Adopting Cloud Based Software Development using the Human Cloud

Mohamed K. Watfa, Nawar Hakeem, and Iyad A. Atatra

Faculty of Engineering & Information Sciences
University of Wollongang in Dubai, UAE

{mohamedwatfa, nawar, iatatra}@uow.edu.au

Abstract

Due to emerging technologies, mainly cloud computing, the "Human Cloud" has evolved from the old offshore insourcing and outsourcing models to newer model definitions utilized mainly by software developers. This research paper uses qualitative research analysis to find critical success factors for the IT trend of cloud based software development. We use the human cloud in the local market based on the old offshore sourcing model and the “virtual software development teams” model. Using the cloud as the facilitator for the whole software development process, we propose a new cloud based software development model using the human cloud and compare it with existing models.

Keyword: Human Cloud, Cloud based software development, Virtual Teams, Offshore insourcing and outsourcing.

I. Introduction

The new trends in cloud computing introduced dramatic changes in the business world especially in the IT industry. These changes proposed solutions for existing challenges and created new opportunities including cloud based software development using the human cloud which has

emerged from the intersection of two areas: offshore insourcing and outsourcing for software development and collaborative global software development as can be depicted in Figure 1.

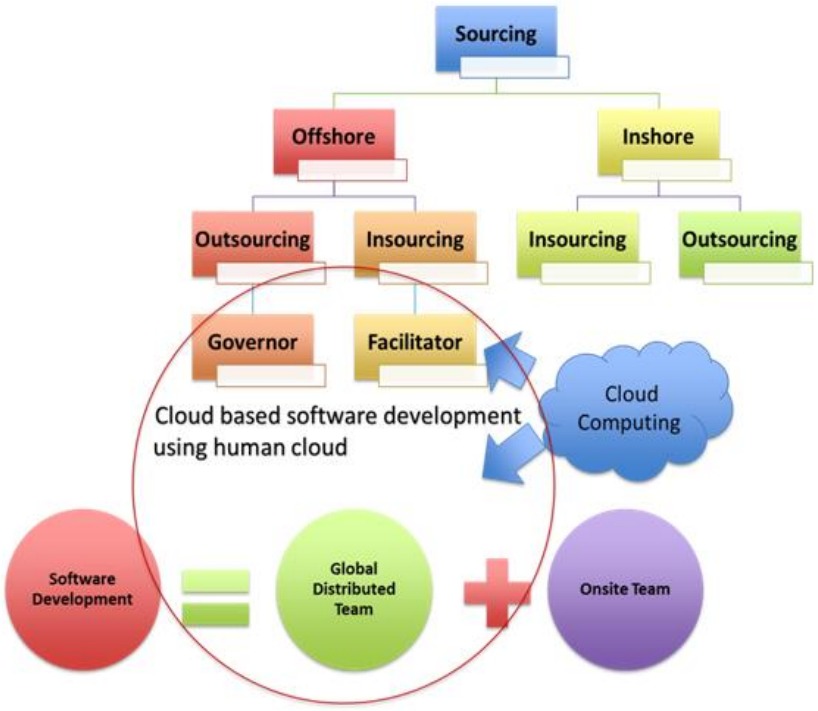

Figure 1: Cloud based software development using the Human Cloud

These areas were facing several challenges such including language and culture differences, communication difficulties, management challenges, and trust issues. The introduction of cloud computing attracted both areas to benefit from its capabilities where on one hand, the outsourcing sector provided solutions including people as a service aka the "human cloud", while on the other hand the collaborative global software development provided solutions that adopted the cloud as a base to facilitate the software development. The human cloud model allows organizations to hire a virtual team that is scattered over the cloud and is facilitated through middlemen. The human cloud overcomes some of the challenges and failure factors associated with offshore outsourcing and insourcing while reserving their advantages such as cost savings and higher skill sets. Cloud based development facilitates the software development for virtual teams and allows scattered teams to

have their centralized development environment to be located in the cloud. Companies have found a perfect combination between these two new models extending their development teams through the human cloud and facilitating the development through a cloud based development. Although this combination model can have different implementation approaches including the use of private or public clouds for the development environment and the use of a human cloud for outsourcing or insourcing, all these implementations have common characteristics that can be utilized.

The purpose of this study is to define the most relevant success factors for adopting cloud based development using the human cloud in the local UAE market. We aim to study the level of awareness and readiness for the local IT development companies to adopt the human cloud and provide a set of recommendations for the successful adoption of cloud based development using the human cloud. We focus on a unique model which combines the characteristics of offshore sourcing, cloud computing and virtual software development teams.

Problem statement and Research Question

To understand the success factors for adopting the cloud based software development using the human cloud, it is important to understand the unique characteristics for this model. We will start by putting it in the right context and then develop the right framework based on the available literature. The cloud based software development using the human cloud emerged from the intersection of two areas: offshore insourcing and outsourcing for software development and collaborative global software development.

The literature provided frameworks for each these areas separately, but none have studied this unique model and provided a roadmap for software companies in order to help them adopt this model successfully. This research will try to answer the following research questions:

Question 1: *What are the critical success factors for the IT trend of adopting cloud based software development using the human cloud?*

Question 2: *What are the recommendations that would help local companies to utilize the human cloud?*

Research Methodology

The type of investigation used in this research is a non-casual correlational and longitudinal study. The basic unit of analysis is the IT industry and more specifically the software development industry. The methodology utilized in this research consists of a number of non-contrived methodologies divided into two phases:

- In the first phase, an exploratory research and literature survey is used to identify the characteristics of the cloud based development model and define the critical success factors for this model based on a combination of several existing models.
- The second phase involves a qualitative study based on interviews and surveys to identify the critical success factors for cloud based software development using the human cloud for local companies in the UAE.

The rest of this paper is divided as follows. Section II discusses the related literature review. Section III discusses our research methodology and sampling techniques. The results, findings and discussions are discussed in Section IV. We conclude this paper in Section V.

II. Literature Review

A. Introduction

Offshore software development includes performing the software development in a country where the customer is located in a different country. There are many reasons why organizations go for offshore sourcing including the need to access new technologies or reach new markets; however, the

main reason for offshore sourcing is the low cost of labor in developing countries (Stratman, 2007). The offshore model started in the 80s where skilled personal relocated to the client side to work onsite on "Time & Material" basis. Although this model is still valid, another model emerged in the mid 90s which involved executing the project in remote locations. Today, organizations have utilized offshore talent in their R&D considering the need for complex products to be outsourced (Radkevitch, et al., 2006). Also, online marketplaces have contributed significantly to outsourcing as they facilitate IT professional services to allow more businesses to connect with freelancers and outsourcing providers. Many of the pioneers in this field have shown rapid growth, including "Rent a Coder" marketplace which was enjoying in 2006 over 12,000 IT projects per month with a 60% yearly growth. (Sharma & Loh, 2009). The increased offshore leverage can be depicted in Figure 2.

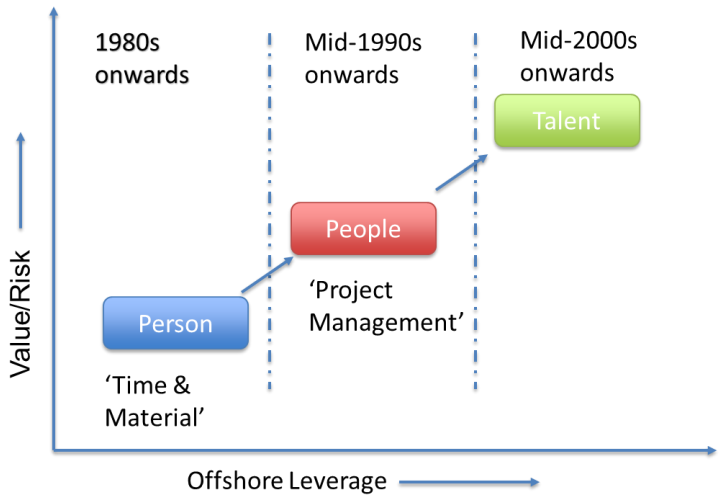

Figure 2: Increasing offshore leverage.

Radkevitch, van Heck, & Koppius (2006) where among the first who studied how online marketplace can facilitate the offshore outsourcing through the internet. Their study analyzed the differences and similarities between these marketplaces and their effects on the firm in terms of cost reduction. They concluded that the emerging marketplaces resulted in tremendous cost reduction on firms, and also lowered the market entry barrier allowing smaller firms to utilize and benefit from offshore outsourcing. Along with the growth of the technology, new models of outsourcing and

software development also evolved. Howe (2006) shaped the term Human-based electronic services and defined it as a specific form of crowd sourcing. The term people services (*pServices*) coined by Kern et al. (2009) refers to human-based electronic services. Kaganer, et al. (2013) used the "Human Cloud" term for the new generation of outsourcing that followed the older two models: *crowdsourcing* and *microsourcing*. Crowdsourcing is definied as delegating small repeatable tasks to a large number of people over the internet. Wikipedia is an example of a crowdsorcing project. Microsourcing allows a one-to-one relationship between the project owner and the outsourcing provider. Kaganer, et al. (2013) discussed the new human cloud models and defined four models:

1. *Facilitator*: In this outsourcing model, the marketplace connects both suppliers and buyers directly through a bidding process. This model is suitable for software development projects.
2. *Arbitrator*: In this model, the marketplace engages multiple suppliers through competitions.
3. *Aggregator*: In this model, the marketplace aggregates hundreds or thousands of micro tasks performed by multiple suppliers.
4. *Governor*: Another IT projects valid model which provides project governance and certifies supplier quality.

Both *Arbitrator* and *Aggregator* models involve simple work such as logo design, idea generation, and content generation. However, *Facilitator* and *Governor* (Lakhani, et al., 2010) models give the ability to outsource complex tasks and projects.

B. Challenges of Offshore Development Over the Cloud

The term "Offshoring" refers to performing the work in a remote location. Offshore sourcing can be either insourcing or outsourcing. The first challenge managers face is to choose which model is more appropriate for their organization. Although it is proven that offshore in-sourcing generally results in cost savings but still the hidden costs (search costs, transition costs, travel costs, layoffs and ongoing costs of managing the contract) need to be evaluated and considered as they can produce an inherit risk factor. It is highly important for managers to understand the cultural and legal issues in offshore

sourcing as they can have a major effect on the success or failure of projects. Early involvement of top management is important in setting up the right direction and making sure to keep ventures on track. It is important to realize that software development is a knowledge intensive task which has to be considered carefully and managers play a major role in defining what to be outsourced (Hanna & Daim, 2009). Hune (2006) differentiated between offshore insourcing and outsourcing and suggested a management discussion model.

We summarize the decision matrix that can be utilized by mangers based on prior research in Table 1.

	Insource	***Outsource***	***Human Cloud***	
			Concluded Results	
Development	**Subsidiary**	**OSP/ODC**	**Facilitator**	**Governor**
		Revenue benefits/risks		
Market entry/presence	√	no	no	no
Leverages/incentives	√	no	no	no
customer support	√	NA	no	no
		Cost benefits/risks		
Cost reduction	√	√	√	√
Initial investment	√	√	Less	Less
Risk: Hidden costs	NA	√	no	no
Risk: Other costs	√	√	No	No
Employee issues	√	√	√	√
		Productivity benefits/risks		
Increased capacity	√	√	√	√
talent shortage	√	√	√	√
Freeing up resources	√	√	√	√
non-core activities	√	√	√	√
		Productivity benefits/risks (cont.)		
knowledge loss	L	H	L	H
IP rights/ security	L	H	H	L
Control	L	H	L	L
SD Range	M to H	L to M	L to M	M to H
Resource flexibility	varies	M	H	H
Mngmt. complexity	L/H	M	M	L
		Quality Benefits/Risks		
Motivation to improve	L	H	L	H
flexibility	yes	N	yes	N
		Other Risks		

Backlash	some	more	More	Less
underperformance	√	√	H	L
Geopolitical risks	√	√	Less	Less

Table 1 : Summary of the Decision matrix for sourcing models.

Common challenges for offshore sourcing such as cutler differences, language and legal issues were discussed by many research papers including (Hanna & Daim, 2009) and (Stratman, 2007). Some major challenges identified include (but are not limited to):

- **Language**: where the differences in languages create a challenge especially when both parties do not have a common spoken language.
- **Culture**: where the culture differences act as a barrier from having a middle management in the case of offshore outsourcing. To overcome this, companies go for offshore insourcing where middle management is transferred to a remote location that can manage and control the remote team.
- **Differences in time zones**: it is always difficult to communicate and coordinate in different time zones but that sometimes can help in the software development process where the development is done in one place and the building and testing is done in a different place.

Other challenges include managing the relationship in offshore software development. For example, Gottschalk & Solli-Sæther (2006) presented a maturity model for the outsourcing relationship based on organizational theories and outsourcing practices.

We summarize our research findings for Human cloud based development in Figure 3 :

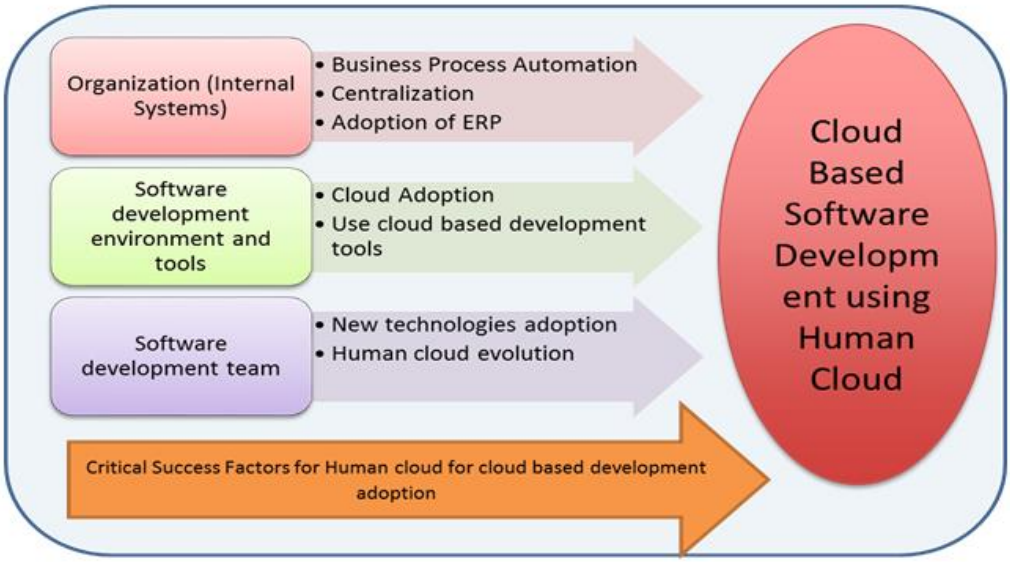

Figure 3: Research Summary of the Human cloud for cloud based development.

C. Adoption of the Human Cloud for Cloud Based Development

In this section, we discuss the technological readiness of an organization to adopt the human cloud and perform software development over the cloud. Our research focuses on the internal organizational readiness in terms of systems and processes and the role of technology in offshore outsourcing. We also research the management models which help leaders to engage the team in new technologies. Finally, we will look into existing literature in cloud software development.

Stratman (2007) discussed the effects of standardizing the transactional infrastructure of enterprise technologies by successfully adopting enterprise systems and the competency that can be developed by reducing and mitigating the challenges resulting from offshore governance. Stratman (2007) proposes that by successfully adopting ERP systems, the organization will be able to standardize its own transactional infrastructure which will result in building better competencies leading to a better management of the offshore business.

Another important dimension in adopting the human cloud for cloud based software development is the development team itself. The development team is the center of the whole development process

and they are the key players in the success of any development project. The team adoption involves introducing new cloud team members who will be playing a key role in the development process. This is an old field of study where team building theories are applicable (Tuckman & Jensen, 1977). These theories include forming, storming, norming, performing and adjourning theories which help mangers and team leaders to have a better understating to the team building process which usually would result in a better traditional team management.

Our research work focuses on the team adoption for the cloud using collaboration technology. Thomas & Bostrom (2010) proposed a five-factors model for adopting collaboration technologies in distributed software development teams which can help the team leader introduce this change successfully within his team. Five strategies ranging from less to more disruptive were discussed in the literature including:

1. **Switching**: which involves switching the team from one collaboration technology to another. This could be due to problems faced by the current technology.
2. **Expanding**: which involves expanding the current used technology.
3. **Merging**: which is applicable when sub-groups merge their similar usage tools into a single collaboration tool.
4. **Modifying**: which involves blocking types of usages for current technologies or adding additional features that require new interaction behaviors.
5. **Creating**: which involves introducing and using new technologies with new features.

The leader has a major role in team adoption strategies. With leader awareness of the new technology, more effective use of the technology adoption would be possible. Hashmi, et al., (2011) proposed a model to overcome the challenges faced in Global Software Development (GSD). They tried to look deeply into GSD challenges and apply the cloud privileges and characteristics to reduce or eliminate the negative effects of these challenges. Their model combines the cloud computing implementations together: PaaS (Platform as a Service), IaaS (Infrastructure as a Service), and SaaS

(Software as a Service). Hashmi, et al., (2011) propose that for globally distributed teams, a private cloud can help in resolving four challenges:

- **Geographic**: the use of the service will reduce the distance. The whole development environment can be hosted on the cloud, and therefore, it is available for all teams.
- **Cultural**: fair distribution of the work and high global visibility will help in reducing the negative cultural effects on the software development process.
- **Linguistics**: the use of multilingual services can reduce the impact of language barriers.
- **Temporal** (Lack of Motivation, Less visibility & Risk): with the cloud, the data will reside on a centralized location.

The advantage of this study over other similar studies is that it discussed the management depth of cloud based development and did not only focus on the technical directions. Cocco, et al. (2012) proposed a similar model to study facilitating the global software development using cloud computing and its effects on management. Their study was based on using agile software development methodologies on a cloud platform (Platform as Service – PaaS). Their model showed that cloud computing can provide perfect compatibility with global software development as the cost will be much lower. When using the public cloud, there will be no need for setting up the infrastructure or even maintaining it. It will also be easier to be reached from anywhere by the distributed team allowing efficient development team collaborations.

D. *Critical Success Factors for the Human Cloud*

Remus and Wiener (2009) studied the critical success factors (CSFs) for offshore software. Due to the lack of research defining clearly CSFs for offshore software development project, Remus and Wiener (2009) categorized the CSFs into six groups based on outsourcing research areas. They also studied twenty nine CSFs for offshore sourcing software development projects and ranked them according to different analytical dimensions. Their research was able to identify seven factors and

rank them as the most relevant general success factor for the OSD projects. These factors include: definition of clear project goals, continuous controlling of project results, ensuring a continuous communication flow, high quality of offshore employees, good language abilities, and composition of an appropriate project team**.** DeRosa & Lepsinger (2010) suggested four success factors for virtual teams: Communication, training, team composition, and team leadership. Milhauser (2011) added a fifth factor which is enabling technology. Goodbody (2005) summarized the virtual team success in three categories: Team foundation (including clear responsibility, agreed goals and linking performance measures to priorities); Trust & collaboration (including ensuring consistency, encouraging collaboration and celebrating achievements); and Team communication (including selecting appropriate technology and sharing information proactively). A summary of our research findings concerning offshore development and the human cloud is depicted in Figure 4.

Static	Dynamic
Internal suitability factors (ISF)	**Internal management factors (IMF)**
Sustained management support	Definition of clear project goals
Standardized and documented processes	Preparation of a detailed project specification
Efficient internal organizational structure	Definition of project standards
Appropriate internal technical knowledge	Early internal change management
Comprehensive experience with IT outsourcing projects	Selection of a suitable software component
International corporate culture	Creation of a cultural sensitivity among employees
	Development of a comprehensive business
External suitability factors (ESF)	**External management factors (EMF)**
High quality of offshore employees	Continuous controlling of project results
Good language abilities of the offshore employees	Ensuring of a continuous communication flow
Financial stability of the offshore provider	Composition of an appropriate project team
Standardized & documented processes on provider side	Creation of a partnership-like relationship
Legal and political stability in the offshore country	Establishment of an efficient IT infrastructure
comprehensive industry knowledge of the offshore provider	Ensuring bilateral knowledge transfer
Suitable company size of the offshore provider	Definition of an accurate contract
Geographical closeness of the offshore provider	Face-to-face meetings with the offshore provider

Figure 4: Summary of the critical success factors for offshore software development.

E. Our Proposed Theoretical Framework

Our proposed theoretical framework depends on two predefined frameworks as well as the adoption model, the offshore sourcing success factors and the virtual team success factors. Analyzing and combining both frameworks resulted in a new model for cloud based software development using the human cloud. The third adoption model is used to categorize the factors based on three dimensions: The organizational dimension, the cloud technology adoption and virtual team or offshore vendors. Figure 5 summarizes our proposed framework for cloud based software development using the human cloud. The framework consists of twenty factors with different ranks (Table 2 & 3) grouped in three areas: the virtual team, organizational internal factors and cloud factors. This logical grouping was a result of the extensive research analysis of existing research for cloud based software development adoption.

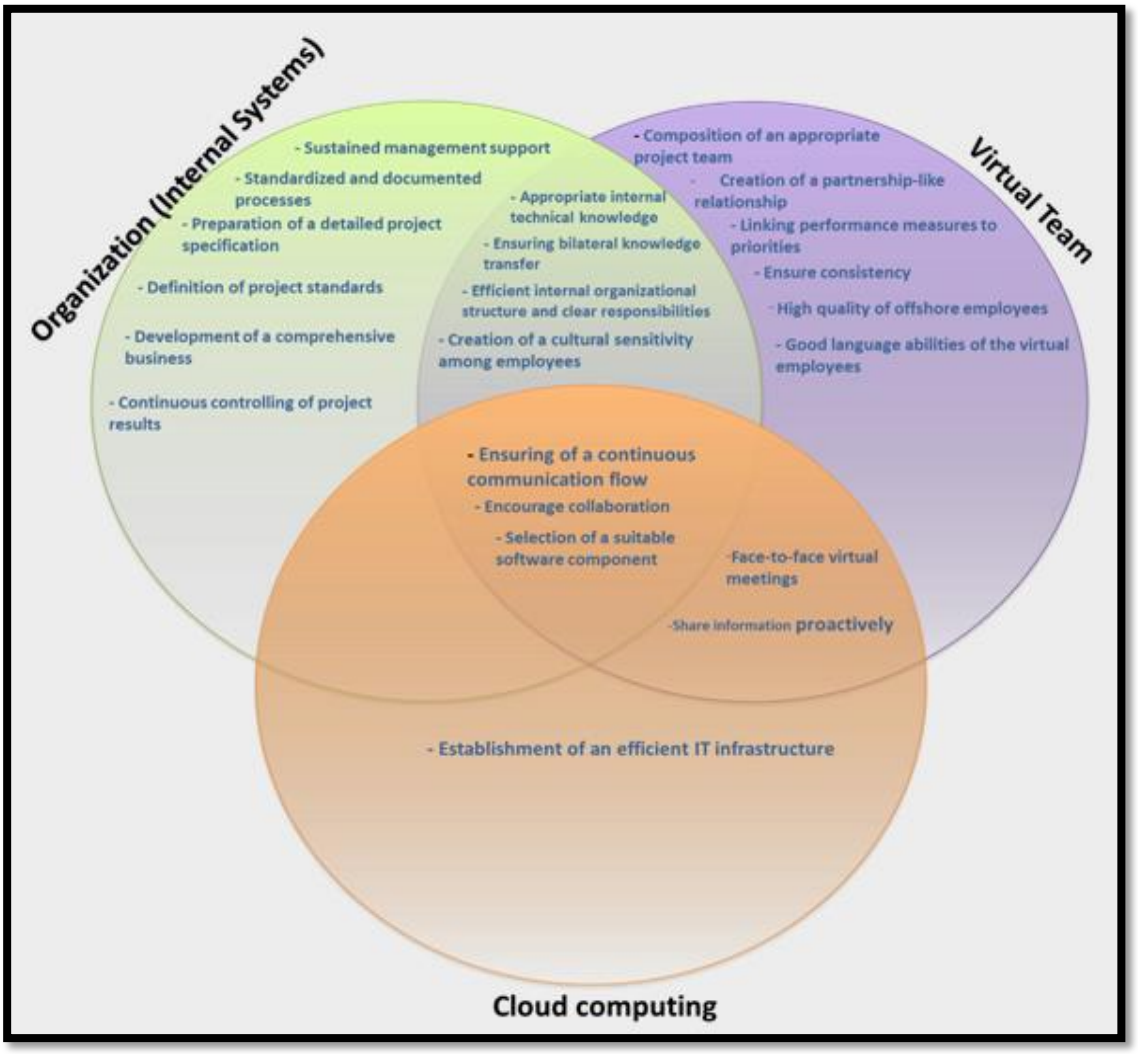

Figure 5: Our proposed framework – Cloud based software development using the human cloud

TABLE 2: OFFSHORE FACTORS	**%**
Continuous Controlling Of Project Results	94.6
Ensuring Of Continuous Communication	93.8
High Quality Of Offshore Employees	93.4
Language Abilities Of The Virtual Employees	91
Composition Of An Appropriate Team	90.8
Preparation Of A Detailed Project	90.4
Creation Of A Partnership-Like Relationship	86
Sustained Management Support	85.8
Efficient IT Infrastructure	85
Ensuring Bilateral Knowledge Transfer	84.8
Definition Of Project Standards	84.4
Standardized And Documented Processes	83.2
Face-To-Face Meetings With Virtual Provider	79
Selection Of A Suitable Software Component	78.6
Efficient Internal Organizational Structure	76.6
Appropriate Internal Technical Knowledge	71.8
Development Of A Comprehensive Business	68.4
Awareness Of Internal Corporate Culture	64.4
Linking Performance Measures To Priorities	؟
Ensure Consistency / Collaboration	؟
Appropriate Communication Technology	؟
Share Information Proactively	؟

	TABLE 3: HUMAN CLOUD FACTOR	**%**
1	Efficient IT infrastructure	93.04
2	Continuous communication flow	90.43
3	Sustained management support	89.57
4	Appropriate internal technical knowledge	86.96
5	Efficient internal organizational structure	86.52
6	Appropriate project team	85.65
7	Encourage collaboration	85.22
8	Efficient Face-to-face meetings	83.77
9	Cultural sensitivity among employees	79.13
10	Ensuring bilateral knowledge transfer	78.26
11	Ensure consistency	77.39
12	High quality of offshore employees	76.96
13	Definition of project standards	75.65
14	Standardized and documented processes	75.65
15	Linking performance to priorities	75.22
16	Continuous controlling of project results	73.04
17	Good language abilities	70.43
18	Selection of suitable software	70.43
19	Dev. of a comprehensive business	69.57
20	Preparation of a detailed project specs	68.70
21	Share information proactively	66.96
22	Creation of a partnership-like relationship	64.35

TABLE 4: TARGET POPULATION

Company Name	Actual software development	Distributed teams	Human Cloud
Alpha Data	Yes	-	No
Exceed IT	Yes	Yes	Yes √
ITQN	Yes	Yes	No
Cubic Art	Yes	Yes	No
UAE design	Yes	No	No
Digital Evol.	Yes	No	No
iSys Solutions	Yes	No	No
AROWANA Co.	Yes	Yes	?
Link Develop	Yes	Yes	No
Init InfoTech	Yes	Yes	Yes √
ISITS	Yes	Yes	Yes √
OMNIX	No	-	
VENTUZ Tech.	No	-	
Active Interact.	No	-	
Al Khadar Tech.	No	-	
Al Mazroui	No	-	
Al Suwaidi	No	-	
Bluechip	No	-	
Cadd Emirates	No	-	

III. Research Methodology

A. Methodology – Sample

Our proposed research involves a qualitative study based on non-probability sampling of conveniently available IT development companies in the UAE. The target population was identified by the IT software development industry represented by specialized companies in the local software development industry and their corresponding international partners. For each company, interviews and surveys were conducted with software development team leaders and senior developers.

B. Sampling

As we are targeting the local market, our first step was to identify and list all available local software development companies. Twenty software development companies were shortlisted (Table 4). By investigating each of these companies separately, we summarized the subset of companies that are doing actual software development or using distributed teams. We also highlighted those companies that are using virtual teams over the cloud as depicted in Table 4. We were able to identify three

local software development companies who use our target model. The next step was to identify the virtual partners for these companies to include them in our study. A set of nine partner companies were identified who are actually participating in the software development process over the cloud.

C. Hypotheses

As the human cloud is the new generation of offshore sourcing, our study aims to understand this trend at the local level leading to a better understanding of this trend at the international level. As part of our study, it is important to understand the critical success factors affecting the human cloud and compare them with the offshore success factors models which will therefore help in better understanding the new human cloud model at the local level within an international context. Through our study, we will try to prove or disprove the following hypotheses :

H1. *Few (less than 20%) UAE software development companies are adopting the cloud based software development using the human cloud.*

H2. *The UAE software development market is less sensitive to cultural issues than the international market.*

H3. *The continuity and smoothness of communication flow is considered less important factor for local UAE companies that international ones.*

H4. *The language barrier issue for the software development teams is less observed UAE software development market than the global market.*

H5. *Efficient internal organizational structure and clear responsibilities is more important for cloud based software development than offshore software development.*

H6. *The extent to which the development team composition is appropriate is more important in the human cloud.*

H7. *Appropriate internal technical knowledge is considered to be more important for the success of cloud based software development that the offshore software development*.

D. Data collection & Analysis

The approach followed by our research included using structured interviews as well as targeted surveys in order to collect the needed qualitative data. Descriptive and inferential statistical analysis were used to represent the findings. We conducted a total of eighteen interviews with the identified local companies. The interviews targeted the team and unit leaders for the virtual teams who are heavily involved in performing the development using the human cloud. In addition to the interviews, the other nine partners were contacted and five team leaders per company were selected for a total of forty five team leaders in the partner companies. The survey and interview questions were designed to collect data related to our framework attributes. Each attribute was addressed by one or more questions, and the answers were unified and scaled from 1 to 5 using Likert scale to simplify the analysis. All the questions were directly related to our framework attributes in order to identify the extent to which each factor is playing in the software development cycle. We utilized descriptive and inferential statistical techniques where the findings were represented using charts after grouping both surveys and interviews results into one set of numerical statistics (a total of sixty respondents). The following results summarized in Figure 6 were noted:

- **Companies that do actual software development in UAE:** Only 55% of our target sample companies are doing actual software development while the others do not develop themselves. They either have other branches do the development or just sell off-the-shelf software products.
- **Software development companies with distributed teams:** 37% of our sample have distributed teams while 63% are doing the development onsite with one or more teams.
- **Companies developing using the human cloud and cloud based software development:** 16% of our sample were found to be using the human cloud and were developing using a cloud based software development environment.

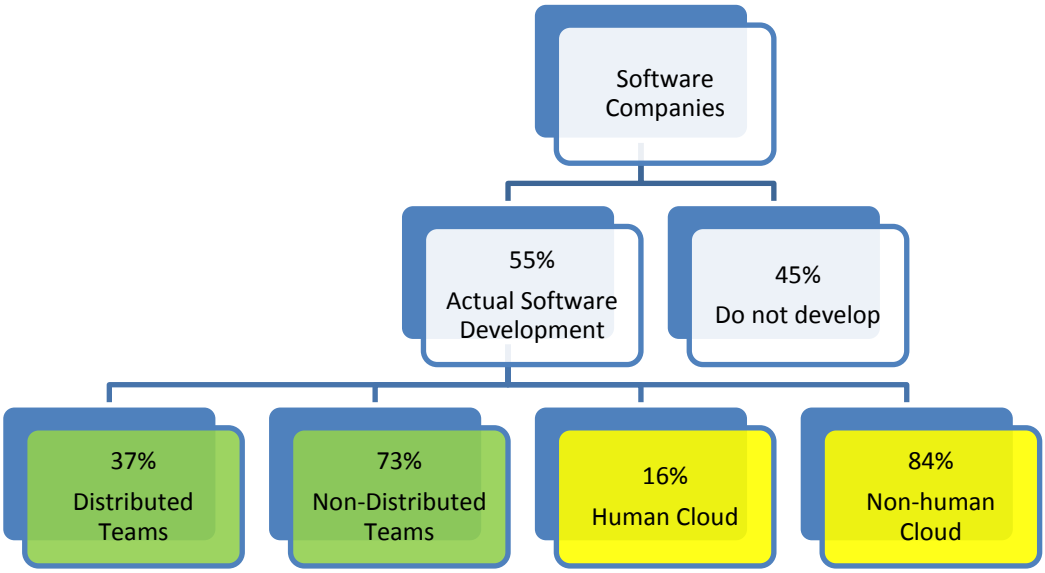

Figure 6: Local Software industry partitioning

After conducting the eighteen interviews, the results were collected and converted to numerical values ranging from 1 to 5 using the Likert scale as well. The results of the interviews were combined with the results from the surveys. According to the results as depicted in Figure 7, the top ten critical success factors were as follows:

Establishment of an efficient IT infrastructure
Ensuring of a continuous communication flow
Sustained management support
Appropriate internal technical knowledge
Efficient internal organizational structure
Composition of an appropriate project team
Encourage collaboration
Efficient Face-to-face (virtual) meetings
Creation of a cultural sensitivity among employees
Good language abilities of the virtual employees

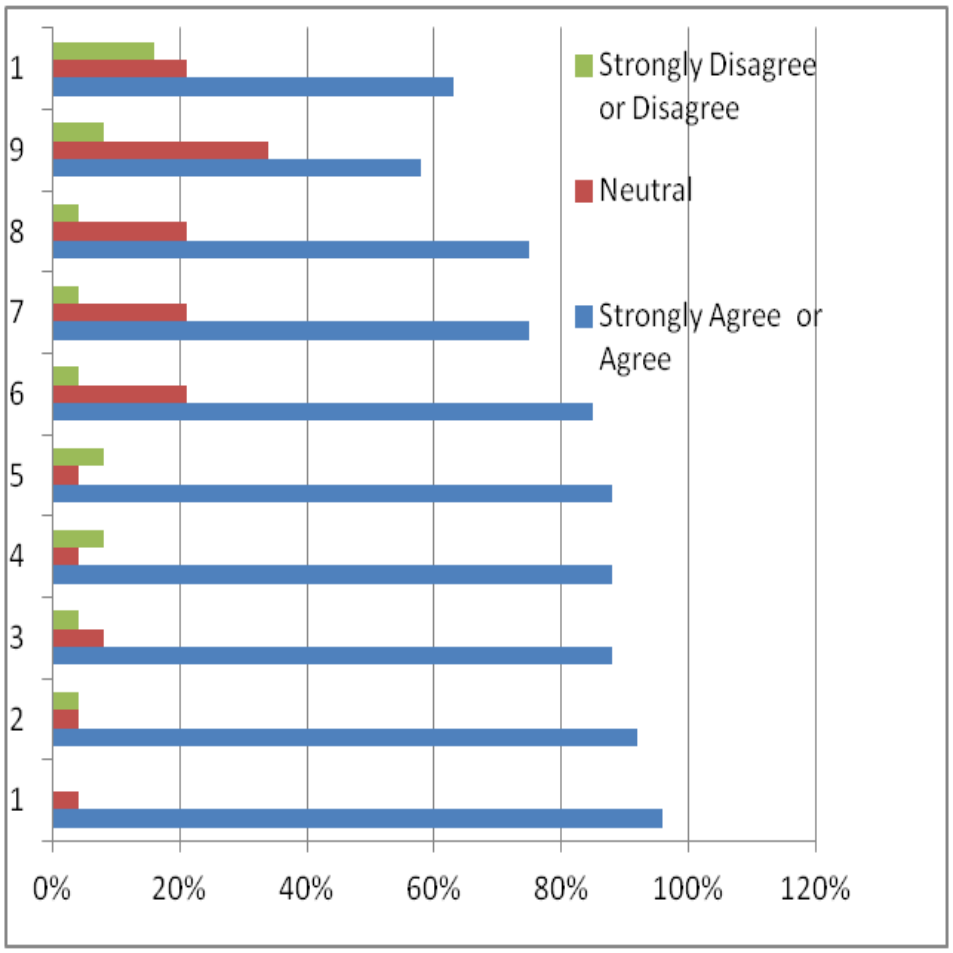

Figure 7: The top ten critical success factors based on the responses collected.

IV. Results, Findings and Discussions

A. Research Results

Based on the CFSs ranking and using rank comparisons between our model factors and the base model critical success factors for offshore outsourcing (as summarized in Figure 8), and by reviewing the literature, the following top critical success factors are concluded:

a) *Establishment of an efficient IT infrastructure*

This factor was ranked 9th in the previous offshore studies with a grade (arithmetic mean percentage) of 85%, while in our study we found that this factor has the top rank with a grade of 93.04%. This result is reasonable in the case of the human cloud and cloud based software development, as the model itself is based on having a virtual development environment hosted on the cloud and

accessible to all developers over the internet. This means that the whole model is very dependent on the technology which requires a very advanced cloud infrastructure. Usually companies have two options in this regards, either to build their own private cloud, or to use one of the public cloud services which would allow them to host their development online as a service.

b) Sustained management support

The sustained management support was ranked 8th in the previous studies with arithmetic mean percentage of 85.8%, while in our study, this factor was ranked 3rd with 89.57%. A good explanation for this can be concluded from understanding the differences between the two models. The offshore outsource model transfers the project and risk completely to the vendors with minimal management involvement from the client side, however, the human cloud framework is tailored more towards insourcing, as the client is the one who manages the project and takes all the associated risks which would increase the importance of their project management and support.

c) Appropriate internal technical knowledge

Another CSF which has significantly increased its ranking (from 16th to 4th) compared to the offshore model is the internal technical knowledge. The reason behind this increase can be justified similarly to the management support factor importance in the human cloud which basically transfers the risk back to the client side and their direct involvement in the development itself instead of transferring the risk to the vendor side. This will therefore require strong internal technical knowledge and team members ability to handle most of the project internally.

d) *Efficient internal organizational structure and clear responsibilities*

This CSF was ranked 15th in the previous offshore study with percentage of 76.6%, while this CSF ranked 5th in our study which is also considered a significant increase of importance. This increase can be justified the same way previous factors were justified, as the offshore outsourcing tend to

transfer the work to external vendors, our model focuses on acquiring human could resources and engage them in the development team. These newly added resources can be engaged on contract or project basis for short or long terms. Different resources can be introduced at any time, which makes it so important to have efficient internal organizational structures and clear responsibilities to ensure smooth and efficient team extensions using the human cloud.

e) *Composition of an appropriate project team*

Composition of appropriate project team was found to be almost at the same relative ranking level as the previous studies. This is also expected given the need for a compatible team composition in any project.

f) *Encourage collaboration*

The collaboration is a new factor that was introduced in our human cloud framework for virtual team success factors which had no relative ranking in previous studies. It is clear that this factor has a significant importance in our model due to the nature of the distributed team and the real need for collaboration through the available frameworks and tools.

g) *Efficient Face-to-face (virtual) meetings*

The meetings among the virtual team members gained increase in relative ranking level (from 13^{th} to 8^{th}) which is due to the nature of the software development process where the development team members are required to have regular meetings depending on the progress of the software development cycle.

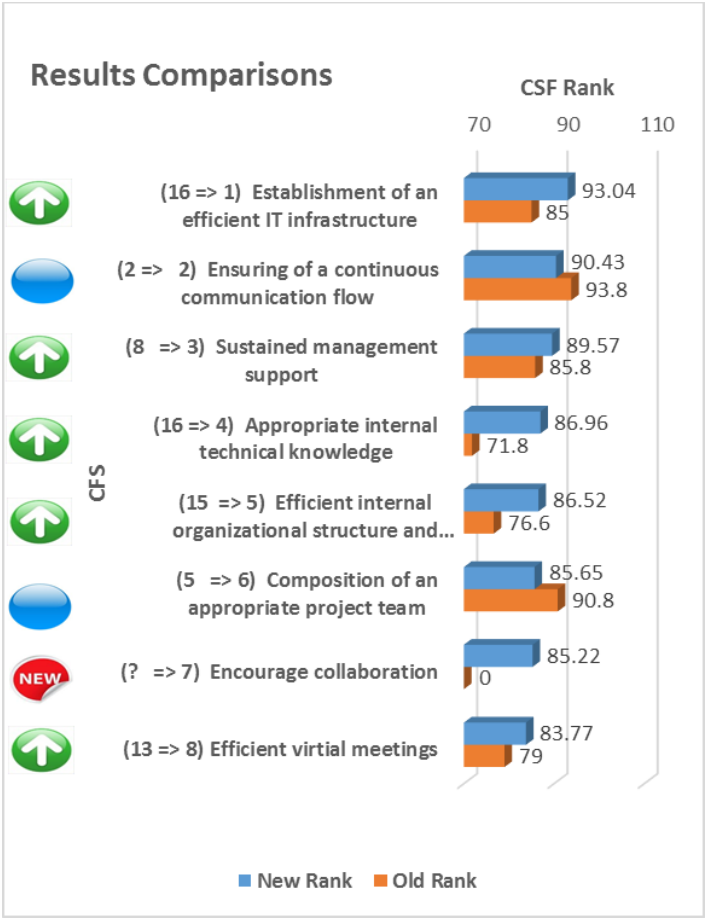

Figure 8: Comparison between the Human Cloud and Offshore CSFs**.**

B. Hypotheses Testing

In this section, inferential statistical analysis is used in order to prove or disprove our hypotheses and claims which were stated is Section III. For international comparisons, we refer to (Westner & Strahringer, 2010). In our analysis, we consider a 95% confidence level (with a level of significance ***α=0.05).***

H_1: At least, one fifth of UAE software development companies are adopting cloud based software development using the human cloud; H_0: at most, one fifth of UAE software development companies are adopting cloud based software development using the human cloud.

One-Sample Statistics					
	N	***μ***	Std.	Std. Error Mean	
Companies	63	.16	.375	.086	
	Test Value = .16				
	t	df	Sig.	Mean	95% CI

			(2-tailed)	Difference	Lower	Upper
Companies	-.024	62	.981	-.002	-.18	.18

Table 5: Single population t-test results

Using a single population t-test (Table 5) while trying to reject the null hypothesis*: P-value (two tail) = 0.981, P-value (one tail) = 0.491 > .05 (α). Therefore, we fail to reject H_0.*

***Conclusion 1**: There is insufficient evidence to say that at least, one fifth of UAE software development companies are adopting cloud based software development using the human cloud.*

For hypotheses H_2 to H7, we conducted multiple 2-population t-tests on a sample size of sixty three local companies and 130 international companies. Our statistical results including basic descriptive statistics and the corresponding P-Values as well as a 95% confidence interval are summarize in Table 6(a) and Table 6(b) for the different attributes. In the table, HCL refers to the human cloud for local companies while HCI, refers to the human cloud for international companies.

	Cultural Issues		Communication flow		Language barrier	
Group	HCL	HCI	HCL	HCI	HCL	HCI
μ	3.79	3.67	4.31	4.69	3.46	4.55
Std	0.7755	1.033	1.257	0.509	1.062	0.763
SEM	0.158	0.09	0.257	0.045	0.217	0.067
P-Value	0.5893		0.0126		0.0001	
95% CI	-0.318196 to 0.558196		-0.68 to -0.083		-1.448 to -0.732	

(a)

	Internal organization		Team composition		Technical knowledge	
Group	HCL	HCI	HCL	HCI	HCL	HCI
μ	4.29	3.83	4.17	4.54	4.25	3.59
Std	0.806	0.864	0.834	0.623	1.225	1.175
SEM	0.165	0.076	0.1703	0.0546	0.25	0.103
P-Value	0.0167		0.0126		0.0131	
95% CI	0.0845 to 0.836		-0.659 to -0.081		0.1409 to 1.179	

(b)

Table 6: Statistical results of both local and international companies for the different human cloud attributes.

***H_2: The UAE software development market is less sensitive to cultural issues than the international market;** H_0: The UAE software development market is more sensitive to cultural issues than the international market.*

Referring to Table 6(a), the two-tailed t-test P-value referring to cultural sensitivity is equal to 0.5893. By conventional criteria, this difference is considered to be statistically insignificant. Therefore, there is insufficient evidence against H_0 .

Conclusion 2: *There is insufficient evidence to say that* ***the UAE software development market is less sensitive to cultural issues than international market.***

To confirm our results and find whether an association between the cultural barrier and UAE market exists, we applied the *Chi-square test* by dividing the results into two groups: UAE based respondents facing cultural barrier issues and international based respondents facing cultural barrier issues. The test resulted in a P-value = *0.4666 >0.05 (α).* Therefore, there is insufficient evidence against $H_{0,}$, which confirms our t-test results.

H_3: The continuity and smoothness of the communication flow is considered a less important factor for local UAE companies than international companies ; *H_0: μ (continuity and smoothness communication flow) UAE ≥ μ (continuity and smoothness communication flow international)*

Referring to Table 6(a), the t-test P-value referring to the continuity of the communication flow is equal to 0.0126 which is < α which implies that this difference is considered to be statistically significant. *Therefore, we reject H_0* leading us to the following conclusion:

Conclusion 3*: There is insufficient evidence to say that the continuity and smoothness of the communication flow is considered a more important factor for local UAE companies than international companies.*

H_4: The language barrier issue for the software development teams is less observed in the UAE software development market than in the global market.
H_0: μ (language barrier issues UAE) ≥ μ (language barrier international)

Referring to Table 6(a), by conducting a 2-population t-test to compare between our findings and the base framework findings, we found that the two-tailed P-value relating to the language barrier issues

is equal to 0.0001 which is < α. This difference is considered to be extremely significant. Therefore, we reject H_0.

Conclusion 4: *The language barrier issue for the software development teams is less observed in the UAE software development market than in the global market.*

As before, we try to find an association between the language barrier and the UAE market, using the *Chi-square test*. The test resulted in a P-value = *0.0186 < .05 (α),* which means that this difference is considered to be statistically significant. *Therefore, there is an association between the UAE market and the language barrier which confirms our earlier results.*

H_5: An efficient internal organizational structure and clear responsibilities is more important for cloud based software development than for offshore software development; H_0: μ (Efficiency of organizational structure for human cloud ≥ μ (Efficiency of organizational structure offshore)

Referring to Table 6(b), by conducting a 2-population t-test to compare between our findings and the base framework findings, we found that the two-tailed P-value relating to the internal organizational structure is equal to 0.0167 which is < α. This difference is considered to be statistically significant. Therefore, we reject H_0 leading us to the following conclusion:

Conclusion 5*: An efficient internal organizational structure and clear responsibilities is more important for cloud based software development than for offshore software development.*

H_6: The extent to which the development team composition is appropriate is more important in the human could software development than in offshore software development; *H_0: μ (appropriate team composition in human cloud) ≤ μ (appropriate team composition in offshore)*

Referring to Table 6(b), the 2-population t-test P-value relating to the development team composition is equal to 0.0126 which is < α which implies that this difference is considered to be statistically significant. Therefore, we reject *H_0* leading us to the following conclusion:

Conclusion 6: *The extent to which the development team composition is appropriate is more important in the human could software development than in offshore software development.*

H_7: Appropriate internal technical knowledge is considered to be more important for the success of cloud based software development than for offshore software development; *H_0: μ (Appropriate Human Cloud internal technical knowledge ≤ μ (Appropriate Offshore internal technical knowledge)*

Referring to Table 6(b), the p-value relating to the internal technical knowledge is equal to 0.0126 which is < α. This difference is statistically significant. Therefore, we reject H_0 leading us to the following conclusion:

Conclusion 7: *Appropriate internal technical knowledge is considered to be more important for the success of cloud based software development than for offshore software development.*

C. Research Questions Discussions

This section summarizes our findings and answers to our research questions and hypotheses concerning the human cloud.

RQ_1: What are the critical success factors for the IT trend to adopt cloud based software development using the human cloud?

To answer this question, the research used an exploratory methodology through extensive literature review (summarized in Figure 9) in order to identify the critical success factors for similar models. These models include the offshore software development and software development virtual teams. These results were confirmed by our research. Table 3 shows the 22 Critical success factors ranked using their arithmetic mean (AM) as a percentage for their relevancy and importance.

RQ_2: How to help companies utilize the human cloud?

Our study focuses on local companies for adopting cloud based software development using the human cloud. Therefore, our findings apply to the local UAE market, and based on these finding, we

are able to suggest a set of recommendations for companies to help them adopt this model. Our recommendations include the following:

1- The human cloud is the next generation of outsourcing, it has many benefits over the traditional models including providing cost savings, increasing the efficiency of the work and providing a reach to the skill sets over the cloud. Adopting this model is highly recommended to achieve a competitive advantage.

2- To be able to adopt this model successfully, companies need to look into the critical success factors provided by this model (Table 3)

3- Through our study, we recommend to consider all success factors during the adopting process; however, these factors are not at the same level of importance. We recommend to pay more attention to the factors with higher priorities as well to some of the claims that turned out to be significant in our studies.

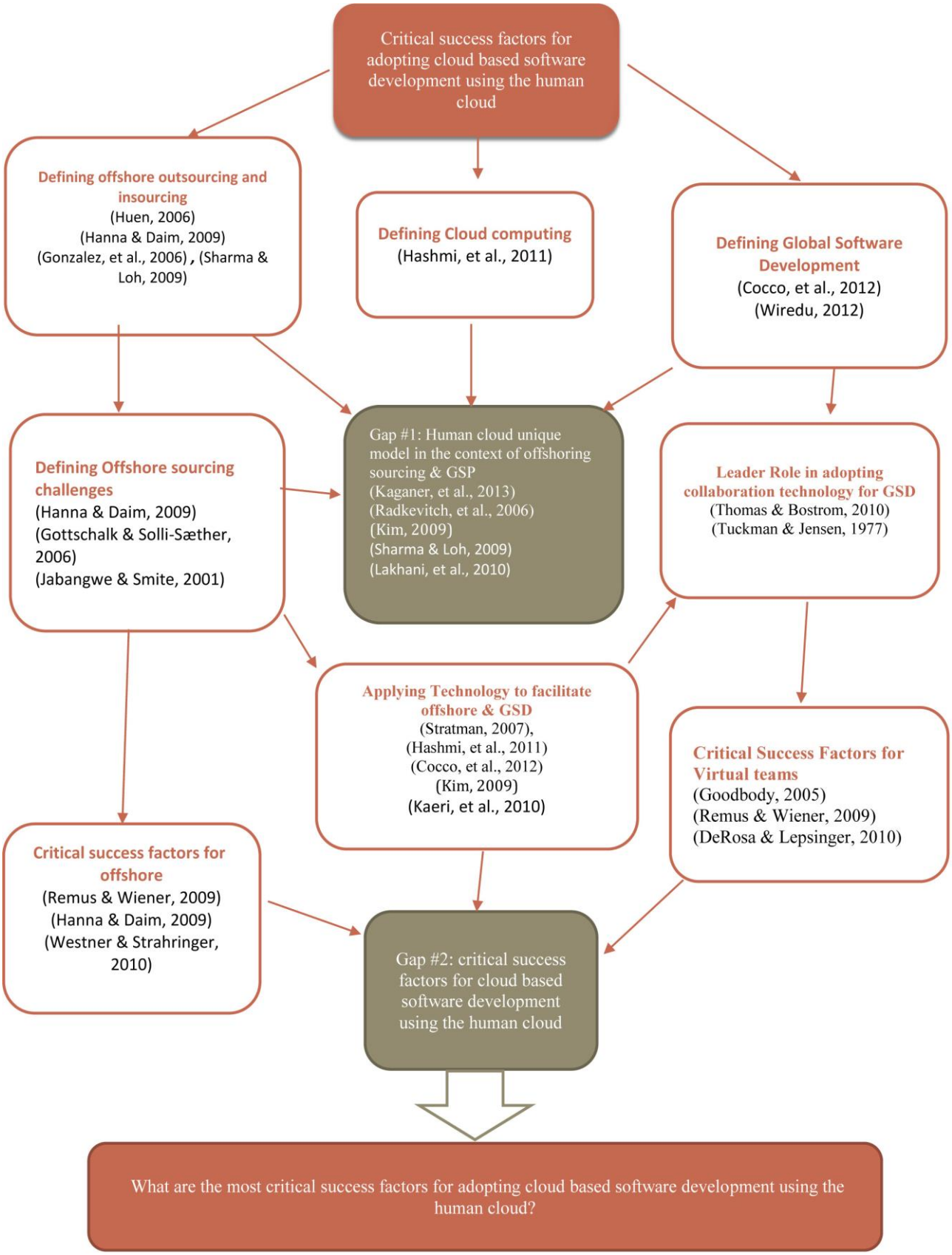

Figure 9. Literature review summary relating to the human cloud CSFs.

III. Conclusion

A. Our Contributions

Our research is considered the first that provides critical success factors for the local IT trend of cloud based software development using human cloud based frameworks. We provided a comprehensive survey on previous works in the area. Most of the previous studies only highlighted one dimension of our proposed model (offshore sourcing). Some other research studied software development virtual teams which represent another dimension in our model. There isn't much research in the literature that studied the complete model which includes both dimensions in addition to cloud computing as a medium to facilitate the software development. Our results could ultimately help the local as well as international IT companies to successfully adopt and benefit from cloud based software development using the human cloud.

B. Research Conclusions

Through this study, we were able to define the critical success factors for the IT trend of cloud based software development using the human cloud. We found that the CSFs for offshore software development and virtual development teams are similar, however they have different levels of importance. We concluded that the most important success factors for our model in the local market include the establishment of an efficient IT infrastructure and ensuring a continuous communication flow with sustained management support and appropriate internal technical knowledge. We also found that many of the software development companies are not aware of this model, and only few of them were able to apply it successfully. By comparing the results of our study with the findings at the international level, we found that both communication flows and language barriers are less effective in the UAE market than in the global market. However, there were insufficient evidence to conclude the same for the cultural sensitivity factor. We also found that an efficient organization structure and appropriate technical team knowledge are more important in the human cloud model than in the offshore model.

C. Future Works

As this topic is still emerging, there are many areas that can be approached by future researchers. Future studies should look into individual factors or groups of factors combined and investigate them against different model implementations including the use of a private cloud versus the use of a public cloud (such as amazon.com web services). Also, future research could also include comparisons between using the human cloud provided by ready platforms versus using the human cloud provided by remote partners or even other company branches, which we would suspect to lead to variations in factors ranking as well as introducing new critical success factors. Another area for future research should look into the effects of organization size on these critical success factors.

References

1. Cocco, L., Mannaro, K. & Concas, G., 2012. *A Model for Global Software Development with Cloud Platforms.* Cagliari, Italy, IEEE, pp. 446 - 452.
2. DeRosa, D. M. & Lepsinger, R., 2010. *Virtual Team Success: A Practical Guide for Working and Leading from a Distance.* 222 ed. s.l.:Pfeiffer.
3. Gonzalez, R., Gasco, J. & Llopis, J., 2006. Information systems offshore outsourcing: A descriptive analysis. *Industrial Management & Data Systems,* 106(9), pp. 1233-1248.
4. Goodbody, J., 2005. Critical success factors for global virtual teams. *Strategic Communication Management,* 9(2), p. 18.
5. Gottschalk, P. & Solli-Sæther, H., 2006. Maturity model for IT outsourcing relationships. *Industrial Management & Data Systems ,* 106(2), pp. 200-212.
6. Hanna, R. & Daim, T. U., 2009. Managing offshore outsourcing in the software industry. *Technology Analysis & Strategic Management,* 21(7), pp. 881-897.
7. Hashmi, S. I. et al., 2011. *Using the Cloud to Facilitate Global Software Development Challenges.* s.l., Global Software Engineering Workshop (ICGSEW), 2011 Sixth IEEE International Conference.
8. Huen, W. H., 2006. *An Enterprise Perspective of Software Offshoring.* San Diego, CA, Frontiers in Education Conference, 36th Annual, pp. 17-22.
9. Jabangwe, R. & Smite, D., 2001. *Decision Support for Offshore Insourcing Software Development.* s.l., Global Software Engineering Workshop (ICGSEW), 2011 Sixth IEEE International Conference.
10. Kaeri, Y. et al., 2010. *A Cloud-based Support System for Offshore Software Development.* 2010 International Conference, Broadband, Wireless Computing, Communication and Applications (BWCCA).
11. Kaganer, E., Carmel, E., Hirscheim, R. & Olsen, T., 2013. Managing the Human Cloud. *MIT Sloan Management Review,* Winter, 54(2), pp. 22-35.
12. Kern, R., Zirpins, C. & Agarwal, S., 2009. *Managing Quality of Human-Based eServices.* Springer Berlin/Heidelberg, Service-Oriented Computing–ICSOC 2008 Workshops..
13. Kim, J. Y. "., 2009. Online Reverse Auctions for Outsourcing Small Software Projects: Determinants of Vendor Selection. *e-Service Journal,* 6(3), pp. 40-55.
14. Lakhani, K., Garvin, D. A. & Lonstein, E., 2010. TopCoder (A): Developing Software through Crowdsourcing. *Harvard Business School General Management Unit Case,* 610(032).
15. Milhauser, K., 2011. *Distributed Team Collaboration in Organizations.* 336 ed. s.l.:IGI Global.
16. Radkevitch, U. L., van Heck, E. & Koppius, O., 2006. Leveraging Offshore IT Outsourcing by SMEs through Online Marketplaces. *Journal of Information Technology Case and Application,* 8(3), pp. 40-57.
17. Remus, U. & Wiener, M., 2009. Critical Success Factors for Managing Offshore Software Development Projects. *Journal of Global Information Technology Management,* 12(1), p. 6.
18. Sharma, A. & Loh, P., 2009. Emerging trends in sourcing of business services. *Business Process Management Journal,* 15(2), p. 149.

19. Stratman, J. K., 2007. Facilitating offshoring with enterprise technologies: Reducing operational friction in the governance and production of services. *Journal of Operations Management,* 26(2), p. 275–287.
20. Thomas, D. M. & Bostrom, R. P., 2010. Team leader strategies for enabling collaboration technology adaptation: team technology knowledge to improve globally distributed systems development work. *European Journal of Information Systems,* 19(2), pp. 223 - 237.
21. Tuckman, B. W. & Jensen, M. A. C., 1977. Stages of Small-Group Development Revisited. *Group & Organization Management,* 2(4), pp. 419-427.
22. Westner, M. & Strahringer, S., 2010. Determinants of success in IS offshoring projects: Results from an empirical study. *Information & Management,* Issue 47, p. 291–299.
23. Wiredu, G. O., 2012. Global software development and the problem of increased uncertainties: information processing requirements for coordination. *Journal of Global Information Management,* 20(2), pp. 1-24.