EVALUATION MODEL FOR ASSESSING THE EFFECTIVENESS OF COORDINATION PROCESSES IN GLOBAL SOFTWARE DEVELOPMENT PROJECTS

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DEDICATION

This thesis is dedicated to my late father, Mr.T.N.Subba Rao. I miss him so much, but I am happy to know that he had witness the progress through to its accomplishment. His motivation and support has made it possible for me to complete this thesis. His absence is deeply felt at this moment of accomplishment.

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ABSTRACT

Effective coordination is a crucial aspect in successful Global Software Development (GSD) projects. Limited studies have examined coordination strategies and their related indicators. Therefore, this study focuses on assessing the coordination processes that require specific strategies and related indicators that can contribute to effective coordination. This study used qualitative design in formulating the evaluation model for assessing the effectiveness of coordination processes in GSD projects. Four research objectives were examined. The first objective is to identify the coordination strategies and related indicators for assessing the coordination processes for GSD projects based on systematic review, with the results of 31 coordination strategies and 116 indicators. The second objective is to identify the coordination strategies and related indicators for assessing the coordination processes for GSD projects based on interviews with 20 GSD practitioners, with the results of 28 coordination strategies and 96 indicators. The third research objective is to formulate an Evaluation Model to assess the effectiveness of coordination processes in GSD projects based on the identified coordination strategies and related indicators. The findings from the literature and GSD practitioners were consolidated using Grounded Theory and validated further by 5 GSD experts from industries using the Delphi Technique. From this, 36 coordination strategies and 167 indicators were finalized. An Evaluation Model for assessing the effectiveness of coordination processes in GSD projects was then formulated. The fourth research objective is to evaluate the proposed Evaluation Model in the GSD environment. The proposed model was evaluated with 12 different projects involving six successful projects and six failure projects from the GSD environment using case studies. Two different types of analysis were used: descriptive and statistical. Descriptive analysis shows that the final indicators do help to accomplish the effectiveness to underpin GSD project success. Statistical analysis using a t-test indicates that the proposed model is significant (p-value=0.01), which interprets that the more number of indicators selected, the more likely the proposed model helps to accomplish the effectiveness towards GSD projects success. In conclusion, this research has contributed to providing the Evaluation Model for assessing the effectiveness of coordination processes in GSD projects. The model is useful for GSD project managers to assess the coordination processes in GSD projects. In addition, the model could help to facilitate coordination processes involved in GSD projects, in line with three bodies of knowledge, which are Software Engineering Body of Knowledge (SWEBOK) under Software Process Assessment, Project Management Body of Knowledge (PMBOK) under Project Management Processes, and GSD Handbook under Facilitate Coordination.

ABSTRAK

Penyelarasan yang berkesan merupakan aspek penting dalam projek Pembangunan Perisian Global (GSD) yang berjaya. Kajian yang terhad telah mengkaji strategi penyelarasan dan petunjuk yang berkaitan. Oleh itu, kajian ini memberi tumpuan kepada penilaian proses penyelarasan yang memerlukan strategi khusus dan petunjuk berkaitan yang boleh menyumbang kepada penyelarasan yang berkesan. Kajian ini menggunakan reka bentuk kualitatif dalam merumuskan model penilaian bagi menilai keberkesanan proses penyelarasan dalam projek GSD. Empat objektif penyelidikan telah digunakan. Objektif pertama adalah untuk mengenal pasti strategi penyelarasan dan petunjuk berkaitan untuk menilai proses penyelarasan bagi projek GSD berasaskan *systematic review*, dengan keputusan 31 strategi penyelarasan dan 116 petunjuk. Objektif kedua adalah untuk mengenal pasti strategi penyelarasan dan petunjuk berkaitan untuk menilai proses penyelarasan bagi projek GSD berdasarkan temu bual dengan 20 pakar GSD, dengan keputusan 28 strategi penyelarasan dan 96 petunjuk. Objektif penyelidikan ketiga adalah untuk merumuskan Model Penilaian untuk menilai keberkesanan proses penyelarasan dalam projek GSD berdasarkan strategi penyelarasan yang dikenal pasti dan petunjuk yang berkaitan. Penemuan dari kajian lepas dan pakar GSD disatukan dengan menggunakan kaedah *Grounded Theory* dan disahkan oleh 5 pakar GSD dari industri dengan menggunakan teknik Delphi. Dari sini, 36 strategi penyelarasan dan 167 petunjuk telah dimuktamadkan. Model Penilaian untuk menilai keberkesanan proses penyelarasan dalam projek GSD kemudiannya dirumuskan. Objektif penyelidikan keempat adalah untuk menilai Model Penilaian yang dicadangkan dalam persekitaran GSD. Model yang dicadangankan itu dinilai dengan 12 projek berlainan yang melibatkan enam projek yang berjaya dan enam projek gagal dari persekitaran GSD dengan menggunakan kajian kes. Dua jenis analisis digunakan: deskriptif dan statistik. Analisis deskriptif menunjukkan bahawa petunjuk akhir membantu untuk mencapai keberkesanan untuk menyokong kejayaan projek GSD. Analisis statistik yang menggunakan Ujian-t menunjukkan bahawa model yang dicadangkan adalah signifikan (p-nilai = 0.01), yang menaksirkan bahawa semakin banyak penunjuk yang dipilih, semakin besar kemungkinan model yang dicadangkan dapat membantu mencapai keberkesanan terhadap kejayaan projek GSD. Kesimpulannya, kajian ini telah memberi sumbangan untuk menyediakan Model Penilaian bagi menilai keberkesanan proses penyelarasan dalam projek GSD. Model ini berguna bagi pengurus projek GSD untuk menilai proses penyelarasan dalam projek GSD. Di samping itu, model ini dapat membantu memudahkan proses penyelarasan yang terlibat dalam projek GSD, selaras dengan sumbangan kepada tiga badan pengetahuan, iaitu Badan Pengetahuan Kejuruteraan Perisian (SWEBOK) di bawah Penilaian Proses Perisian, Badan Pengetahuan Pengurusan Projek (PMBOK) di bawah Pengurusan Proses Projek, dan Buku Panduan GSD di bawah Kemudahan Penyelarasan.

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LIST OF ABBREVIATIONS

SR	-	Systematic Review
SLR	-	Systematic Literature Review
ISO	-	International Organization for Standardization
IEC	-	International Electrotechnical Commission
IEEE	-	Institute of Electrical and Electronics Engineers
ACM	-	Association for Computing Machinery
GSD	-	Global Software Development
GSE	-	Global Software Engineering
DSE	-	Distributed Software Engineering
DSD	-	Distributed Software Development
PAMs	-	Process Assessment Models
SPICE	-	Software Process Improvement and Capability dEtermination
CMMI	-	Capability Maturity Model Integration
SMEs	-	Small and Medium Enterprises
TAM	-	Technology Acceptance Model
PU	-	Perceived Usefulness
PEOU	-	Perceived Ease Of Use
R	-	Round
RQ	-	Research Question
QA	-	Quality Assessment
IT	-	Information Technology
No	-	Number
IND	-	Indicator
CP	-	Coordination Process
CS	-	Coordination Strategy
MTTF	-	Mean Time to Failure
DRE	-	Defect Removal Effectiveness
ID	-	IDentification
QD	-	Quartile Deviation
ERP	-	Enterprise Resource Planning

SAP	-	Systems Applications and Products
QAD	-	Quality Assurance Division
SD	-	Standard Deviation
USA	-	United States of America
IAG	-	Indicator Assessment Grid

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This chapter begins with a general background on Global Software Development, which took place globally in the software development context. It also includes the problem statement, research goal, research questions, research objectives, the scope of research, research contributions, significance of study, operational definition, and the thesis outline.

1.2 Background of the Study

Rapid globalization has an impact on modern world technology and has also brought significant transformation into software development businesses. When software is being developed across the countries, this strategy is called Global Software Development (GSD) (Jain & Suman, 2015). Many software organizations are shifting their strategies towards GSD approach as it has many benefits such as access to large pool of competent developers, less time taken for software development, reduction of software development costs, less time taken to market the software product and production of better quality software compared to traditional ways of development (Kaur & Sharma, 2014).

According to GSD strategy, the cost of software organizations can be reduced by replacing expensive collocated employees with distributed resources. Some software organizations are trimming down their collocated resources by 65% with distributed resources in order to cut down the development cost (Chua & Pan, 2008). Some of the

challenges faced by GSD are lack of effective communication, lack of cultural understanding in teams, lack of coordination, time zone problem and others (Niazi *et al*., 2013; Silva et al., 2010). These challenges are due to economic, technical, political, and cultural dispersions (Herbsleb & Moitra, 2001). The main contributing factors to these challenges are due to differences in time zones, languages, and geographical locations (Damian & Moitra, 2006).

In reaction to these challenges, GSD projects are facing difficulties in communicating and coordinating the projects as these projects are geographically distributed (Ó Conchúir et al. 2009). Darja Smite (2005) claims that coordination in the distributed environment remains a great challenge, and it is not very widely explored. Research by Nguyen *et al*. (2015) show that studies on team coordination in GSD is lacking and the geographical distribution has impacted the coordination in GSD environment. Poor coordination between the collocated and distributed team is affecting the scope of the contract in GSD projects as stated by Khan (Abdul Khan & Samee Khan, 2014).

Dingsoyr, Moe, Faegri and Seim (2018) emphasized that a major challenge in GSD is coordinating many teams. Their research focuses on how coordination practices change over time in a large-scale agile programme. The same study also highlights how coordination practices could enable the participants to adjust themselves according to the needs of the programme. Moreover, one of the main category identified in identifying the success factors of software process improvement in GSD domain is coordination (Khan *et al*.,2018). The researchers performed an industrial survey to explore integration failure factors in GSD. Their study identified that minimal interaction between the distributed team members causes a big frustration between collocated and distributed developers, which became hurdles in system integration. This minimal interaction is referring to coordination.

According to GSD Handbook by Sangwan (2006), the probability of coordination difficulties is always reduced or neglected. Thus, the potential impact of the coordination

on the project is not explored sufficiently enough. Researchers have found many coordination difficulties in GSD. For example, decrease of communication frequency, vast communication network, lack of trust, lack of team identity, delay in communication and coordination, difficulty in organizing task, misinterpretation of tasks, extra coordination due to mismatches in goals, complicated communication and coordination paths and others (Nguyen-Duc, Cruzes, & Conradi, 2015).

Delay in communication frequency happened due to team members being physically separated. Thus, the tendency of discussing any activity is lesser compared to a collocated setting. They can only meet and coordinate their task at a specific time upon the consensus of all the team members as all of them have their different time zones. This could delay the communication and coordination. Therefore, more coordination is needed in GSD setting as the team members are widely spread. They need to get the things right before executing any projects to avoid the misinterpretation of any assigned task. Team members hardly know each other, and this makes them difficult to trust each other. This barrier puts them in an awkward position to share their tasks, and as a consequence, affects the coordination between them.

In addition to that, Babar and Leicester's (2014) study shows that since GSD projects involve typically a big group of stakeholders, organizations are facing several kinds of challenges such as lack of effective communication, lack of cultural understanding in teams, lack of coordination, time zone problems and others (Niazi *et al*., 2013). Babar and Leicester (2014) also have grouped these challenges into three different themes, namely, coordination, collaboration, and communication mechanisms.

Coordination is defined as the process of working together to achieve a specific goal (Malone & Crowston, 1994). Vizcaino et al. (2012) described communication as a complete process of exchanging unambiguous information so that the sender and receiver can reach a mutual understanding of the GSD project. Specific coordination strategies are essential to managing the GSD projects to enhance excellent communication between distributed team members in GSD environment. According to Ellis *et al.* (1991),

collaboration is defined as a method where internal processes of coordination, collaboration, and communication are joined together to achieve a specific goal. For software development to be successful, coordination and collaboration depend on communication (Smite *et al*., 2010).

Although all the three themes play essential roles in the GSD environment, coordination (Babar & Leicester, 2014) is the main focus of this research. Although coordination is one of the immensely researched topics in GSD, there is not much research reported on coordination in the International Conference on Global Software Engineering in 2013. Moreover, Deshpande and Richardson (2013) claim that coordination between collocated and distributed settings in GSD environment is one of the most challenging aspects to improve due to geographical dispersion. This is because development work in a distributed setting consumes 2.5 times longer in time completion as compared to the collocated environment (Herbsleb, 2001).

Coordination is one of the primary mechanisms used to communicate between collocated and distributed software development team in GSD. Coordination can be viewed as a process of working together effectively. In the modern world of computer science, study coordination is essential because it involves both the human beings and machinery tools. When team members from collocated and distributed are physically separated, they need a high level of coordination to work together (Espinosa & Carmel, 2004). Therefore, it is vital for coordination to take place between them in GSD setting (Prikladnicki, 2012; Steinmacher *et al*.,2010; Noll *et al*.,2010; Smite *et al*.,2010).

Kwan, Schroter, and Damian (2011) argue that the higher the level of coordination effectiveness, the more likely for software development projects to be successful. Literature suggests that, for agile software development, the higher the coordination effectiveness, the probability of project success also increases (Addas & Pinsonneault, 2013; Melo *et al*., 2013; Scheerer *et al*., 2014). An empirical research indicates that achieving a state of effective coordination is a key success factor for GSD projects

(Cataldo & Herbsleb, 2012; Lee, Espinosa, & DeLone, 2013; Lagerberg & Skude, 2013; Lagerberg, Skude, Emanuelsson, Sandahl, & Stahl, 2013).

Since GSD involves large scale software development across the boundaries, one of the most critical issue is effective coordination among team members (Bick *et al*., 2017). Bick *et al.* (2017) also highlighted that there were many reports saying frequent frustrations were occurring among team members due to ineffective coordination. Research has also reported that there are many other reasons that could lead to ineffective coordination. Major source for a project failure is ineffective coordination (Cataldo & Herbsleb, 2012).

To overcome coordination challenges, many researchers have proposed coordination frameworks with team members as the main component. For example, Deshpande (2012) has proposed a model which consist of coordination processes and strategies for GSD. Begel *et al*. (2009) have proposed ways processes, tools and team members could coordinate in GSD. Bass *et al.* (2009) and Smite *et al*. (2008) have proposed on team member's connection with coordination and risk in GSD.

The coordination model named "coordination configurations" was developed by Systems Applications and Products (SAP) researchers to check on the influence of coordination effectiveness (Scheerer *et al.* 2014; Scheerer & Kude 2014). For team coordination, Paasivaara and Lassenius (2014) describe a survey at Ericsson, which portrays a vast development initiative with 40 teams where they have applied different types of practice to coordinate teams. The importance of coordination in team level was highlighted by Strode *et al.* (2015) and a model for "coordination strategy and coordination effectiveness" was developed for agile software development. Paul *et al.* (2016) discussed the effect of coordination effectiveness in GSD in enabling the team members to accomplish their goals in GSD. It is a necessity for coordination to be effective (Paul *et al*., 2016).

In spite of having many proposed frameworks for coordination in GSD, to confirm an effective coordination in GSD still remains a big challenge. Although researchers are producing many distinctive solutions, effective coordination is still a promising area to explore as effective coordination is a key success factor for GSD projects.

1.3 Problem Statement

GSD is a prevalent trend where knowledgeable workers develop software at collocated and distributed locations. Over the decades, many Information Technology (IT) industries have adapted this GSD strategy to yield GSD benefits namely in the reduction of development costs, less time taken for development, access to a large pool of competent developers across the globe and in the production of a better quality software. Despite enjoying the benefits, IT industries that adapted GSD are suffering from many challenges (Niazi *et al*., 2013). Babar and Leicester (2014) have grouped these challenges into three different themes, namely, coordination, collaboration, and communication mechanisms. Although all the three themes play essential roles in GSD environment, coordination is the main focus of this research. Coordination Theory defines coordination as the process of working together and managing interlinks between activities to achieve a specific goal (Malone & Crowston, 1994). Literature shows that many difficulties are occurring in GSD environment due to a lack of coordination between the collocated and distributed team members, and one of the prominent reason is ineffective coordination. Ineffective coordination in GSD has caused many problems such as delay in coordination, difficulty in organizing task, misinterpretation of tasks, extra time needed for coordination due to mismatches in goals, and others. Empirical research indicates that achieving a state of effective coordination is a crucial success factor for GSD projects. Although researchers are producing many distinctive solutions for coordination in GSD, to confirm an effective coordination in GSD still remains a big challenge. Thus, this has motivated the researcher to propose an evaluation model to assess the effectiveness of coordination processes by incorporating coordination strategies and related indicators for each coordination processes in GSD projects.

1.4 Research Goal

This study aims to formulate an evaluation model for assessing the effectiveness of coordination processes in GSD projects.

1.5 Research Questions

This study seeks to investigate the following research questions:

Question 1: What are the coordination strategies and related indicators for assessing the coordination processes in GSD projects?

Question 2: How is the Evaluation Model for assessing the effectiveness of the coordination processes in GSD projects formulated?

Question 3: How is the proposed Evaluation Model evaluated in the GSD environment?

1.6 Research Objectives

The following are the research objectives:

Objective 1: To identify the coordination strategies and related indicators for assessing the coordination processes in GSD projects based on literature.

Objective 2: To identify the coordination strategies and related indicators for assessing the coordination processes in GSD projects based on GSD practitioners.

Objective 3: To formulate Evaluation Model for assessing the effectiveness of coordination processes in GSD projects based on the identified coordination strategies and related indicators.

Objective 4: To evaluate the proposed Evaluation Model in the GSD environment.

1.7 Scope of Research

Following are the research scope of this study. This research limits to:

a) Identify the coordination strategies and related indicators for assessing the coordination processes that is in GSD projects from Springer Link, Science Direct, Wiley, IEEE and ACM databases only. Scopus and Web of Science databases were excluded as they are digitalised databases where there will be a redundancy of articles in different databases.
b) Identify the coordination strategies and related indicators for assessing the coordination processes that is in GSD projects from the selected GSD practitioners who has more than five years of working experience with their roles at project management level in GSD domain only.
c) Formulate the Evaluation Model for assessing the coordination processes by getting consensus from the selected experts of GSD domain only.
d) Evaluate the proposed Evaluation Model for assessing the effectiveness of coordination processes and usefulness of the model from the selected GSD case study only.

1.8 Research Contributions

This research provides contributions to the state of knowledge and state of practice of assessing the coordination processes in GSD which includes:

a) A list of coordination strategies and related indicators from GSD projects that are identified through the literature, which will lead the formulation of the Evaluation Model for assessing the effectiveness of coordination processes in GSD projects.
b) A list of coordination strategies and related indicators from software projects that are identified from the GSD practitioners through interview, which will lead the

formulation of the Evaluation Model for assessing the effectiveness of coordination processes in GSD projects.

c) A collection of consolidated coordination strategies and related indicators that are identified through a combination of literature and interview, which will lead to the formulation of the Evaluation Model for assessing the effectiveness of coordination processes in GSD projects. Also a validated and verified proposed Evaluation Model for assessing the effectiveness of coordination processes in GSD projects.
d) An evaluated and useful Evaluation Model for assessing the effectiveness of coordination processes in GSD projects.

1.9 Significance of Research

This research adds significant knowledge to the software engineering domain especially to coordination process assessment in GSD domain.

a) List of coordination strategies and related indicators from GSD projects that are identified through the literature could add knowledge to Software Engineering Body of Knowledge (SWEBOK Guide version 3.0, page 153) which stated that software process assessments are used to evaluate the content of a software process, which may be specified by a standardized set of criteria under Software Process Assessment.
b) List of coordination strategies and related indicators from GSD projects that are identified from the GSD practitioners through interview could add knowledge to Project Management Body of Knowledge (PMBOK® Guide, 2008 Section 3, page 47-60) under Project Management Processes.
c) The formulation of a proposed Evaluation Model for assessing the effectiveness of coordination processes in GSD projects which could add knowledge to the GSD Community (GSD Handbook, 2006, Section 2.2.4, page 13) under Facilitate Coordination.

d) The formulation of an evaluated and useful Evaluation Model for assessing the effectiveness of coordination processes in GSD projects that would help project managers to assess the effectiveness of coordination processes in GSD projects.

1.10 Operational Definition

The operational definitions of terminologies used in this research are presented as below:

Globalization

Process of integration of nation and people, culturally, economically and politically into a bigger community (Eckes & Zeilers, 2003).

GSD

Software developed at collocated and distributed environment regardless of different geographical locations, different cultures, different time zone and different languages (Agerfalk *et al*.,2008).

GSD Team Members

Members who are distributed but collaborate on a common software project. They work across geographical, temporal, cultural, political and organizational boundaries to accomplish an independent task (Barney *et al*., 2009; Vizcaino *et al*., 2012).

Coordination

A process of working together and managing interlink between activities to achieve a certain goal in GSD (Malone & Crowston, 1994).

Processes

A series of actions or steps taken in order to achieve a particular end related to coordination in GSD (Humphrey, 1989).

Strategy

A plan of action designed to achieve a long-term or overall aim related to coordination in GSD (Chandler ,1962).

Indicator

An indicator is characterized as an observable variable assumed to point to, or estimate, some other (usually unobservable) variable (Bunge, 1975). An indicator is a metric or combination of metrics that provide insights into the software process, a software project, or the product itself related to coordination in GSD.

1.11 Thesis Outline

The chapters in this thesis is organized as follows:

Chapter 1 presents the introduction to the research, and discusses the background of the study, problem statement, research goals, research questions, objectives, scope of research, research contributions and the significance of the research.

Chapter 2 provides a comprehensive review of related studies in the existing body of literature. This chapter is organized according to definitions, benefits and challenges related to GSD as well as coordination and software process assessment. Besides that, conceptual model that was used in this study was also described. Finally, the formulation of the proposed model is described.

Chapter 3 discusses in detail the phases of the research design and methodology. Explanation of the research phases includes related activities and deliverables. This chapter also discusses the research instruments and the evaluation criteria which were adopted in this work.

Chapter 4 documents and illustrates the data collection process using Systematic Review (SR) and the adoption of an existing mapping study. The results of this SR are the compilation of coordination strategies and related indicators that can be used for assessing the coordination processes in GSD projects.

Chapter 5 documents the process of semi-structured interviews and the analysis of the interviews. The semi-structured interview sessions were conducted among the GSD project managers and consultants from GSD environment. It highlights their practice, opinions and experiences in assessing the coordination processes in GSD projects. The results of the semi-structured interview sessions are the coordination strategies and related indicators that are being used in GSD projects for assessing the coordination processes in their projects.

Chapter 6 describes the final coordination strategies and related indicators identified in Chapters 4 and 5 of this thesis. These coordination strategies and related indicators were finalized and presented in this chapter. A detailed description for each identified indicators was provided and they were then validated by GSD experts for the formulation of the proposed model. This chapter elaborates in details the proposed model in this study. It describes all the activities and the outcomes of the proposed model. Identified elements for the proposed model are coordination processes, coordination strategies, indicators and the description of each element.

Chapter 7 presents the evaluation outcomes of the proposed model. The evaluation phase is divided into two stages namely investigation of the effectiveness of the proposed model towards the success of the GSD project and the model's usefulness. The GSD project managers evaluated the proposed model for these two stages using the selected projects.

Chapter 8 concludes this study by providing the research summary and achievements. The contributions and limitations of this research are also presented. Finally, some suggestions for future work are provided.

1.12 Summary

In summary, this chapter gives a brief explanation on the current issues in GSD and the need for assessing the coordination processes in GSD in the background of this study. In the problem statement, the rationale of selecting the research topic and identification of the research gap were described. In line with this, the research questions and objectives for this study were formulated and presented. The research scope was also identified and explained in this chapter. This chapter also described the significance of this study and how it contributes to the body of knowledge in the area of software process assessment. This chapter also explains how this study was undertaken and completed. The next chapter reviews the current state-of-the-art in the related literature, specifically in the areas of coordination in GSD.

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Appendix A

Primary Study in Structured Review

#	Citation
S1	Anand, T., Reddy, C., & Mani, V. S. (2016), System Testing Optimization in a Globally Distributed Software Engineering Team. Paper presented at the 2016 IEEE 11th International Conference on Global Software Engineering (ICGSE).
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S7	Filipovikj, P., Feljan, J., & Crnković, I. (2013) Ten tips to succeed in global software engineering education: What do the students say? Paper presented at the 2013 3rd International Workshop on Collaborative Teaching of Globally Distributed Software Development (CTGDSD).
S8	Bass, J. M. (2013) Agile Method Tailoring in Distributed Enterprises: Product Owner Teams. Paper presented at the 2013 IEEE 8th International Conference on Global Software Engineering.
S9	Espinosa, J. A., Cummings, J. N., & Pickering, C. (2012), Time Separation, Coordination, and Performance in Technical Teams. IEEE Transactions on Engineering Management, 59(1), 91-103. doi: 10.1109/TEM.2011.2126579
S10	Deshpande, S., Richardson, I., Casey, V., & Beecham, S.(2010), Culture in Global Software Development - A Weakness or Strength? Paper presented at the 2010 5th IEEE International Conference on Global Software Engineering.
S11	Casey, V. (2009), Leveraging or Exploiting Cultural Difference? Paper presented at the 2009 Fourth IEEE International Conference on Global Software Engineering.
S12	Milewski, A. E., Tremaine, M., Egan, R., Zhang, S., Kobler, F., & Sullivan, P. O. (2008), Guidelines for Effective Bridging in Global Software Engineering. Paper presented at the 2008 IEEE International Conference on Global Software Engineering.
S13	Lamersdorf, A., Münch, J., & Rombach, D. (2008), Towards a Multi-criteria Development Distribution Model: An Analysis of Existing Task Distribution Approaches. Paper presented at the 2008 IEEE International Conference on Global Software Engineering.

S14	Zahedi, M., Shahin, M., & Ali Babar, M. (2016), A systematic review of knowledge sharing challenges and practices in global software development. International journal of information management, 36(6, Part A), 995-1019. doi: http://dx.doi.org/10.1016/j.ijinfomgt.2016.06.007
S15	Bjarnason, E., Smolander, K., Engström, E., & Runeson, P. (2016) A theory of distances in software engineering. Information and Software Technology, 70, 204-219. doi: http://dx.doi.org/10.1016/j.infsof.2015.05.004
S16	Ali, S., & Khan, S. U. (2016), Software outsourcing partnership model: An evaluation framework for vendor organizations. Journal of systems and software, 117, 402-425. doi: http://dx.doi.org/10.1016/j.jss.2016.03.069
S17	Portillo-Rodríguez, J., Vizcaíno, A., Piattini, M., & Beecham, S. (2014), Using agents to manage Socio-Technical Congruence in a Global Software Engineering project. Information Sciences, 264, 230-259. doi: http://dx.doi.org/10.1016/j.ins.2014.01.009
S18	Manteli, C., van den Hooff, B., & van Vliet, H. (2014), The effect of governance on global software development: An empirical research in transactive memory systems. Information and Software Technology, 56(10), 1309-1321. doi: http://dx.doi.org/10.1016/j.infsof.2014.04.012
S19	Handley, S. M., & Benton Jr, W. C. (2013), The influence of task- and location-specific complexity on the control and coordination costs in global outsourcing relationships. Journal of Operations Management, 31(3), 109-128. doi: http://dx.doi.org/10.1016/j.jom.2012.12.003
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S22	Moe, N. B., Šmite, D., Hanssen, G. K., & Barney, H. (2014), From offshore outsourcing to insourcing and partnerships: four failed outsourcing attempts. Empirical software engineering, 19(5), 1225-1258. doi: 10.1007/s10664-013-9272-x
S23	Lamersdorf, A., & Münch, J. (2010), A multi-criteria distribution model for global software development projects. Journal of the Brazilian Computer Society, 16(2), 97-115. doi: 10.1007/s13173-010-0010-6
S24	García Guzmán, J., Saldaña Ramos, J., Amescua Seco, A., & Sanz Esteban, A. (2010), How to get mature global virtual teams: a framework to improve team process management in distributed software teams. Software Quality Journal, 18(4), 409-435. doi: 10.1007/s11219-010-9096-5
S25	Imtiaz, S., & Ikram, N. (2017), Dynamics of task allocation in global software development. Journal of Software: Evolution and Process, 29(1), n/a-n/a. doi: 10.1002/smr.1832
S26	Paasivaara, M., & Lassenius, C. (2014), Agile coaching for global software development. Journal of Software: Evolution and Process, 26(4), 404-418. doi: 10.1002/smr.1577
S27	Gotel, O., Kulkarni, V., Say, M., Scharff, C., & Sunetnanta, T. (2012), Quality indicators on global software development projects: does 'getting to know you' really matter? Journal of Software: Evolution and Process, 24(2), 169-184. doi: 10.1002/smr.474

Appendix B

Interview Instrument

Coordination in Global Software Development Projects

Interview Outline

1. Interview Setting

Date: _____
Time: _____
Venue: _____

2. Self-introduction, a brief introduction to the research study, and to illustrate the purpose of this research.

Self-introduction

Greetings. My name is Anusuyah Subbarao, phD scholar from UTM who is currently pursuing research in the field of Global software development.

A brief introduction about the research

Well-coordinated development is assumed to not only produce software faster, but also to produce software of higher quality and at lower cost. Research shows that software organizations are facing many challenges related to coordination issues by adopting Global Software Development (GSD) approach. Coordination is one of the main mechanisms used in between collocated and distributed software development teams in GSD environment. A lack of coordination in GSD can decrease the productivity, complicate the process and delay the completion of tasks. Effective coordination is a critical factor in successful software projects. In order to coordinate the processes effectively, it need to be assessed. Development of indicators for each coordination processes and strategies will lead to coordination effectiveness.

Purpose of the research

The aim of this study is to formulate an Evaluation Model to Assess the Effectiveness of Coordination Processes in Global Software Development (GSD) Projects which consist of coordination processes, coordination strategies, and related indicators.

3. Respondent's Profile

Company Name	
Name	
Email ID	
Position Title	

Total Work Experience	
Total no of GSD Projects Managed	
Current project	
List of the countries involved	
Domain of the project	

4. Based on the literature, we have found the following coordination processes in GSD environment. Please mention yes or no for the following processes which are applicable in your projects. If there is more, please specify.

☐ **Team Setup**	☐ **Onsite Visit**
☐ **Team Development**	☐ **Managing Cultural Diversity**
☐ **Team Management**	☐ **Temporal Differences**
☐ **Task Allocation**	☐ **Managing Client-Vendor Relationship**
☐ **Bridging**	☐ **Communication and Coordination**
☐ _____	

5. What are the strategies and related indicators that need to be considered in order to **setup an ideal team** in GSD environment?

6. What are the strategies and related indicators that need to be considered for **successful team development** in GSD environment?

7. What are the strategies and related indicators that need to be considered in order to have successful **team management** in GSD environment?

8. What are the strategies and related indicators that need to be considered to **allocate a task** to your team member?

9. What are the strategies and related indicators that need to be considered to manage two or more separate work sites that exist on either side of their location in GSD environment?
   (This is called **bridging**)

10. What are the strategies and related indicators that need to be considered before appointing someone for an **on-site visit**?

11. What are the strategies and related indicators that need to be considered to manage **culture diversity** among the team members in GSD environment?

12. What are the strategies and related indicators that need to be considered to accommodate different time zone in GSD environment?
    (This is called **temporal differences**)

13. What are the strategies and related indicators that need to be considered to manage the **client-vendor relationship** while operating in the GSD environment?

14. What are the strategies and related indicators that need to be considered to facilitate **communication and coordination** in GSD projects?

15. Which coordination processes will lead to successful GSD projects?

- ☐ **Team Setup**
- ☐ **Team Development**
- ☐ **Team Management**
- ☐ **Task Allocation**
- ☐ **Bridging**
- ☐ **Onsite Visit**
- ☐ **Managing Cultural Diversity**
- ☐ **Temporal Differences**
- ☐ **Managing Client-Vendor Relationship**
- ☐ **Communication and Coordination**

16. In your opinion, which coordination process do you think that highly contributing to make the coordination more effective in GSD projects?

- ☐ **Team Setup**
- ☐ **Team Development**
- ☐ **Team Management**
- ☐ **Task Allocation**
- ☐ **Bridging**
- ☐ **Onsite Visit**
- ☐ **Managing Cultural Diversity**
- ☐ **Temporal Differences**
- ☐ **Managing Client-Vendor Relationship**
- ☐ **Communication and Coordination**

17. Any other comments

18. Conclusion Remarks

Appendix C

Consolidation Data in Grounded Theory

Coordination Process 1: Team Setup

Coordination Strategy	Indicators from SR (Ind1)	Indicators from Semi-structured Interview (Ind2)	Similarity Type	Consolidation Case	Suggested Indicators (based on Ind1 & Ind2)	Final Indicators
Team Members Selection	Knowledge	Knowledge	Explicit	Scenario 1	Knowledge	Knowledge
	Technical Skills	-	-	Scenario 2	Number of technical skills	Total number of technical skills
	Type of gender	-	-	Scenario 2	Type of gender	Type of gender
	Area of expertise	-	-	Scenario 2	Type of skill or expertise	Type of skill or expertise
	Ability of working with others and solve problem	cross functionality	Implicit	Scenario 1	Able to handle cross functionality	Able to handle cross functionality
	Number of years of experience	Number of years' experience	Explicit	Scenario 1	Number of years of experience	Total number of years of experience
	Trust	-	-	Scenario 2	Build the trust	Build the trust
	Competent and committed developers	competence skills	Explicit	Scenario 1	Competent and committed developers	Competent and committed developers
	-	Labour Cost	-	Scenario 3	Labour Cost	Labour Cost
Team Structure	Communication Structure	-	-	Scenario 2	Communication Structure	Communication Structure
	Work Structure	-	-	Scenario 2	Work Structure	Work Structure
	Roles & Responsibilities	Roles & Responsibilities	Explicit	Scenario 1	Roles & Responsibilities	Roles & Responsibilities
	Number of source-code files dependencies	-	-	Scenario 2	Number of source-code files dependencies	Total number of source-code files dependencies
	Number of hours to spend in a task	-	-	Scenario 2	Number of hours to spend in a task	Total number of hours spend for a task
	Expertise about a task	-	-	Scenario 2	Type of expertise about a task	Type of expertise about a task
	-	Size of the project	-	Scenario 3	Size of the project	Size of the project (Small/Medium/Big)

	-	Team Size	-	Scenario 3	Number of people in a team	Number of people in a team
	-	Team player	-	Scenario 3	Team player	Being a team player
	-	Training plan	-	Scenario 3	Training plan	Having an adequate training plan(weekly/monthly/annually)
	-	Number of resources	-	Scenario 3	Number of resources	Type and number of resources

Coordination Process 2: Team Development

Coordination Strategy	Indicators from SR (Ind1)	Indicators from Semi-structured Interview (Ind2)	Similarity Type	Consolidation Case	Suggested Indicators (based on Ind1 & Ind2)	Final Indicators
Team performance	Number of people in a team	-	-	Scenario 2	Number of people in a team	Number of people in a team
	Project size	-	-	Scenario 2	Project size	Size of the project (Small/Medium/Big)
	Number of years with the company	-	-	Scenario 2	Number of years with the company	Total number of years with the company
	Number of project resources	-	-	Scenario 2	Number of project resources	Type and number of project resources
	Project priority	Project Priority	Explicit	Scenario 1	Project priority	Project priority
	Role description	-	-	Scenario 2	(Combined with Role distribution)	-
	Role distribution	Role distribution	Explicit	Scenario 1	Team member role description and distribution	Team member role description and distribution
	Task Uncertainty	Task Certainty	Explicit	Scenario 1	Task Certainty	Task Uncertainty
	Task type	Task type	Explicit	Scenario 1	Type of task assigned	Type of task assigned
	Number of years of experience	-	-	Scenario 2	Number of years of experience	Total number of years of experience
	Number of Successfully Completed Projects according to schedule	Number of projects completed on time	Implicit	Scenario 1	Number of projects Completed successfully on-time	Total number of projects Completed successfully on-time
	Number of Successfully Completed Projects according to cost	-	-	Scenario 2	Number of projects Completed successfully on-budget	Total number of projects Completed successfully on-budget

	Percentage of user participation	-	-	Scenario 2	Percentage of user participation	% of user participation
	Percentage of team member satisfaction	Team member satisfaction	Explicit	Scenario 1	Percentage of team member satisfaction	% of team member satisfaction
	-	Tracking on-time performance	-	Scenario 3	Tracking on-time performance	% of team member performance
	Number of allocated task per location	Number of modules involved	Implicit	Scenario 1	Number of allocated task per location	Total number of allocated task per location
	Project complexity	-	-	Scenario 2	Level of Project complexity	Level of Project task complexity(High/Medium/Low)
	-	Number of hours needed to complete the project	-	Scenario 3	Number of hours needed to complete the project	Total number of hours needed to complete the project
	-	Team member attitude	-	Scenario 3	Team member attitude	Team member attitude

Coordination Process 4: Task Allocation

Coordination Strategy	Indicators from SR (Ind1)	Indicators from Semi-structured Interview (Ind2)	Similarity Type	Consolidation Case	Suggested Indicators (based on Ind1 & Ind2)	Final Indicators
Collaborative Artifacts	Skills	Skills	Explicit	Scenario 1	Type of skills	Type of skills
	Interest	Interest	Explicit	Scenario 1	Interest	Interest
Collaborative Tools	Teammates motivation	-	-	Scenario 2	Teammates motivation	Teammates motivation
	Knowledge	-	-	Scenario 2	Knowledge	Knowledge
	Skills	-	-	Scenario 2	Type of skills	Type of skills
	-	Number of tool to track each team member's contribution	-	Scenario 3	Type and number of tool to track each team member's contribution	Type and number of tool to track each team member's contribution
Techniques of Task Allocation	Labour Cost	Labour Cost	Explicit	Scenario 1	Staff Cost	Labour Cost
	Reliability	-	-	Scenario 2	Reliability	Reliability
	Proximity to client	-	-	Scenario 2	Proximity to client	Proximity to client
	Number of multi-site requests	-	-	Scenario 2	Number of multi-site requests	Total number of multi-site requests
	Number of multi-site modification requests	Number of modification request from client	Implicit	Scenario 1	Number of multi-site modification requests	Total number of multi-site modification requests

	Number of core members per location	-	-	Scenario 2	Number of core members per location	Total number of core members per location
	Expertise	-	-	Scenario 2	Type of Expertise	Type of Expertise
	Proximity to market	-	-	Scenario 2	Proximity to market	Proximity to market
	Development time per days of work	Number of development time-days of work	Explicit	Scenario 1	Total time spend per day for the development	Total time spend per day for the development
	Competence Level	Competence level	Explicit	Scenario 1	Competence Level	Competence Level
	Percentage of staff turnover rate	Percentage of turnover rate	Explicit	Scenario 1	Percentage of staff turnover rate	% of staff turnover rate
	Number of team members availability	Number of personal availability	Explicit	Scenario 1	Number of team members availability	Total number of team members availability
	Strategic planning	-	-	Scenario 2	Strategic planning	Strategic planning
	Maturity of site/Site characteristics	-	-	Scenario 2	Maturity of site/Site characteristics	Maturity of site/Site characteristics
	Development quality	Development quality	Explicit	Scenario 1	Development quality	Development quality
	Personal trust	-	-	Scenario 2	Personal trust	Personal trust
	Willingness at site	-	-	Scenario 2	Willingness at site	Willingness at site
	Process ownership	Process ownership	Explicit	Scenario 1	Process ownership	Process ownership
	Number of component dependency	Component dependency	Explicit	Scenario 1	Number of component dependency	Total number of component dependency
	Task Size	Task size	Explicit	Scenario 1	Task Size	Size of the task
	-	Team member attitude	-	Scenario 3	Team member attitude	Team member attitude
	-	Project Urgency	-	Scenario 3	Project Urgency	Project Urgency
	-	Number of projects to burn-out	-	Scenario 3	Number of projects to burn-out	Total number of projects to burn-out

Coordination Process 7: Managing Cultural diversity

Coordination Strategy	Indicators from SR (Ind1)	Indicators from Semi-structured Interview (Ind2)	Similarity Type	Consolidation Case	Suggested Indicators (based on Ind1 & Ind2)	Final Indicators
Training	Cultural Awareness	Culture Awareness	Explicit	Scenario 1	Cultural Awareness	Cultural Awareness
	Leadership Skills	-	-	Scenario 2	Type of Skills	Type of Skills
	Assertiveness/Confidence Skills	Assertive Skills	Explicit	Scenario 1	Type of Skills	Type of Skills
	Negotiation Skills	-	-	Scenario 2	Type of Skills	Type of Skills
Customer involvement	Market needs(Percentage)	-	-	Scenario 2	Percentage of market needs	% of market needs
Collaborative Tools	Type of Communication tools	-	-	Scenario 2	Type of Communication tools	Type of Communication tools
Labour turnover	Gender attitudes	Type of gender	Implicit	Scenario 1	Type of gender	Type of gender
	Religion attitudes	Balance of religion	Implicit	Scenario 1	Balance of religion	Balance of religion
	-	Face-to-face meetings	-	Scenario 3	Total number of meetings with team members	Total number of meetings with team members
	-	Set expectation	-	Scenario 3	Set expectation	Set expectation
Social Network	-	Number of team building activities	-	Scenario 3	Number of team building activities per (annum/project)	Total number of team building activities per (annum/project)
Coordination Performance	Number of Mean Time To Failure (MTTF) or Mean Time Between Failure (MTBF)	-	-	Scenario 2	Number of Mean Time To Failure (MTTF) or Mean Time Between Failure (MTBF)	Total number of Mean Time To Failure (MTTF) or Mean Time Between Failure (MTBF)
	Percentage of Defect Removal Effectiveness	-	-	Scenario 2	Percentage of Defect Removal Effectiveness	% of Defect Removal Effectiveness
	Number of Reciprocal Time to Fix	-	-	Scenario 2	Number of Reciprocal Time to Fix	Total number of Reciprocal Time to Fix
Team awareness	Experience level of team members	-	-	Scenario 2	Years of experience level of team members	Total years of experience level of team members
	Knowledge level of team members	-	-	Scenario 2	Knowledge level of team members	Knowledge level of team members
	Number of tasks that have to complete	-	-	Scenario 2	Number of tasks that have to complete	Total number of tasks that have to complete

	Schedules	-	-	Scenario 2	Schedules	Schedules
Communication Skill	-	Cultural Attitude	-	Scenario 3	Cultural Attitude	Cultural Attitude

Coordination Process 8: Temporal Differences

Coordination Strategy	Indicators from SR (Ind1)	Indicators from Semi-structured Interview (Ind2)	Similarity Type	Consolidation Case	Suggested Indicators (based on Ind1 & Ind2)	Final Indicators
Hands-on & Shake-off Sessions	Number of time zones spanned by each team	Number of time zone involved	Explicit	Scenario 1	Number of time zones spanned by each team	Number of time zones spanned by each team
	Maximum time zone spanned by each team	-	-	Scenario 2	Maximum time zone spanned by each team	Maximum time zone spanned by each team
	Tracking performance over time	-	-	Scenario 2	Tracking performance over time	Tracking performance over time
	-	How much work completed	-	Scenario 3	Percentage of work completed	% of work completed
	-	Impact on personal life	-	Scenario 3	Impact on personal life	Impact on personal life
	-	Number of working hours	-	Scenario 3	Number of working hours	Total number of working hours

Coordination Process 9: Managing Client-Vendor Relationship

Coordination Strategy	Indicators from SR (Ind1)	Indicators from Semi-structured Interview (Ind2)	Similarity Type	Consolidation Case	Suggested Indicators (based on Ind1 & Ind2)	Final Indicators
Outsourcing relationship management	Number of meetings	-	-	Scenario 2	Number of meetings	Number of meetings
	Client language skills training	-	-	Scenario 2	Number of language or skills training	Number of language or skills training
	Number of informal meetings, social networking and joint celebration	-	-	Scenario 2	Number of informal meetings, social networking and joint celebration	Number of informal meetings, social networking and joint celebration
	-	Back-up team	-	Scenario 3	Having a Back-up team	Having a Back-up team
	-	build the trust	-	Scenario 3	Build the trust	Build the trust

	-	Good understanding on client roadmap and goal	-	Scenario 3	Good understanding on client roadmap and goal	Good understanding on client roadmap and goal
Technology	-	-	-	-	-	-
Staff Turnover	Skillful developers	-	-	Scenario 2	Number of skills	Number of skills
	Ability of working with others and solve problem	-	-	Scenario 2	Ability of working with others and able to solve problem	Ability of working with others and able to solve problem
	Number of years of experience	-	-	Scenario 2	Number of years of experience	Total number of years of experience
	Domain expertise	-	-	Scenario 2	Domain expertise	Domain expertise
	Trust	-	-	Scenario 2	Build the trust	Build the trust
	Technical knowledge	-	-	Scenario 2	Number of technical knowledge	Number of technical knowledge
	Competent and committed developers	-	-	Scenario 2	Competent and committed developers	Competent and committed developers
	-	Mix role	-	Scenario 3	Mix role	Mix role
Project failure	-	Acceptance to improve	-	Scenario 3	Acceptance to improve	Acceptance to improve
	-	Number of hours spend in planning	-	Scenario 3	Number of hours spend in planning	Total number of hours spend in planning
	-	Skills to lead the market	-	Scenario 3	Skills to lead the market	Skills to lead the market
	-	Project impact	-	Scenario 3	Project impact	Project impact
Vendor selection	-	Cost	-	Scenario 3	Cost	Cost
	-	On-time delivery	-	Scenario 3	Number of completed projects on-time	Number of completed projects on-time
	-	Track their performance records	-	Scenario 3	Track vendor performance records	Track vendor performance records(Good/Average/Bad)
	-	Vendor staff turnover	-	Scenario 3	Vendor staff turnover	Vendor staff turnover

Appendix D

Indicators Description

Description for Team Setup indicators

Indicator ID	Indicator Name	Purpose of the indicator	Method of application	Measurement formula and data element computations (X)	Interpretation of measured value	Indicator scale type	Input to measurement	Target audience	Source	Indicators are correctly described (Yes/No)
TS1	Knowledge	What type of knowledge does the team member has?	Determine what type of knowledge the team member have	X=Type of knowledge	More knowledge is good	Nominal	Project Manager Records	Project Manager	(Deshpande et al., 2010)	
TS2	Total number of technical skills	Does the technical skill required?	Determine the list of technical skill required	X=List of technical skill required	Better the skills, better the productivity	Nominal	Project Manager Records	Project Manager	(Moe et al., 2014)	
TS3	Type of gender(Male/Female)	Does the team have a balance gender?	State the gender	X=Gender Type	Having a balance gender is an advantage. Also depends on the culture and the country	Nominal	Project Manager Records	Project Manager	(Deshpande et al., 2010)	
TS4	Type of skill or expertise	What types of skills/expertise does the team member has?	Determine types of skills/expertise	X=Type of skills/expertise	More number of skills/expertise, better for the team	Nominal	Project Manager Records	Project Manager	GSD Expert	
TS5	Able to handle cross functionality	Can the team member handle more than one task?	Determine the cross functionality tasks	X=List of cross functionality tasks	Able to handle cross functionality task is good	Nominal	Project Manager Records	Project Manager	(Moe et al., 2014)	
TS6	Total number of years of experience	How many years of experience in working in GSD projects?	Count the number of years working in GSD projects	X=Total Number of Years in GSD projects	More the number of years in GSD, better the familiarity	Ratio	Project Management Plan	Project Manager	(Moe et al., 2014)	
TS7	Build the trust	Do they trust their peers?			Build the trust among peers is good	Nominal	Project Manager Records	Project Manager	(Moe et al., 2014)	

TS8	Competent and committed developers	How committed the developer is on a particular project?	Count the total time spend in a day/week/month	X= Total time spend in a day/week/month	More time spend, the dedication and commitment towards the project.	Ratio	Project Manager Records	Project Manager	(Moe et al., 2014)	
TS9	Labour Cost	How much salary to pay?	Determine the salary based on the skillset and experience	X=Total salary paid	Higher the skillset and experience, higher the salary is	Ratio	Project Management Plan	Project Manager	GSD Expert	
TS10	Communication Structure	How is the communication structure? Is it flexible?	Determine the communication structure (Flat/hierarchical)	X=Type of communication structure	Direct communication link to customers can enable offshore to get engaged in discussion, elicit requirements from customers and prepare specifications themselves	Nominal	Project Manager Records	Project Manager	(Zahedi et al., 2016)	
TS11	Work Structure	How clear is the work structure?	Determine the clarity in work structure	X=Good clarification on the work structure	Better clarification could help smooth the flow of information between distributed team members	Nominal	Project Manager Records	Project Manager	(Zahedi et al., 2016)	
TS12	Roles & Responsibilities	Is the roles and responsibilities are clearly defined?	Determine the roles and responsibilities clearly	X=Clearly defined roles and responsibilities	Clearly defined roles and responsibilities experienced better exchange of knowledge	Nominal	Project Manager Records	Project Manager	(Zahedi et al., 2016)	
TS13	Total number of source-code files dependencies	Is the source-code files are dependent to each other?	Determine the source-code files which are dependent to each other,	X=Total number of source-code files dependent	Lesser the source-code files are dependent, better the coordination.	Ratio	Project Management Plan	Project Manager	(Portillo-Rodríguez, Vizcaíno, Piattini, & Beecham, 2014)	

			determine the team structure							
TS14	Total number of hours spend for a task	How many hours spend for a task?	Count number of hours spend for a task	X=Total number of hours spend for a task	Determine number of hours needed for a task correctly	Ratio	Project Management Plan	Project Manager	(Portillo-Rodríguez et al., 2014)	
TS15	Type of expertise about a task	What types of expertise does the team member has specifically about a task?	Determine types of expertise about a task	X=Type of expertise about a task	More expertise about a task better it is	Nominal	Project Manager Records	Project Manager	(Portillo-Rodríguez et al., 2014)	
TS16	Size of the project(Small/Medium/Big)	How many kLOC in the project?	Determine kLOC in the project	X=Total kLOC in the project	kLOC determines the size of the project	Ratio	Project Management Plan	Project Manager	GSD Expert	
TS17	Number of people in a team	How many people involved in the GSD project?	Determine number of people involved in a project	X=Total number of people involved in a project	Not more than 8 people involved in a project	Ratio	Project Management Plan	Project Manager	GSD Expert	
TS18	Being a team player	Is this person a team player?	Determine years of experience in distributed projects	X=Total years of experience in distributed projects	The more number of years in distributed projects, better it is	Nominal	Project Manager Records	Project Manager	GSD Expert	
TS19	Having an adequate training plan(weekly/monthly/annually)	Does the training required?	Determine the list of training required	X=List of training required	The detail plan of training should be available before starting the project	Nominal	Project Management Plan	Project Manager	GSD Expert	
TS20	Type and number of resources	Does the resources list is prepared?	Determine the list of resources listed	X=Allocated list of resources	Detail list of resources should be available before starting the project	Nominal	Project Management Plan	Project Manager	GSD Expert	

Description for Team Development indicators

Indicator ID	Indicator Name	Purpose of the indicator	Method of application	Measurement formula and data element computations (X)	Interpretation of measured value	Indicator scale type	Input to measurement	Target audience	Source	Indicators are correctly described (Yes/No)
TD1	Number of people in a team	How many people involved in the GSD project?	Count the number of people involved in a project	X=Total number of people involved in a project	Multiple site teams tend to be larger	Ratio	Project Management Plan	Project Manager	(J. A. Espinosa et al., 2012)	
TD2	Size of the project(Small/Medium/Big)	How many kLOC in the project?	Determine kLOC in the project	X=Total kLOC in the project	kLOC determines the size of the project	Ratio	Project Management Plan	Project Manager	(J. A. Espinosa et al., 2012) GSD Expert	
TD3	Total number of years with the company	How many years of experience with the company?	Count the number of years with the company	X=Total Number of Years with the company	More the number of years in the same company, better the familiarity	Ratio	Project Management Plan	Project Manager	(J. A. Espinosa et al., 2012)	
TD4	Type and number of project resources	Does the resources list is prepared?	Determine the list of resources listed	X=Allocated list of resources	Detail list of resources should be available before starting the project	Nominal	Project Management Plan	Project Manager	(J. A. Espinosa et al., 2012)	
TD5	Project priority	Which project has the highest priority?	Determine the highest priority project	X= List of project according to the priority	The highest priority project should be considered first	Nominal	Project Management Plan	Project Manager	(J. A. Espinosa et al., 2012)	
TD6	Team member role description and distribution	Is the team member roles description are clearly defined?	Determine the roles description clearly	X=Clearly defined roles description	Clearly defined roles and responsibilities experienced better exchange of knowledge	Nominal	Project Manager Records	Project Manager	(Manteli et al., 2014)	
TD7	Task Uncertainty	What are the new work or task that has never done before is assigned to the team member?	Determine the new task	X=List of new tasks	Lesser new task assigned is better	Nominal	Project Manager Records	Project Manager	(J. A. Espinosa et al., 2012)	

TD8	Type of task assigned	What types of task is assign?	Determine types of task assigned	X=List of type of task assigned	Type of task assigned influence the performance of team members	Nominal	Project Manager Records	Project Manager	(J. A. Espinosa et al., 2012)	
TD9	Total number of years of experience	How many years of experience in working in GSD projects?	Count the number of years working in GSD projects	X=Total Number of Years in GSD projects	More the number of years in GSD, better the familiarity	Ratio	Project Management Plan	Project Manager	(J. A. Espinosa et al., 2012)	
TD10	Total number of projects Completed successfully on-time	How many projects completed successfully on-time?	Count number of on-time completed projects	X=Total number of on-time completed projects	More number of projects completed on-time, better the performance of team members	Ratio	Project Management Plan	Project Manager	(J. A. Espinosa et al., 2012)	
TD11	Total number of projects Completed successfully on-budget	How many projects completed successfully on-budget?	Count number of on- budget completed projects	X=Total number of on- budget completed projects	More number of projects completed on-budget, better the performance of team members	Ratio	Project Management Plan	Project Manager	(J. A. Espinosa et al., 2012)	
TD12	% of user participation	What is the percentage of user participation on a specific project?	Count the percentage of user participation	X=User participation evaluation	Higher the percentage is, better the user participation	Ratio	Project Management Plan	Project Manager	(J. A. Espinosa et al., 2012)	
TD13	% of team member satisfaction	What is the percentage of team member satisfaction on a specific project?	Count the percentage of team member satisfaction	X= Team member satisfaction evaluation	Higher the percentage is, better the team member satisfaction	Ratio	Project Manager Records	Project Manager	(J. A. Espinosa et al., 2012)	
TD14	% of team member performance	How is the performance of team member on a specific project?	Count the percentage of team member performance	X= A/B*100 A=Number of successfully completed projects B=Total number of undertaken projects	Higher the percentage is, better the team member performance	Ratio	Project Manager Records	Project Manager	GSD Expert	

TD15	Total number of allocated task per location	Which task is allocated for the specific location?	Determine the task allocated for the specific location	X=Total number of task allocated for the specific location	Allocated task must match the capacities of that location	Ratio	Project Manager Records	Project Manager	(Manteli et al., 2014)	
TD16	Level of Project task complexity(High/Medium/Low)	What is the level of complexity of the task escalated?	Determine the level of task complexity	X=Level of task complexity	Lesser the number of dependencies between remote members, less complex the task is.	Interval	Project Manager Records	Project Manager	(Manteli et al., 2014)	
TD17	Total number of hours needed to complete the project	How many hours needed to complete the project?	Count the number of hours completed in specific project	X=Total number of hours needed to complete the project	More number of hours spent, faster the completion of the project will be.	Ratio	Project Manager Records	Project Manager	GSD Expert	
TD18	Team member attitude	What types of attitude does the team member has?	Determine type of attitude	X=Type of attitude(Positive/ Negative)	Type of attitude influence the performance of team members	Nominal	Project Manager Records	Project Manager	GSD Expert	

Description for Task Allocation indicators

Indicator ID	Indicator Name	Purpose of the indicator	Method of application	Measurement formula and data element computations (X)	Interpretation of measured value	Indicator scale type	Input to measurement	Target audience	Source	Indicators are correctly described (Yes/No)
TA1	Type of skills	What types of skills does the team member has?	Determine types of skills	X=Type of skills	More number of skills better for the team member	Nominal	Project Manager Records	Project Manager	(Filipovikj et al., 2013)	
TA2	Interest	Does the team member has an interest in the project?	Determine the interest in the project	X=Interest status(Yes/No)	Having interest shows a better commitment	Nominal	Project Manager Records	Project Manager	(Filipovikj et al., 2013)	
TA3	Teammates motivation	What type of award/reward/incentive given to the team member?	Determine the type of award/reward/incentive	X=List of award/reward/incentive	Award/reward/incentive motivates the team members to perform better	Nominal	Project Management Plan	Project Manager	(Filipovikj et al., 2013)	

TA4	Knowledge	What type of knowledge does the team member has?	Determine what type of knowledge the team member have	X=Type of knowledge	More knowledge is good	Nominal	Project Manager Records	Project Manager	(Filipovikj et al., 2013)	
TA6	Type and number of tool to track each team member's contribution	Is the list of collaborative tools to track each team member's contribution ready?	Determine the list of collaborative tools	X=Allocated list of collaborative tools	Detail list of collaborative tools should be available before starting the project to track each team member's contribution	Nominal	Project Management Plan	Project Manager	GSD Expert	
TA7	Labour Cost	How much salary to pay?	Determine the salary based on the skillset and experience	X=Total salary paid	Higher the skillset and experience, higher the salary is	Ratio	Project Management Plan	Project Manager	(Imtiaz & Ikram, 2017), (Paasivaara & Lassenius, 2014)	
TA8	Reliability	How consistently well the team member is performing?			More reliable the team member is, easier for task allocation	Nominal	Project Manager Records	Project Manager	(Alsri et al., 2014)	
TA9	Proximity to client	How is the performance of client on a specific project?	Count the percentage of client performance	X= A/B*100 A=Number of successfully completed projects B=Total number of undertaken projects	Higher the percentage is, better the client performance	Ratio	Project Manager Records	Project Manager	(Alsri et al., 2014)	
TA10	Total number of multi-site requests	How many requests from different sites?	Count the number of requests from all sites	X=Total requests from all sites	Minimizing this multi-site requests, maximizes the productivity.	Ratio	Project Manager Records	Project Manager	(Lamersdorf et al., 2008)	
TA11	Total number of multi-site modification requests	How many set of changes to existing files?	Count the number of set of changes to existing files	X=Total number of set of changes to existing files	Minimizing this multi-site modification requests,	Ratio	Project Manager Records	Project Manager	(Lamersdorf et al., 2008)	

					maximizes the productivity.					
TA12	Total number of core members per location	Which team member is allocated for the specific location?	Determine the team member allocated for the specific location	X=Total number of team members allocated for the specific location	Allocated total team members must match the capacities of that location	Ratio	Project Manager Records	Project Manager	(Manteli et al., 2014)	
TA13	Type of Expertise	What types of expertise does the team member has?	Determine types of expertise	X=Type of expertise	More number of expertise, easier for the team allocation	Nominal	Project Manager Records	Project Manager	(Lamersdorf & Münch, 2010)	
TA14	Proximity to market	How does the messages being sent out electronically to the clients?	Determine medium of electronic	X=Medium of electronic(Mobile device users)	Done according to the proximity marketing strategies	Nominal	Project Manager Records	Project Manager	(Lamersdorf & Münch, 2010)	
TA15	Total time spend per day for the development	How much time spend per day for the development on a specific project?	Count the total time spend in a day for the development	X=Total time spend in a day for the development	Limit the practical team size; further growing the team size would not fit to their way of working.	Ratio	Project Manager Records	Project Manager	(Paasivaara & Lassenius, 2014)	
TA16	Competence Level	How competent is the team member?	Determine the competence level	X=Competence Level	Team members should be highly competent	Ratio	Project Manager Records	Project Manager	(Paasivaara & Lassenius, 2014)	
TA17	% of staff turnover rate	How is the rate of staff turnover?	Count the percentage of staff turnover	X=A/B*100 A=Total number of staff turnover B=Total number of staff	Lesser the staff turnover rate, better the task allocation is	Ratio	Project Manager Records	Project Manager	(Lamersdorf & Münch, 2010)	
TA18	Total number of team members availability	How many personnel available throughout the project?	Count the number of personnel availability accounts for holidays or unavailability or personnel due to other project obligations	X=Total number of personnel availability throughout the project	Project Manager should have a list of personnel availability accounts for holidays or unavailability or personnel due to other project obligations	Ratio	Project Manager Records	Project Manager	(Imtiaz & Ikram, 2017)	

TA19	Strategic planning	How many hours spent in planning?	Count the total hours spend in planning	X=Total hours spend in planning	More time spent in planning, less time taken for development	Ratio	Project Manager Records	Project Manager	GSD Expert	
TA20	Maturity of site/Site characteristics					Nominal	Project Manager Records	Project Manager	(Lamersdorf & Münch, 2010)	
TA21	Development quality			X= List of capability of the team	Depends on capability of the team	Nominal	Project Manager Records	Project Manager	(Lamersdorf & Münch, 2010)	
TA22	Personal trust	Do they trust their peers?			Build the trust among peers is good	Nominal	Project Manager Records	Project Manager	(Lamersdorf & Münch, 2010)	
TA23	Willingness at site	Is the team member willing to work at the site?	Check the willingness	X=Willingness to work at the site (Yes/No)	More willingness to work at the site, easier for task allocation	Nominal	Project Manager Records	Project Manager	(Lamersdorf & Münch, 2010)	
TA24	Process ownership	Who has the process ownership?	Determine who has the process ownership	X=Individual who has the process ownership	More importance given to process ownership by less experienced individuals	Nominal	Project Manager Records	Project Manager	(Imtiaz & Ikram, 2017)	
TA25	Total number of component dependency	How many modules are dependent to each other?	Check whether there is any dependencies between modules before assigning them to distributed sites	X=Total number of dependencies between modules	Lesser the dependency, easier the decision of allocating a task	Ratio	Project Manager Records	Project Manager	(Imtiaz & Ikram, 2017)	
TA26	Size of the task	How big is the task assigned?	Determine the size of the task	X=Task size	Smaller the task is, easier to manage the task	Ratio	Project Manager Records	Project Manager	(Imtiaz & Ikram, 2017)	
TA27	Team member attitude	What types of attitude does the team member has?	Determine type of attitude	X=Type of attitude(Positive/ Negative)	Type of attitude influence the performance of team members	Nominal	Project Manager Records	Project Manager	GSD Expert	
TA28	Project Urgency	Which project has the highest urgency?	Determine the highest urgency project	X= List of project according to the urgency	The highest urgency project should be considered first	Nominal	Project Management Plan	Project Manager	GSD Expert	

TA29	Total number of projects to burn-out	How much total effort against the amount of work delivered at each iteration?	Checks the total effort against the amount of work delivered at each iteration	X=Total effort/Amount of work delivered at each iteration	Shows how quickly project manager and team members are burning through customer's user stories	Ratio	Project Manager Records	Project Manager	GSD Expert	

Description for Bridging indicators

Indicator ID	Indicator Name	Purpose of the indicator	Method of application	Measurement formula and data element computations (X)	Interpretation of measured value	Indicator scale type	Input to measurement	Target audience	Source	Indicators are correctly described (Yes/No)
B1	Total number of common collaborative tool	Is the list of collaborative tools to support the team members ready?	Determine the list of collaborative tools	X=Allocated list of collaborative tools	Detail list of collaborative tools should be available before starting the project to support the bridging	Nominal	Project Management Plan	Project Manager	(Anand et al., 2016)	
B2	Total number of common language between sites	What are the common languages to support the sites?	Determine the list of common languages	X=Agreed list of common languages	List of common languages between sites should be agreed before starting the project to support the bridging	Nominal	Project Management Plan	Project Manager	GSD Expert	
B3	Appointing functional person	Who is the appointed functional person?	Determine list of tasks	X=Agreed list of tasks	List of tasks should be agreed before starting the project	Nominal	Project Manager Records	Project Manager	GSD Expert	
B4	Total cost	How much does it cost for travelling to the site?	Total money spend to travel to the site	X=Total money spend to travel to the site		Ratio	Project Manager Records	Project Manager	GSD Expert	
B5	Frequent update	How frequent the update is to the team members?	Determine the frequency of the update	X=Frequency of update (Daily/Weekly/ Monthly)	Constant update gives a clear idea to the team members	Nominal	Project Manager Records	Project Manager		

B6	Multitasking	Can the team member handle more than one task?	Determine the cross functionality tasks	X=List of cross functionality tasks	Able to handle cross functionality task is good	Nominal	Project Manager Records	Project Manager	GSD Expert	
B7	Type and number of resources available	Does the resources list is prepared?	Determine the list of resources listed	X=Allocated list of resources	Detail list of resources should be available before starting the project	Nominal	Project Management Plan	Project Manager		
B8	% of team satisfaction	What is the percentage of team member satisfaction on a specific project?	Count the percentage of team member satisfaction	X= Team member satisfaction evaluation	Higher the percentage is, better the team member satisfaction	Ratio	Project Manager Records	Project Manager	GSD Expert	
B9	Number of stand-up meetings covering different locations	How many stand-up meetings covering different locations?	Count the number of stand-up meetings	X=Total number of stand-up meetings	Better team coordination through the stand-up meetings covering different locations thru bridging	Ratio	Project Manager Records	Project Manager	(Anand et al., 2016)	

Description for Onsite Visit indicators

Indicator ID	Indicator Name	Purpose of the indicator	Method of application	Measurement formula and data element computations (X)	Interpretation of measured value	Indicator scale type	Input to measurement	Target audience	Source	Indicators are correctly described (Yes/No)
O1	Type of cultural training	Is the cultural training required?	Determine the list of cultural training required	X=List of training required	The detail plan of cultural training should be provided before the site visit	Nominal	Project Management Plan	Project Manager		
O2	Type of gender	Does the team have a balance gender?	State the gender	X=Gender Type	Having a balance gender is an advantage. Also	Nominal	Project Manager Records	Project Manager		

					depends on the culture and the country					
O3	Business Needs	What are the business needs?	Clearly define the business needs	X=Detail list of business needs	Detail list of business needs is good	Nominal	Project Manager Records	Project Manager		
O4	Knowledge	What type of knowledge does the team member has?	Determine what type of knowledge the team member have	X=Type of knowledge	More knowledge is good	Nominal	Project Manager Records	Project Manager		
O7	Emphasis on aligning with the solution	Is the project align with solution?	Clearly define the project must align with the solution	X=List of suggested solution	Aligning the project with solution is good	Nominal	Project Manager Records	Project Manager		
O8	Having the Requirement right	Is the requirement right?	Determine the right requirements	X=List of requirements	Having the right requirement determine the success of the project	Nominal	Project Manager Records	Project Manager		
O9	Total Travel time	How many hours/days of travelling to the site?	Total hours/days taken to arrive at the site	X=Total hours/days taken to arrive at the site		Ratio	Project Manager Records	Project Manager	(J. A. Espinosa et al., 2012)	
O10	Numbers of sites	How many sites in total involved in the specific project?	Total number of sites involved in the specific project	X=Total number of sites involved	More sites in a different time zone, reduction in performance	Ratio	Project Manager Records	Project Manager	(J. A. Espinosa et al., 2012)	
O11	Type of communication methods	What type of communication methods needed to support the project?	Determine the type of communication methods	X=Type of communication methods(Horizontal/vertical)	Type of communication should be decided before starting the project	Nominal	Project Management Plan	Project Manager		
O12	Number of team members	How many people involved in the specific project?	Count the number of people involved in the specific project	X=Total number of people involved in the specific project	Multiple site teams tend to be larger	Ratio	Project Manager Records	Project Manager	(J. A. Espinosa et al., 2012)	
O13	Total Cost for travelling to another site	How much does it cost for travelling to the site?	Total money spend to travel to the site	X=Total money spend to travel to the site		Ratio	Project Manager Records	Project Manager	GSD Expert	

O14	Gain experience	How many sites visited in total in the specific project?	Total number of sites visited in the specific project	X=Total number of sites visited	More sites visited, gain more experience	Ratio	Project Manager Records	Project Manager		
O15	Total number of meetings with stakeholders	How many meetings with stakeholders?	Count the number of stakeholder meetings	X=Total number of stakeholder meetings	More meetings with stakeholders are better	Ratio	Project Manager Records	Project Manager	GSD Expert	
O16	Type of Skills	What types of skills does the team member has?	Determine types of skills	X=Type of skills	More number of skills better for the team member	Nominal	Project Manager Records	Project Manager		

Description for Managing Cultural Diversity indicators

Indicator ID	Indicator Name	Purpose of the indicator	Method of application	Measurement formula and data element computations (X)	Interpretation of measured value	Indicator scale type	Input to measure ment	Target audience	Source	Indicators are correctly described (Yes/No)
CD1	Cultural Awareness					Nominal	Project Manager Records	Project Manager		
CD2	Type of Skills (Leadership skills/Assertiveness Skills/Confidence Skills/Negotiation Skills)	What types of skills does the team member has?	Determine types of skills	X=Type of skills	More number of skills better for the team member	Nominal	Project Manager Records	Project Manager		
CD3	% of market needs	What is the percentage of market needs on a specific project?	Count the percentage of market needs	X=Market needs evaluation	Higher the percentage is, higher the market needs is	Ratio	Project Managem ent Plan	Project Manager	(Monasor et al., 2014)	
CD4	Type of Communication tools	What type of collaborative tools needed to support the project?	Determine the list of collaborative tools	X=Allocated list of collaborative tools	Detail list of collaborative tools should be available before starting the project to support the communication and coordination	Nominal	Project Managem ent Plan	Project Manager		

CD5	Type of gender	Does the team have a balance gender?	State the gender	X=Gender Type	Having a balance gender is an advantage. Also depends on the culture and the country	Nominal	Project Manager Records	Project Manager		
CD6	Balance of religion	Does the team have a balance of religion?	State the religion	X=Religion Type	Having a balance of religion is an advantage. Also depends on the culture and the country	Nominal	Project Manager Records	Project Manager		
CD7	Total number of meetings with team members	How many meetings with team members?	Count the number of meetings	X=Total number of meetings	More meetings with team members, better the coordination is	Ratio	Project Manager Records	Project Manager	GSD Expert	
CD8	Set expectation					Nominal	Project Manager Records	Project Manager		
CD9	Total number of team building activities per (annum/project)	How many team building activities per annum/project?	Count the number of team building activities	X=Total number of team building activities	More team building activities, more closeness the team members are	Ratio	Project Manager Records	Project Manager	GSD Expert	
CD10	Total number of Mean Time To Failure (MTTF) or Mean Time Between Failure (MTBF)	How much is the average time difference between two consecutive failures?	Count the average time difference between two consecutive failures	X=average(t 2..n+1–t 1..n)	Greater value suggests better coordination	Ratio	Project Manager Record	Project Manager	(Feczak & Hossain, 2011)	
CD11	% of Defect Removal Effectiveness	How many number of bugs fixed/total number of bugs identified?	Count the number of bugs fixed/total number of bugs identified	X=Total Number of Bugs Fixed/Total Number of Bugs Identified	Greater value suggests better coordination	Ratio	Project Manager Record	Project Manager	(Feczak & Hossain, 2011)	

CD12	Total number of Reciprocal Time to Fix	How much average of the time differences between a bug ticket opened and closed?	Count the average of the time differences between a bug ticket opened and closed	X=∑(Close ticket time-Open ticket time)/Total ticket bugs	Greater value suggests better coordination	Ratio	Project Manager Record	Project Manager	(Feczak & Hossain, 2011)	
CD13	Total years of experience level of team members	How many years of experience in working in GSD projects?	Count the number of years working in GSD projects	X=Total Number of Years in GSD projects	More the number of years in GSD, better the familiarity	Ratio	Project Management Plan	Project Manager	(Feczak & Hossain, 2011)	
CD14	Knowledge level of team members	What is the level of knowledge?	Determine the knowledge level	X=Knowledge Level	Higher the knowledge level, better it will be	Ratio	Project Management Plan	Project Manager	(Feczak & Hossain, 2011)	
CD15	Total number of tasks that have to complete	Does the list of task is prepared?	Determine the list of tasks	X=Allocated list of tasks	The detail task should be available before the project starts	Nominal	Project Management Plan	Project Manager	(Feczak & Hossain, 2011)	
CD16	Schedules	How many shifting work hours for each team member?	Determine the work schedule shifting scheme to reduce the maximum time zone span	X=Total shifting work hours	Shifting schedules to reduce the time zone span	Nominal	Project Manager Records	Project Manager		
CD17	Cultural Attitude	How do the team members react towards other team member from different cultural background?	Determine type of attitude	X=Type of attitude(Positive/ Negative)	Type of attitude influence the performance of team members	Nominal	Project Manager Records	Project Manager	GSD Expert	

Description for Managing Client-Vendor Relationship indicators

Indicator ID	Indicator Name	Purpose of the indicator	Method of application	Measurement formula and data element computations (X)	Interpretation of measured value	Indicator scale type	Input to measurement	Target audience	Source	Indicators are correctly described (Yes/No)
CV1	Number of meetings	How many meetings with vendor?	Count the number of meetings	X=Total number of meetings	More meetings with vendor, better the relationship is	Ratio	Project Manager Records	Project Manager	(Ali & Khan, 2016)	
CV2	Number of language or skills training	Does the language/skill training required?	Determine the list of training required	X=List of training required	More number of training, better the productivity	Nominal	Project Management Plan	Project Manager	(Ali & Khan, 2016)	
CV3	Number of informal meetings, social networking and joint celebration	How many informal meetings with vendor?	Count the number of meetings	X=Total number of meetings	More meetings with vendor, better the relationship is	Ratio	Project Manager Records	Project Manager	(Ali & Khan, 2016)	
CV4	Having a Back-up team							Project Manager		
CV5	Build the trust	Do they trust their vendors?			Build the trust among vendors is good	Nominal	Project Manager Records	Project Manager		
CV6	Good understanding on client roadmap and goal							Project Manager		
CV7	Number of skills	Does the technical skill required?	Determine the list of technical skill required	X=List of technical skill required	Better the skills, better the productivity	Nominal	Project Management Plan	Project Manager	(Moe et al., 2014)	
CV8	Ability of working with others and able to solve problem							Project Manager		
CV9	Total number of years of experience	How many years of experience in working in GSD projects?	Count the number of years working in GSD projects	X=Total Number of Years in GSD projects	More the number of years in GSD, better the familiarity	Ratio	Project Management Plan	Project Manager	(Moe et al., 2014)	
CV10	Domain expertise					Nominal	Project Manager Records	Project Manager		
CV12	Number of technical knowledge	What is the level of technical knowledge?	Determine the technical knowledge level	X=Technical Knowledge Level	Higher the technical	Ratio	Project Management Plan	Project Manager	(Moe et al., 2014)	

					knowledge level, better it will be					
CV13	Competent and committed developers	How committed the developer is on a particular project?	Count the total time spend in a day/week/month	X= Total time spend in a day/week/month	More time spend, better	Ratio	Project Manager Records	Project Manager		
CV14	Mix role	Can the team member handle mix role?	Determine the roles clearly	X=List of clearly defined roles	Mix roles is better	Nominal	Project Manager Records	Project Manager		
CV15	Acceptance to improve							Project Manager		
CV16	Total number of hours spend in planning	How many hours spent in planning?	Count the total hours spend in planning	X=Total hours spend in planning	More time spent in planning, less time taken for development	Ratio	Project Manager Records	Project Manager	GSD Expert	
CV17	Skills to lead the market	What types of skills does the team member need to have to lead the market?	Determine types of skills	X=Type of skills needed to lead the market	Appropriate skills leads the market well	Nominal	Project Manager Records	Project Manager		
CV18	Project impact							Project Manager		
CV19	Cost	How much does the vendor charge for the whole project?	Total amount spent to pay to the vendor	X=Total cost to be paid to vendor	Lesser the charge is, better for the client	Ratio	Project Management Plan	Project Manager	GSD Expert	
CV20	Number of completed projects on-time	How many projects completed on-time?	Count number of on-time completed projects	X=Total number of on-time completed projects	More number of projects completed on-time, better the performance of team members	Ratio	Project Management Plan	Project Manager	GSD Expert	
CV21	Track vendor performance records (Good/Average/Bad)	How is the performance of the vendor?	Track the vendor performance record	X=State the vendor performance	Better the vendor performance record, more likely to assign them new projects	Nominal	Project Management Plan	Project Manager	GSD Expert	
CV22	Vendor staff turnover	How is the rate of vendor turnover?	Count the percentage of vendor turnover	X=A/B*100 A=Total number of vendor turnover B=Total number of vendors	Lesser the vendor turnover rate, better the client-vendor relationship is	Ratio	Project Manager Records	Project Manager		

Appendix E

Delphi Round 1 Content Validation Sample

Please refer to next page.

UTM
UNIVERSITI TEKNOLOGI MALAYSIA
Advanced Informatics School (UTM AIS)

EXPERT REVIEW: CONTENT VALIDITY FORM

Research Title:

EVALUATION MODEL TO ASSESS THE EFFECTIVENESS OF COORDINATION PROCESSES IN GLOBAL SOFTWARE DEVELOPMENT(GSD) PROJECTS

Dear Dr/Sir/Madam,

Thank you for your interest in this study. I am a Doctor of Philosophy (PhD) student in Universiti Teknologi Malaysia (UTM), Kuala Lumpur Campus. My research title is "**Evaluation Model to Assess the Effectiveness of Coordination Processes in Global Software Development Projects".** The aim of this questionnaire is to gain an understanding and suitability of indicator of each strategy for each coordination process. A Content Validity Questionnaire (CVQ) with specific instructions is enclosed for your review.

I need your valuable idea and opinion to ensure the appropriateness of the factors and items. I really hope you can spare around 30-40 minutes of your time rating and evaluating the **questionnaire items.** I am also seeking suggestions for items that you feel should be added, deleted or modified and for your overall assessment of the items. Therefore, your cooperation is highly appreciated as it is beneficial to both industry and academia. Your support and cooperation in this matter is very much appreciated. Thank you.

For further info, you may contact:

Student	**Anusuyah Subbarao (PAN153006)** PhD Candidate Advanced Informatics School (AIS), UTMKL E-mail: anusya_r@yahoo.com Telephone: 016-3365934
Supervisor	**Dr. Mohd Naz'ri Mahrin** Senior Lecturer, AIS, UTMKL E-mail: mdnazrim@utm.my

The CVQ structure is as below and the question for Delphi Study later will use Scale and Category for Section 1, Five Points Likert Scale (1-Strongly Disagree to 5-Strongly Agree) for Section 2 and Yes/No for Section 3.

Section	Description/Element/Factor	Item	No. of Item	
1	Respondent's Profile	RP1: Role RP2: Experience RP3: Knowledge level on GSD RP4: Training in GSD RP5: Project Management Certification RP6: Total Number of Projects Coordinate (Past and Present) with other countries	6	
2	**Coordination Process**	**Coordination Strategy**	**Indicator**	**No. of item**
B1	**CP1 Team Setup**	Team Members Selection	TS1 Team Knowledge TS2 Total number of technical skills TS3 Type of gender TS4 Type of skill or expertise TS5 Able to handle cross functionality TS6 Total number of years of experience TS7 Build the trust TS8 Competent and committed developers TS9 Labour Cost	9
		Team Structure	TS10 Communication Structure TS11 Work Structure TS12 Roles & Responsibilities TS13 Total number of source-code files dependencies TS14 Total number of hours spend for a task TS15 Type of expertise about a task TS16 Size of the project(Small/Medium/Big) TS17 Number of people in a team TS18 Being a team player TS19 Having an adequate training plan (weekly /monthly /annually) TS20 Type and number of resources	11
B2	**CP2 Team Development**	Team Performance	TD1 Number of people in a team TD2 Size of the project (Small/ Medium/ Big) TD3 Total number of years with the company TD4 Type and number of project resources TD5 Project priority TD6 Team member role description and distribution TD7 Task Uncertainty TD8 Type of task assigned TD9 Total number of years of experience TD10 Total number of projects Completed successfully on-time TD11 Total number of projects Completed successfully on-budget TD12 % of user participation TD13 % of team member satisfaction	18

Section	Description/Element/Factor	Item	No. of Item	
			TD14 % of team member performance TD1 5 Total number of allocated task per location TD16 Level of Project task complexity (High/ Medium/ Low) TD17 Total number of hours needed to complete the project TD18 Team member attitude	
B3	**CP3 Team Management**	Training	TM1 Number of Soft skills Achieved	1
		Tool Selection	TM2 Type and number of collaborative tools TM3 Total cost of virtual communication	2
		Team Cognition	TM4 Team Qualification and Expertise TM5 Being a teamwork player	2
		Team Motivation	TM6 Award Rewards or Incentives TM7 % of team member job satisfaction	2
		Team Operation	TM8 Time needed to prepare and launch the teams TM9 Delay in submission of deliverables TM10 Total time taken to complete the project vs allocated time TM11 Team role distribution TM12 Total cost of travels between sites TM13 Constant briefing to team members	6
B4	**CP4 Task Allocation**	Collaborative Artefacts	TA1 Type of skills TA2 Interest	2
		Collaborative Tools	TA3 Teammates motivation TA4 Team Knowledge TA5 Type of skills TA6 Type and number of tool to track each team member's contribution	4
		Techniques of Task Allocation	TA7 Labour Cost TA8 Reliability TA9 Proximity to client TA10 Total number of multi-site requests TA11 Total number of multi-site modification requests TA12 Total number of core members per location TA13 Type of Expertise TA14 Proximity to market TA15 Total time spend per day for the development TA16 Competence Level TA17 % of staff turnover rate TA18 Total number of team members availability TA19 Strategic planning TA20 Maturity of site/Site characteristics TA21 Development quality TA22 Personal trust TA23 Willingness at site TA24 Process ownership TA25 Total number of component dependency	23

Section	Description/Element/Factor	Item	No. of Item	
			TA26 Size of the task TA27 Team member attitude TA28 Project Urgency TA29 Total number of projects to burn-out	
B5	**CP5 Bridging**	Collaborative Artifacts	B1 Total number of common collaborative tool B2 Total number of common language between sites	2
		Bridging Approach	B3 Appointing functional person B4 Total cost B5 Frequent update B6 Multitasking B7 Type and number of resources available B8 % of team satisfaction B9 Number of stand-up meetings covering different locations	7
B6	**CP6 Onsite Visit**	Training	O1 Type of cultural training O2 Type of gender O3 Business Needs O4 Team Knowledge	4
		Backup Team	O5 Type of cultural training O6 Type of gender	2
		Project Phases	O7 Emphasis on aligning with the solution O8 Having the Requirement right	2
		Planning the Visits	O9 Total Travel time O10 Numbers of sites O11 Type of communication methods O12 Number of team members O13 Total Cost for travelling to another site O14 Gain experience O15 Total number of meetings with stakeholders O16 Type of Skills	8
B7	**CP7 Managing Cultural Diversity**	Training	CD1 Cultural Awareness CD2 Type of Skills	2
		Customer involvement	CD3 % of market needs	1
		Collaborative Tools	CD4 Type of Communication tools	1
		Labour turnover	CD5 Type of gender CD6 Balance of religion CD7 Total number of meetings with team members CD8 Set expectation	4
		Social Network	CD9 Total number of team building activities per (annum/project)	1
		Coordination Performance	CD10 Total number of Mean Time to Failure (MTTF) or Mean Time Between Failure (MTBF) CD11 % of Defect Removal Effectiveness CD12 Total number of Reciprocal Time to Fix	3
		Team Awareness	CD13 Total years of experience level of team members CD14 Knowledge level of team members CD15 Total number of tasks that have to complete CD16 Schedules	4
		Communication Skill	CD17 Cultural Attitude	1

Section	Description/Element/Factor	Item	No. of Item	
B8	**CP8 Temporal Differences**	Hands-on & Shake-off Sessions	TF1 Number of time zones spanned by each team TF2 Maximum time zone spanned by each team TF3 Tracking performance over time TF4 % of work completed TF5 Impact on personal life TF6 Total number of working hours	6
B9	**CP9 Managing Client-Vendor Relationship**	Outsourcing Relationship Management	CV1 Number of meetings CV2 Number of language or skills training CV3 Number of informal meetings, social networking and joint celebration CV4 Having a Back-up team CV5 Build the trust CV6 Good understanding on client roadmap and goal	6
		Technology	CV7 Number of skills	1
		Labour Turnover	CV8 Ability of working with others and able to solve problem CV9 Total number of years of experience CV10 Domain expertise CV11 Build the trust CV12 Number of technical knowledge CV13 Competent and committed developers CV14 Mix role CV15 Acceptance to improve	8
		Project Failure	CV16 Total number of hours spend in planning CV17 Skills to lead the market CV18 Project impact CV19 Cost	4
		Vendor Selection	CV20 Number of completed projects on-time CV21 Track vendor performance records(Good/Average/Bad) CV22 Vendor staff turnover	3
B10	**CP10 Communication and Coordination**	Collaborative Techniques	CC1 Number of people in a team CC2 Number of completed task per-day CC3 Number of completed task vs committed time-line	3
		Technology	CC4 Shifting schedules of each team member	1
		Collaboration Tool	CC5 Number of collaboration tool	1
		Social Attributes (Networking/Tools/Technology)	CC6 Trust and rapport CC7 Number of changes to the same artefact made CC8 Number of dependencies between source fil CC9 Number of distribution lists where the engineer is included CC10 Timely access to that person CC11 Perceived cost associated with accessing	6
		Effective Communication	CC12 Total number of working hours for a team (day/week/month) CC13 Communicate project status on daily basis CC14 Real-time feedback	6

Section	Description/Element/Factor	Item	No. of Item	
			CC15 Number of meetings involve stakeholders CC16 Role assignment CC17 Frequency of team communication	
TOTAL OF ITEMS				**166**
3	**Indicator**	**Indicator Description**	**No. of Item**	
	CP1 **…** **…** **….** **….** **CP10**	**TS1** **TS2** **…** **…** **…** **CC11**	**166**	
4	**Feedback**			
5	**Verification on Content Validation by Expert**			

SAMPLE

Below is a **sample** on how you can complete this **CVQ** by **ticking (√) at the number from 1 to 4 under Relevancy column** as an indication of the level of your argument with the statement. For the **comment section** you may **add, delete of modify** the factors and items **if any.**

The scale of Relevancy	**1**	**2**	**3**	**4**
	Not Relevant	**Somewhat Relevant**	**Quite Relevant**	**Highly Relevant**

SECTION B	**COORDINATION PROCESS**
This section intends to look into each coordination strategy and related indicators of the coordination processes in GSD projects.	

Sub-Section B1	**COORDINATION PROCESS 1 : TEAM SETUP**
Description	Setting up an ideal team which consist of geographically distributed teams and collocated team members in GSD environment.
Source	**Interview:** Process derive from an interview session
	Literature review: Process derived from LR (Manteli, van den Hooff, and van Vliet 2014)

Sub-Section B1.1		**COORDINATION STRATEGY 1: TEAM MEMBERS SELECTION**					
Description		To be selected as a team member of a geographically distributed teams					
Source		**Interview:** Strategy derive from an interview session					
		Literature review: Strategy derived from LR (Espinosa, Cummings, and Pickering 2012), (Moe et al. 2014)					
Indicators			**Indicators are titled correctly (Yes/No)**	**Relevancy**			
				1	**2**	**3**	**4**
1.	TS1	Team Knowledge					
	TS2	Total number of technical skills					
	TS3	Type of gender					
	TS4	Type of skill or expertise					
	TS5	Able to handle cross functionality					
	TS6	Total number of years of experience					
	TS7	Build the trust					
	TS8	Competent and committed developers					
	TS9	Labor Cost					
2.	Overall, the presence of **team members selection** can influence the Evaluation Model establishment in GSD.						

Appendix F
List of Global Software Development Experts for Delphi Technique

PARTICIPATION AS A GSD EXPERT FOR DELPHI: MODEL FORMULATION

Expert Name	Company Name	Company Website	Date	Signature
Expert A	OnApp Sdn Bhd	www.onapp.com	2018-02-08	
Expert B	BAE Systems	https://www.baesystems.com/en/home	20-3-18	
Expert C	DXC Technologies	http://www.dxc.technology/	21-02-2018	
Expert D	HCL AXON Malaysia	www.myhcl.com	22nd Jan 18	
Expert E	Techsap ASP Sdn. Bhd	http://www.techsap.com/	28th FEB 18	

Appendix G

Delphi Round 1 Survey Instrument Sample

Please refer to next page.

Advanced Informatics School (UTM AIS)

UNIVERSITI TEKNOLOGI MALAYSIA

DELPHI QUESTIONNAIRE: ROUND 1

Dear Prof/Dr/Sir/Madam,

Re: An Invitation to verify and validate the coordination strategies and related indicators together with its description to assess the effectiveness of coordination processes for development of Evaluation Model in Global Software Development(GSD) Projects

The Delphi Round One.

My Name is Anusuyah Subbarao. I am undertaking a PhD research program at the Advanced Informatics School (AIS), University of Technology Malaysia (UTM), Kuala Lumpur Campus. The title of my research is **"Evaluation Model to Assess the Effectiveness of Coordination Processes in Global Software Development Projects".** I am currently fulfilling my third activity of my third objective of research that is to verify and validate the **coordination strategies and related indicators together with its description to assess the effectiveness of coordination processes for development of Evaluation Model in GSD Projects**. I seek for your participation in verifying and validating the coordination strategies and related indicators together with its description in the respective research.

A group of five **(5) GSD experts** from various countries were selected to verify and validate the proposed coordination strategies and related indicators together with its description. You are invited to participate in this study based on your expertise and experience in this field. Your insight and opinions pertaining to the issues being explored shall provide a valuable contribution to the best practice and body of knowledge of this research. We decided to adopt Delphi techniques to achieve this objective.

The Delphi technique is described as a qualitative method which involves a survey of expert opinion and is designed to feed information back to its respondents in GSD projects. Delphi does not only involve a one-off posting of questions. Rather, the survey is circulated, to the same set of respondents/experts, **at least twice.** A group of panel experts who has been chosen will be asked to give feedback to achieve some consensus pertaining to the topic discussed.

The statement in this Round One were developed based on Systematic Review (SR) and Interview. It is presented such way to ease you and the other experts to understand feedback of others and state your opinion using scale. Therefore, it will require you to rate the strategies and the indicators and input provided by all five GSD experts to get consensus on what constitute to the development of Evaluation Model to Assess the Effectiveness of Coordination Processes in GSD projects.

This questionnaire is divided into four sections, namely (1) Respondent profile (2) How to answer the survey and brief explanation of the research (3) Coordination strategies and related indicators to assess the effectiveness of coordination processes for the development of Evaluation Model in GSD Projects and (4) The Indicator Description Validation. Please read and review the questionnaire and rate each statement from **1 to 5 by marking '√'** at the appropriate number. A rating of **1 (one) means that you think the statement is extremely irrelevant** when considering the indicators of coordination strategies in GSD project. A rating of **5 (five) shows the statement is extremely relevant.** You may also leave **a comments/suggestion (if any)** in space given.

Please keep a completed copy of the summaries for your record so that you may refer to it later. If you would like to suggest new strategies or indicators that are not addressed in the first round, you may write a short note that describes your new ideas. It is highly appreciated you could send your response **via email** by latest 2**1st February 2018** or in two weeks' time.

Thank you very much for your cooperation and I really appreciate it. For further info, you may contact:

Student	**Anusuyah Subbarao (PAN153006)** PhD Candidate Advanced Informatics School (AIS), UTMKL E-mail: anusya_r@yahoo.com Telephone: 016-3365934
Supervisor	**Dr. Mohd Naz'ri Mahrin** Senior Lecturer, AIS, UTMKL E-mail: mdnazrim@utm.my

SECTION 1: Respondent Profile

Please mark (√) for your answer.

<table>
<tr><th>No</th><th>Items/Questions</th></tr>
<tr><td>RP1</td><td>Role in any GSD project:

<table>
<tr><td></td><td>Business Consultant/Expert</td><td></td><td>Project Manager</td></tr>
<tr><td></td><td>Business Executive</td><td></td><td>IT Executive</td></tr>
<tr><td></td><td>Chief Information Officer</td><td></td><td>IT Consultant/Expert</td></tr>
<tr><td></td><td>IT Director</td><td></td><td>IT Solution Provider/Vendor</td></tr>
<tr><td></td><td>Others: IT Manager</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>RP2</td><td>Working Experience in GSD Projects:

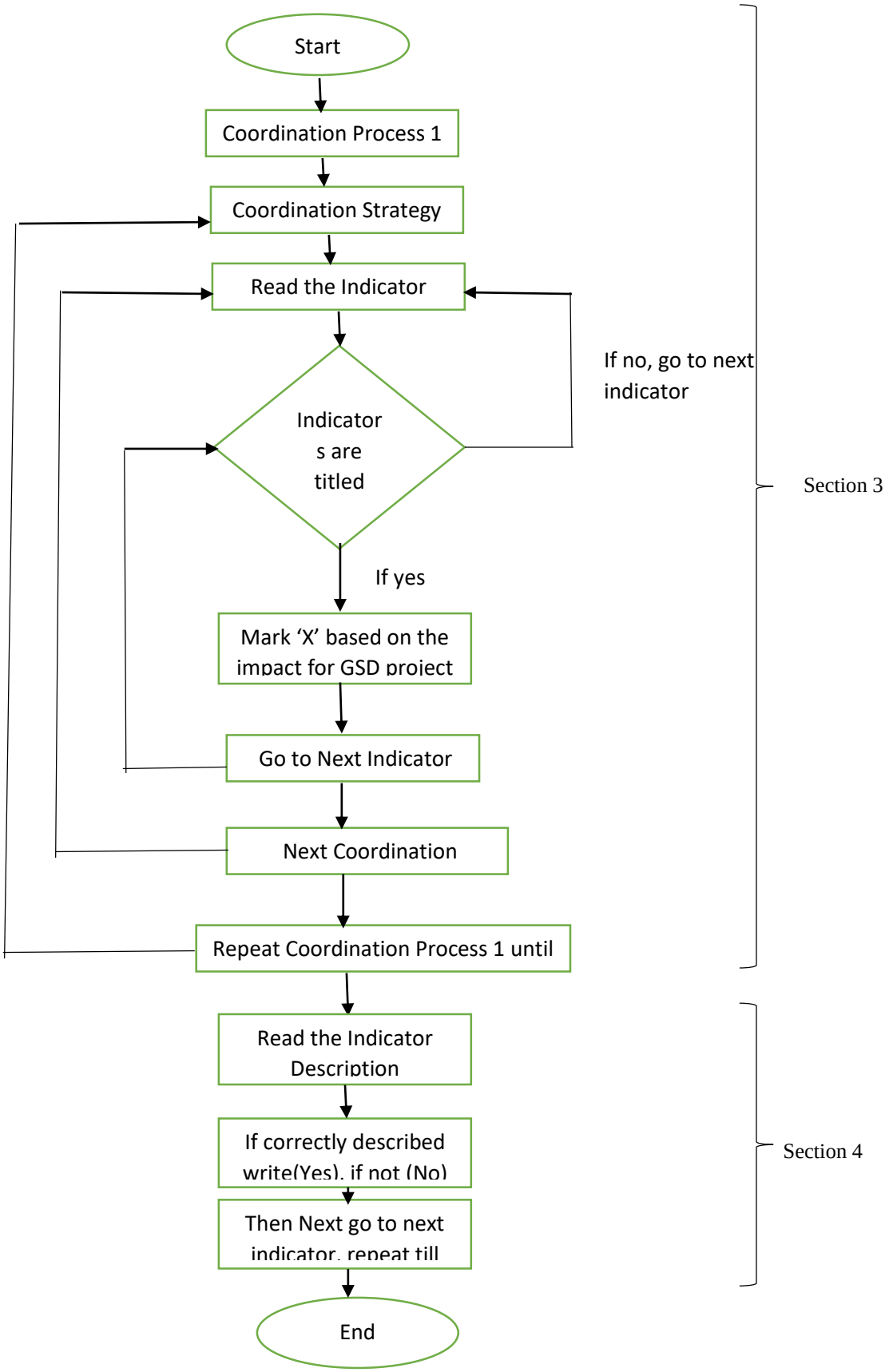
<table>
<tr><td></td><td>5 to 10 years</td><td></td><td>20 to 25 years</td></tr>
<tr><td></td><td>11 to 15 years</td><td></td><td>25 to 30 years</td></tr>
<tr><td></td><td>16 to 20 years</td><td></td><td>More than 30 years</td></tr>
</table></td></tr>
<tr><td>RP3</td><td>Knowledge level on GSD:

<table>
<tr><td></td><td>Expert</td><td></td><td></td></tr>
<tr><td></td><td>Advanced</td><td></td><td></td></tr>
<tr><td></td><td>Competent</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>RP4</td><td>Attended any formal training related to GSD:
<table>
<tr><td>Yes</td><td></td></tr>
<tr><td>No</td><td></td></tr>
</table>
Yes (If Yes, please specify):
_____
_____</td></tr>
<tr><td>RP5</td><td>Attended and received any Project Management certification:
<table>
<tr><td>Yes</td><td></td><td></td></tr>
<tr><td>No</td><td></td><td></td></tr>
</table>
Yes (If Yes, please specify):
_____
_____</td></tr>
<tr><td>RP6</td><td>Total Number of Projects Coordinate (Past and Present) with other countries

<table>
<tr><td></td><td>Less than 5</td><td></td><td>16 to 20 Projects</td></tr>
<tr><td></td><td>5 to 10 Projects</td><td></td><td>More than 20 Projects</td></tr>
<tr><td></td><td>11 to 15 Projects</td><td></td><td></td></tr>
</table></td></tr>
</table>

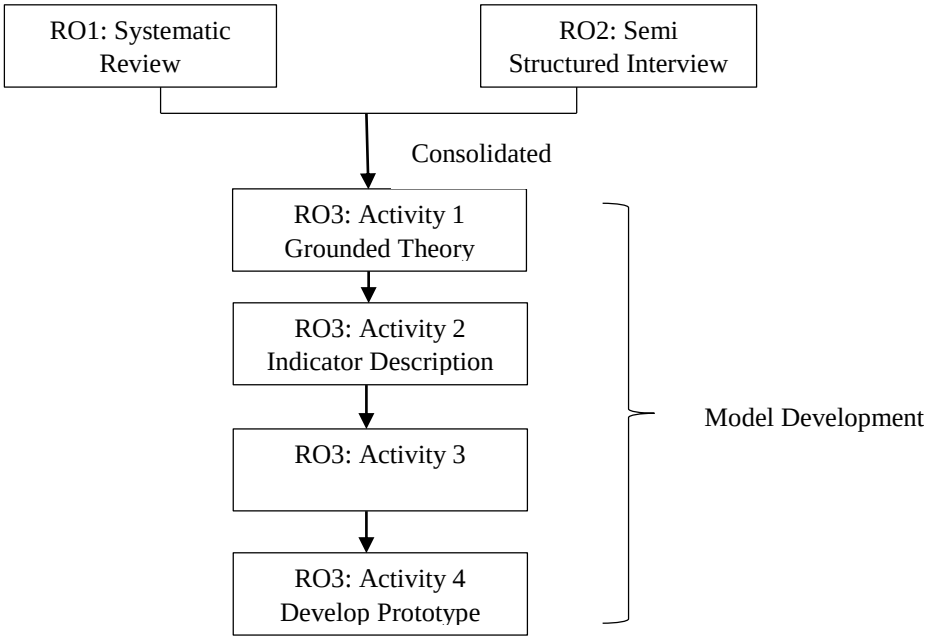
SECTION 2: How to answer the survey and brief explanation of the research

Flowchart of structure of the survey



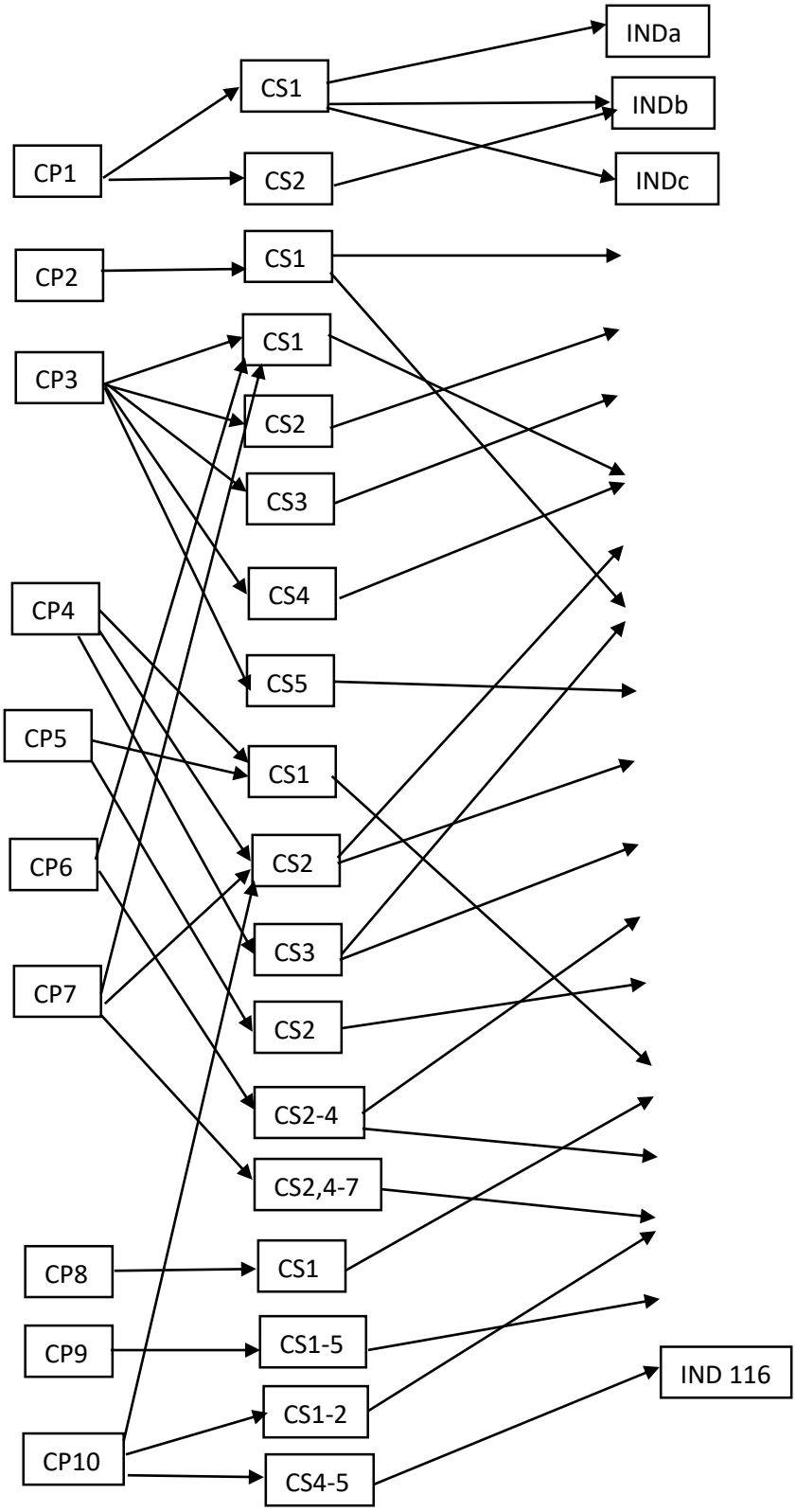
Brief explanation about the research

Coordination strategy and the related indicators are found using 2 different methods which is Systematic Review from the literature and Semi structured interview from the real Global Software Development practitioners. Output from these methods were consolidated using a method called Grounded Theory. Then this output is tabled to form this survey form. This technique is called Delphi technique. This explanation is illustrated using a visual diagram below.



There are all together 10 coordination processes, 37 coordination strategies and 166 indicators. Kindly please take note that several coordination strategies are repeated in different coordination processes and several indicators are repeated in different coordination strategies. The reason is they belong to different processes but the indicators are still the same. This explanation is illustrated in the diagram below.

Hierarchical Conceptual Model



COORDINATION PROCESS(CP) COORDINATION STRATEGY (CS) INDICATOR(IND)

SECTION 3: Coordination strategies and related indicators to assess the effectiveness of coordination processes for the development of Evaluation Model in GSD Projects

INSTRUCTION: Please mark **(√)** at the number from **1 to 5** as an indication of the level of your agreement with the statement. The scale of **Relevancy** is:				
1	**2**	**3**	**4**	**5**
Extremely irrelevant	**Irrelevant**	**Uncertain**	**Relevant**	**Extremely Relevant**

SECTION B	**COORDINATION PROCESS**
This section intends to look into each coordination strategy and related indicators of the coordination processes in GSD projects.	

Sub-Section B1	**COORDINATION PROCESS 1 : TEAM SETUP**
Description	Setting up an ideal team which consist of geographically distributed teams and collocated team members in GSD environment.
Source	**Interview:** Process derive from an interview session
	Literature review: Process derived from LR (Manteli, van den Hooff, and van Vliet 2014)

Sub-Section B1.1		**COORDINATION STRATEGY 1: TEAM MEMBERS SELECTION**						
Description		To be selected as a team member of a geographically distributed teams						
Source		**Interview:** Strategy derive from an interview session						
		Literature review: Strategy derived from LR (Espinosa, Cummings, and Pickering 2012), (Moe et al. 2014)						
Indicators			**Indicators are titled correctly (Yes/No)**	**If Yes, how impact the indicator is for GSD project**				
				1	**2**	**3**	**4**	**5**
1.	TS1	Team Knowledge						
	TS2	Total number of technical skills						
	TS3	Type of gender						
	TS4	Type of skill or expertise						
	TS5	Able to handle cross functionality						
	TS6	Total number of years of experience						
	TS7	Build the trust						
	TS8	Competent and committed developers						
	TS9	Labor Cost						
2.	Overall, the presence of **team members selection** can influence the Evaluation Model establishment in GSD.							
Comments/Suggestions (if any):								

Appendix H

Delphi Round 2 Survey Instrument

Please refer to next page.

UTM UNIVERSITI TEKNOLOGI MALAYSIA	**QUESTIONNAIRE ROUND 2** **VALIDATION OF THE COORDINATION STRATEGIES AND RELATED INDICATORS FOR THE DEVELOPMENT OF EVALUATION MODEL IN GLOBAL SOFTWARE DEVELOPMENT(GSD) PROJECTS** **PANEL INFORMATION:** **XXX** **Position:** **Company Name:** **Headquarters:** **No of Countries in GSD:**

DELPHI ROUND TWO

Thank you for completing the questionnaire in Round One. Based on the answers and feedback from the panel of experts in Round One, I have analyzed and formed a Round Two questionnaire. This questionnaire consists of three parts.

PART ONE: FEEDBACK ON INDICATORS IMPACT, STRATEGIES INFLUENCE AND INDICATORS DESCRIPTION IN GSD PROJECTS

This part pertains to the summary and results of Round One undertaken previously. Kindly assess the following statements and state your final answers in the "Final Answer" column. The "Final Answer (Round 2)" column can be left blank if an answer from Round 1 is retained. The researcher will use your previous round rating in the calculation of Delphi Round Two. If your new rating is lower than the current median value, you need to give your reasons in the column provided. But if your new rating is more than the current median value, its optional for the respondent to justify it.

This questionnaire uses the 5-point Likert scale, as follows (please state the number):

Strongly Disagree	Disagree	Partially Agree	Agree	Strongly Agree
1	2	3	4	5

Source taken from (Jillson, 1975a)

*For Item Code, the respondents need to read the provided Delphi Round 1 instrument (File is given)

** The stages of consensus are fixed based on IQR as follows: i) High consensus = IQR is 0 to 1; ii) Moderate consensus = IQR is 1.01 to 1.99; and iii) Without consensus = IQR is 2.0 and above

Source taken from (Siraj & Ali, 2008)

PART ONE: INDICATORS IMPACT AND STRATEGIES INFLUENCE

Legend: White cells indicates indicators and green cells indicates strategies.

No.	*Item Code	Median (Round 1)	**IQR (Q3- Q1) i)High consensus = IQR is 0 to 1 ii)Moderate consensus = IQR is 1.01 to 1.99 iii) Without consensus = IQR is 2.0 and above	Your Answer (Round 1)	Final Answer (Round 2)	Reason (If the answer from Round 1 is retained)	Comments/Reasons from experts in Round One
1	TS1	4.00					
2	TS2	4.00					
3	TS3	1.00					
4	TS4	4.00					

No.	*Item Code	Median (Round 1)	**IQR (Q3- Q1) i)High consensus = IQR is 0 to 1 ii)Moderate consensus = IQR is 1.01 to 1.99 iii) Without consensus = IQR is 2.0 and above	Your Answer (Round 1)	Final Answer (Round 2)	Reason (If the answer from Round 1 is retained)	Comments/Reasons from experts in Round One
5	TS5	4.00					
6	TS6	3.00					
7	TS7	5.00					
8	TS8	4.00					
9	TS9	4.00					
	CS1	4.00					
10	TS10	5.00					
11	TS11	4.00					
12	TS12	4.00					
13	TS13	3.00					
14	TS14	4.00					
15	TS15	4.00					Same as T20(remove)
16	TS16	3.00					Same as T20 (remove)
17	TS17	4.00					
18	TS18	4.00					
19	TS19	4.00					
20	TS20	4.00					
	CS2	4.00					
21	TD1	4.00					
22	TD2	2.00					
23	TD3	4.00					
24	TD4	4.00					
25	TD5	5.00					
26	TD6	4.00					
27	TD7	4.00					
28	TD8	4.00					
29	TD9	4.00					
30	TD10	3.00					
31	TD11	3.00					
32	TD12	4.00					
33	TD13	3.00					
34	TD14	4.00					
35	TD1 5	4.00					
36	TD16	4.00					
37	TD17	4.00					
38	TD18	5.00					
	CS1	5.00					
39	TM1	4.00					
	CS1	4.00					
40	TM2	4.00					
41	TM3	4.00					
	CS2	4.00					
42	TM4	4.00					
43	TM5	4.00					
	CS3	5.00					
44	TM6	5.00					
45	TM7	5.00					
	CS4	5.00					
46	TM8	4.00					
47	TM9	3.00					
48	TM10	4.00					

No.	*Item Code	Median (Round 1)	**IQR (Q3- Q1) i)High consensus = IQR is 0 to 1 ii)Moderate consensus = IQR is 1.01 to 1.99 iii) Without consensus = IQR is 2.0 and above	Your Answer (Round 1)	Final Answer (Round 2)	Reason (If the answer from Round 1 is retained)	Comments/Reasons from experts in Round One
49	TM11	3.00					
50	TM12	4.00					
51	TM13	5.00					
	CS5	5.00					
52	TA1	4.00					
53	TA2	4.00					
	CS1	4.00					
54	TA3	4.00					
55	TA4	4.00					
56	TA5	4.00					
57	TA6	4.00					
	CS2	4.00					
58	TA7	4.00					
59	TA8	4.00					
60	TA9	5.00					
61	TA10	4.00					
62	TA11	4.00					
63	TA12	4.00					
64	TA13	4.00					Same as TA16
65	TA14	4.00					
66	TA15	4.00					
67	TA16	5.00					Same as TA13
68	TA17	4.00					
69	TA18	4.00					
70	TA19	5.00					
71	TA20	1.00					
72	TA21	4.00					
73	TA22	4.00					
74	TA23	4.00					
75	TA24	4.00					
76	TA25	4.00					
77	TA26	3.00					
78	TA27	4.00					
79	TA28	4.00					
80	TA29	4.00					
	CS3	4.00					
81	B1	4.00					
82	B2	4.00					
	CS1	4.00					
83	B3	4.00					
84	B4	4.00					
85	B5	4.00					
86	B6	4.00					
87	B7	4.00					
88	B8	4.00					
89	B9	4.00					
	CS2	4.00					
90	O1	4.00					
91	O2	1.00					
92	O3	4.00					
93	O4	4.00					

No.	*Item Code	Median (Round 1)	**IQR (Q3- Q1) i)High consensus = IQR is 0 to 1 ii)Moderate consensus = IQR is 1.01 to 1.99 iii) Without consensus = IQR is 2.0 and above	Your Answer (Round 1)	Final Answer (Round 2)	Reason (If the answer from Round 1 is retained)	Comments/Reasons from experts in Round One
	CS1	4.00					
94	O5	3.00					Remove this
95	O6	1.00					Remove this
	CS2	2.00					
96	O7	4.00					Need to rename
	O7(r)	Please refer to the Rename Indicators Section					
97	O8	5.00					
	CS3	4.00					
98	O9	3.00					
99	O10	4.00					
100	O11	4.00					
101	O12	4.00					
102	O13	4.00					
103	O14	4.00					
104	O15	4.00					
105	O16	4.00					
	CS4	4.00					
106	CD1	4.00					
107	CD2	4.00					
	CS1	4.00					
108	CD3	4.00					
	CS2	4.00					
109	CD4	5.00					
	CS3	5.00					
110	CD5	1.00					
111	CD6	4.00					
112	CD7	4.00					
113	CD8	4.00					
	CD(n)	Please refer to New Indicators Section.					Need to add indicators
	CD(n)	Please refer to New Indicators Section.					Need to add indicators
	CS4	4.00					
114	CD9	4.00					
	CS5	4.00					
115	CD10	4.00					
116	CD11	4.00					
117	CD12	4.00					
	CD(n)	Please refer to New Indicators Section.					Need to add indicators
	CS6	4.00					
118	CD13	4.00					
119	CD14	4.00					
120	CD15	4.00					
121	CD16	4.00					
	CS7	4.00					
122	CD17	5.00					
	CS8	5.00					
123	TF1	4.00					
124	TF2	4.00					
125	TF3	4.00					
126	TF4	4.00					
127	TF5	4.00					
128	TF6	4.00					

No.	*Item Code	Median (Round 1)	**IQR (Q3- Q1) i)High consensus = IQR is 0 to 1 ii)Moderate consensus = IQR is 1.01 to 1.99 iii) Without consensus = IQR is 2.0 and above	Your Answer (Round 1)	Final Answer (Round 2)	Reason (If the answer from Round 1 is retained)	Comments/Reasons from experts in Round One
	CS1	4.00					
129	CV1	4.00					
130	CV2	4.00					
131	CV3	4.00					
132	CV4	4.00					Need to rename
	CV(r)	Please refer to the Rename Indicators Section					
133	CV5	5.00					
134	CV6	4.00					
	CS1	4.00					
135	CV7	4.00					
	CS2	4.00					
136	CV8	4.00					
137	CV9	4.00					
138	CV10	4.00					
139	CV11	5.00					
140	CV12	4.00					
141	CV13	4.00					
142	CV14	4.00					
143	CV15	4.00					
	CS3	4.00					
144	CV16	4.00					
145	CV17	4.00					
146	CV18	4.00					
147	CV19	5.00					
	CS4	4.00					
148	CV20	4.00					
149	CV21	4.00					
150	CV22	4.00					
	CV(n)	Please refer to New Indicators Section.					Need to add indicators
	CS5	4.00					
151	CC1	4.00					
152	CC2	4.00					
153	CC3	4.00					
	CS1	4.00					
154	CC4	4.00					
	CS2	4.00					
155	CC5	4.00					
	CS3	4.00					
156	CC6	4.00					
157	CC7	4.00					
158	CC8	4.00					
159	CC9	4.00					
160	CC10	5.00					
161	CC11	4.00					
	CS4	4.00					
162	CC12	3.00					
163	CC13	4.00					
164	CC14	4.00					
165	CC15	4.00					
166	CC16	4.00					
167	CC17	5.00					

	CS5	4.00					

PART TWO: NEW ITEMS AS PER SUGGESTION IN ROUND ONE

This section comprises of new items suggested by the Delphi panel of experts in Round One. Please rate all the items for the first time based on the Likert-scale of agreement 1 to 5.

Strongly Disagree	Disagree	Partially Agree	Agree	Strongly Agree
1	2	3	4	5

New Items			Your OPINION for this round (mark '√')					Comments /Reason
			1	2	3	4	5	
1.								
	CD(n)	Awards Rewards or Incentives						
2.								
	CD(n)	% of team member job satisfaction						
3.								
	CD(n)	Meantime to resolve/complete the task						
4.								
	CV(n)	Cost						
Comments/Suggestions (if any):								

PART THREE: RENAME ITEMS AS PER SUGGESTION IN ROUND ONE

This section comprises of new items suggested by the Delphi panel of experts in Round One. Please rate all the items for the first time based on the Likert-scale of agreement 1 to 5.

Strongly Disagree	Disagree	Partially Agree	Agree	Strongly Agree
1	2	3	4	5

Rename Items			Your OPINION for this round (mark '√')					Comments /Reason
			1	2	3	4	5	
1.								
	CV4	Backup Resources						
2.								
	O7	Deliverables at each project phases need to define.						

Appendix I

Supporting Tool Sample

Please refer to next page

Project Title: Evaluation Model to Assess the Effectiveness of Coordination Processes in Global Software Development (GSD) Projects

Participant Information Sheet

My Name is Anusuyah Subbarao. I am undertaking a PhD research program at the Advanced Informatics School (AIS), University of Technology Malaysia (UTM), Kuala Lumpur Campus. I am currently fulfilling my fourth objective of research that is to evaluate the usefulness of the Evaluation Model in GSD Projects. I seek for your participation in evaluating this assessment instrument in two different perspectives.

You are invited to participate in this study based on your expertise and experience in this field. Your insight and opinions pertaining to the issues being explored shall provide a valuable contribution to the best practice and body of knowledge of this research.

The input for this model was developed based on Systematic Review (SR) and Interview. Then, it was validated by the experts in GSD field from numerous countries till we get the consensus. Finally, the model was formulated which comprises of 3 main components namely, coordination process, coordination strategy and related indicators.

Thank you very much for your cooperation and I really appreciate it.

Instructions

Kindly please go to "Instuction" tab to start your particpation.

Right to Refuse or Withdraw

The participation in this study is voluntary. Refusal to participate will involve no penalty or loss of benefits. You are free to withdraw from this study at any time without penalty.

Confidentiality

The results of this study will be used for research purposes and research publications. Your identity will not be disclosed.

Contact Details

Anusuyah Subbarao (PAN153006)
PhD Candidate
Advanced Informatics School (AIS), UTMKL
E-mail: anusya_r@yahoo.com
Telephone: 016-3365934

Project Title: Evaluation Model to Assess the Effectiveness of Coordination Processes in Global Software Development (GSD) Projects

Instructions

Kindly please click radiobutton "Yes" or "No" to state your agreement.
Yes indicates you agree with the indicator and No indicates you disagree with the indicator.

Number	Coordination Strategy	Indicator ID	Indicator Name	Description	Yes	No
CP1 Team Setup						
1	Team Members Selection	TS1	Team Knowledge	It is not constrained to the knowledge held by individuals, but also includes knowledge stored within organizational databases, business processes, systems, and relationships.	○	○
2		TS2	Total number of technical skills	Technical knowledge (programming languages, methodologies, and software architecture) in distributed work has been found to have a significant effect on software development performance	○	○
3		TS4	Type of skill or expertise	Refers to domain expertise, software development expertise	○	○
4		TS5	Able to handle cross functionality	Team member should be able to handle multiple task	○	○
5		TS8	Competent and committed developers	Dedication and commitment towards the project.	○	○
6		TS9	Labour Cost	Higher the skillset and experience, higher the salary is	○	○
7	Team Structure	TS10	Communication Structure	Direct communication link to customers can enable offshore to get engaged in discussion, elicit requirements from customers and prepare specifications themselves	○	○
8		TS11	Work Structure	Better clarification could help smooth the flow of information between distributed team members	○	○
9		TS12	Roles & Responsibilities	Clearly defined roles and responsibilities experienced better exchange of knowledge	○	○
10		TS15	Type of expertise about a task	More expertise about a task better it is	○	○
11		TS17	Number of people in a team	Not more than 8 people involved in a team	○	○
12		TS18	Being a team player	A person who plays or works well as a member of a team.	○	○
13		TS19	Having an adequate training plan(weekly/monthly/annually)	The detail plan of training should be available before starting the project	○	○
CP2 Team Development						
14	Team Performance	TD1	Number of people in a team	Multiple site teams tend to be larger	○	○
15		TD3	Total number of years with the company	More the number of years in the same company, better the familiarity	○	○
16		TD4	Type and number of project resources	Detail list of resources should be available before starting the project	○	○
17		TD6	Team member role description and distribution	Clearly defined roles and responsibilities experienced better exchange of knowledge	○	○
18		TD8	Type of task assigned	Type of task assigned influence the performance of team members	○	○
19		TD9	Total number of years of experience	More the number of years in GSD, better the familiarity	○	○
20		TD14	% of team member performance	How well a team member is performing	○	○
21		TD15	Total number of allocated task per location	Allocated task must match the capacities of that location	○	○
22		TD16	Level of Project task complexity(High/Medium/Low)	Lesser the number of dependencies between remote members, less complex the task is.	○	○
23		TD17	Total number of hours needed to complete the project	More number of hours spent, faster the completion of the project will be.	○	○
24		TD18	Team member attitude	Type of attitude influence the performance of team members	○	○
CP3 Team Management						
25	Training	TM1	Number of Soft skills Achieved	Better the skills, more effective the teamwork	○	○
26	Tool Selection	TM2	Type and number of collaborative tools	Detail list of collaborative tools should be available before starting the project to support the team members	○	○
27		TM3	Total cost of virtual communication	Lists of collaborative tools should be purchased before starting the project	○	○
28	Team Cognition	TM4	Team Qualification and Expertise	Better the qualification and expertise, better for the team	○	○
29		TM5	Being a teamwork player	A person who plays or works well as a member of a team.	○	○
30	Team Motivation	TM6	Award Rewards or Incentives	Award/reward/incentive motivates the team members to perform better	○	○
31		TM7	% of team member job satisfaction	How satisfied a team member is working in a project, with peers.	○	○
32	Team Operation	TM8	Time needed to prepare and launch the teams	Higher the result of the participation in training and coaching the different teams, more effective the global software team management is	○	○
33		TM10	Total time taken to complete the project vs allocated time	Smaller the difference is, more effective the team management is	○	○
34		TM13	Constant briefing to team members	Constant briefing gives a clear idea to the team members	○	○

Appendix J

t- Test Results

For CP2, successful projects have more number of indicators (mean, m = 10.00, standard deviation, SD = 0.98) than the failure projects (m = 6.17, SD = 4.58). These difference, mean = 3.83 is significant, t (10) = 2.00, p = 0.0731.

For CP3, successful projects have more number of indicators (mean, m = 9.00, standard deviation, SD = 0.82) than the failure projects (m = 4.67, SD = 2.34). These difference, mean = 4.33 is significant, t (10) = 4.28, p = 0.0016.

For CP4, successful projects have more number of indicators (mean, m = 21.00, standard deviation, SD = 2.19) than the failure projects (m = 11.50, SD = 5.82). These difference, mean = 9.5 is significant, t (10) = 3.74, p = 0.0038.

For CP5, successful projects have more number of indicators (mean, m = 8.00, standard deviation, SD = 0.00) than the failure projects (m = 3.50, SD = 2.26). These difference, mean = 4.50 is significant, t (10) = 4.88, p = 0.0006.

For CP6, successful projects have more number of indicators (mean, m = 11.00, standard deviation, SD = 0.84) than the failure projects (m = 4.33, SD = 3.27). These difference, mean = 6.67 is significant, t (10) = 4.84, p =0.0007.

For CP7, successful projects have more number of indicators (mean, m = 17.00, standard deviation, SD = 0.55) than the failure projects (m = 11.33, SD = 3.14). These difference, mean = 5.67 is significant, t (10) = 4.36, p = 0.0014.

For CP8, successful projects have more number of indicators (mean, m = 6.00, standard deviation, SD = 0.00) than the failure projects (m = 3.83, SD = 1.17). These difference, mean = 2.17 is significant, t (10) = 4.54, p = 0.0011.

For CP9, successful projects have more number of indicators (mean, m = 23.00, standard deviation, SD = 0.00) than the failure projects (m = 13.67, SD = 3.14). These difference, mean = 9.33 is significant, t (10) = 7.28, p = 0.0000.

For CP10, successful projects have more number of indicators (mean, m = 16.00, standard deviation, SD = 0.41) than the failure projects (m = 10.17, SD = 3.54). These difference, mean = 5.83 is significant, t (10) = 4.01, p = 0.0025.

Appendix K

Evaluation Model Validation Confirmation

Reg. Address: LSE-18 Enterprise 4 Technology Park Malaysia, Lebuhraya Puchong
Sungai Besi, Bukit Jalil, 57000 Kuala Lumpur, Malaysia
Tel: +60 (3) 8994 1000 Fax: +60 (3) 8994 1060
www.hcl.com
www.hcl-asean.com

Dated: June 12, 2019

Ref No. HCL/EAP/1556301

TO WHOM SO EVER IT MAY CONCERN

This is to certify that **Ms. Punithevalli Nyanasagaran(51318916)**, Employee Code **51318916** is working with our company HCL Malaysia Sdn.Bhd. Her date of joining of HCL Malaysia is **February 1, 2010.**

As per our records, her designation is **ASSOCIATE CONSULTANT**

This certificate is being issued to her as a proof of her employment for the purpose of **employment proof permanent/regular employment**.

Regards,

Employee HR Services

Appendix K

Evaluation Model to assess the effectiveness of coordination processes in Global Software Development (GSD) Projects Validation Confirmation

EVALUATION MODEL: FEEDBACK FROM THE PRACTITIONER

GSD industry currently has any model for assessing the effectiveness of coordination processes in the GSD projects.

[ ] Yes [ ] No [/] Others: Please specify Not specifically on process.

Do you think that the GSD industry needs an Evaluation Model to assess the effectiveness of coordination processes in the GSD projects?

[/] Yes [ ] No [ ] Others: Please specify_____

Do you think that it is important to have the Evaluation model to ensure the success of GSD projects?

[/] Yes [ ] No [ ] Others: Please specify_____

Do you think the proposed model from this research are suitable to be imposed in the GSD industry in order to assist the coordination?

[/] Yes [ ] No [ ] Others: Please specify_____

You are invited to give any suggestion on the proposed model:

_____

_____

_____

Signature : N9. Punitha

Name : Punithevalli Nyanasagaran

Designation : Associate Consultant.

Appendix K

Evaluation Model to assess the effectiveness of coordination processes in Global Software Development (GSD) Projects Validation Confirmation

EVALUATION MODEL: FEEDBACK FROM THE PRACTITIONER

GSD industry currently has any model for assessing the effectiveness of coordination processes in the GSD projects.

☐ Yes ☑ No ☐ Others: Please specify_____

Do you think that the GSD industry needs an Evaluation Model to assess the effectiveness of coordination processes in the GSD projects?

☑ Yes ☐ No ☐ Others: Please specify_____

Do you think that it is important to have the Evaluation model to ensure the success of GSD projects?

☑ Yes ☐ No ☐ Others: Please specify_____

Do you think the proposed model from this research are suitable to be imposed in the GSD industry in order to assist the coordination?

☑ Yes ☐ No ☐ Others: Please specify_____

You are invited to give any suggestion on the proposed model:

_____

_____

_____

Signature : 

Name :

Designation :

Jefferson Manuel
Chief Operating Officer
PILOT MULTIMEDIA (M) SDN. BHD.
(582627-V)
A-29-2, Level 29, Menara UOA Bangsar
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Appendix K

Evaluation Model to assess the effectiveness of coordination processes in Global Software Development (GSD) Projects Validation Confirmation

EVALUATION MODEL: FEEDBACK FROM THE PRACTITIONER

GSD industry currently has any model for assessing the effectiveness of coordination processes in the GSD projects.

☐ Yes ☑ No ☐ Others: Please specify_____

Do you think that the GSD industry needs an Evaluation Model to assess the effectiveness of coordination processes in the GSD projects?

☑ **Yes** ☐ **No** ☐ **Others: Please specify**_____

Do you think that it is important to have the Evaluation model to ensure the success of GSD projects?

☑ **Yes** ☐ **No** ☐ **Others: Please specify**_____

Do you think the proposed model from this research are suitable to be imposed in the GSD industry in order to assist the coordination?

☑ **Yes** ☐ **No** ☐ **Others: Please specify**_____

You are invited to give any suggestion on the proposed model:

_____

_____

_____

Signature : Davendran

Name :

Designation : DAVENDRAN MARIAPPAN
DELIVERY MANAGER

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