Therefore, the investigation was limited within this particular country, in terms of ISDM use, techniques, IS environment, trend of ISDM adoption, barrier, etc. The study did not investigate the ISDM practices from the IS developer point of view. IS developers input could differ considerably from that of their senior IS managers, and such differences should be investigated thoroughly as they may provide new insight on the ISDM adoption phenomenon. This research employed the Delphi method and was conducted in the UK. The rationale behind this stage relates to the availability of experts in the ISDM field in the UK compared with Oman where the number of ISDM experts is very limited. Thus, this stage was limited to ISDM experts from UK organizations and was conducted during a specific period of time. Finally, the application of the ISDM adoption model and the primary data at collected were conducted within the context of a single Omani organization, which represents the viewpoint of the selected organization personnel towards the adoption model variables.

Future studies on ISDM practices within the context of developing countries are highly recommended to manifest the status of ISDM practices in these developing economies. From an ISDM adoption decision support perspective, future research should explore the use of other decision-making techniques such as System dynamics (SD). The authors have recently engaged in this direction and results will be reported in follow-on publications. Finally, the authors would like to

encourage the deployment and validation of the proposed model of ISDM adoption in other socio-organizational settings. This forms the focus of a number of ongoing PhD research in the main author's institution.

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