IMPACT OF TEAM WISDOM ON SUCCESSFUL COMPLETION OF SOFTWARE PROJECTS IN GLOBAL SOFTWARE DEVELOPMENT

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Candidate of **Master of Science in Software Engineering (MSSE)** at the National University of Modern Languages do hereby declare that the thesis **Impact of Team Wisdom on Successful Completion of Software Projects in Global Software Development** submitted by me in partial fulfillment of MSSE degree, is my original work, and has not been submitted or published earlier. I also solemnly declare that it shall not, in future, be submitted by me for obtaining any other degree from this or any other university or institution. I also understand that if evidence of plagiarism is found in my thesis/dissertation at any stage, even after the award of a degree, the work may be cancelled and the degree revoked.

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ABSTRACT

Impact of Team Wisdom Mechanisms on Successful Completion of Software projects in Global Software Development

Global Software Development (GSD) becomes more popular due to the involvement of diverse team members around the world. This diversity creates huge impact on successful completion of GSD projects. Team wisdom in GSD works best to assess the impact of this diverseness. Team wisdom can be conceptualized as multifaceted process to measure the knowledge stock of team members. It is also helpful to utilize that knowledge in decision making of GSD projects. A lot of research has been done in the context of team wisdom but there is lack of research on how team wisdom mechanisms effects successful completion of GSD projects. The aim of this study is to identify the software team wisdom mechanisms and their impact on successful completion of GSD projects.

Systematic Literature Review (SLR) was conducted to identify team wisdom mechanisms. 31 out of 564 studies were selected for SLR. A detailed review of these studies was performed by following SLR protocols. Extracted results were analyzed by frequency analysis process. Team wisdom mechanisms: team networking, team diversity, team experience, team prudence, professional ethics and joint-epistemic actions were identified from the literature. Team experience, team networking and team diversity got the highest frequency from SLR. To find the impact of identified team wisdom mechanisms on successful completion of GSD projects, an interview approach was used. Semi structured interviews of eight GSD experts were conducted. Interview transcripts were analyzed by thematic analysis.

Team experience and team networking were identified as the most effective team wisdom mechanisms in GSD context. Team diversity, team prudence and joint epistemic actions were considered to be the effective and professional ethics was defined as moderate team wisdom mechanism in GSD. Furthermore, the results of thematic analysis were validated through member checking process. GSD experts found these team wisdom mechanisms helpful in successful completion of software projects in global software development.

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LIST OF ABBREVIATIONS

GSD	-	Global Software Development
SLR	-	Systematic Literature Review
DIKW	-	Data Information Knowledge Wisdom
BDTW	-	Basic Dynamics of team Wisdom
AGSD	-	Agile Global Software Development
RE	-	Requirements Engineering

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I would like to pay special tribute to my Parents, it’s because of them whatever and wherever I am, it’s just because of them and their selfless sacrificial life and their great efforts with hard work, pain and unceasing prayers have enabled me to reach at this point in life.

DEDICATION

This thesis work is dedicated to my parents and my brother who have been a constant source of support and motivation during the challenges, who have always loved and believed in me. This work is also dedicated to my teachers throughout my education career, who have always encouraged me and whose good examples have taught me to work hard for the things that I aspire to achieve.

CHAPTER 1

INTRODUCTION

1.1 Overview

Global Software Development (GSD) is the process of developing software projects around the world where vendors and clients are too away from each other [1]. From last two decades, GSD bears a lot of attention because of its low labor cost [2]. Many organizations started adopting GSD to get benefits of multi-site development which results in decrement in development cost and increment in product quality [3]. In addition, it provides a large pool to access skillful and talented software developers which work as team for the development of GSD projects [4]. But along with all the benefits, the GSD organization is still not that mature, the main reason behind it is the lack of coordination among team members and management skills across boundaries [5].

In development of any project, teamwork and effective coordination among all team members is mandatory for success [6]. Different team members from various geographical locations around the globe participate in the development process of GSD projects [7]. Because of this diversity, the team members have to face many distance challenges such as linguistic, temporal, cultural and geographical which results in communication, coordination and collaboration issues [8]. These issues lead to make great impact on many areas of software development [9].

The main area being affected by GSD is knowledge sharing [10]. Since software development is a knowledge-based activity whose success mostly depends upon the knowledge stock being shared among different team members and implantation of that knowledge for project related factors [11].

The knowledge stock of projects firstly exist in the form of data and go through many processes [12]. The world we live in has diverse data, different processing steps convert this data into useful information [13]. But the information exists in fragmented form which is not enough to take decisions like “how to do”. The abstraction, conversion and application of this fragmented information shows up as “knowledge” and then the use of specific knowledge beyond its literal meaning, which is what we say “wisdom” [14]. In general, wisdom is the process of combing expertise and knowledge stock and applying them in practical decisions [15].

In GSD, since different teams involve in development process so it is important to manage the knowledge stock of different team members for successful completion of GSD projects [16]. Team wisdom works best in this way. Team wisdom can be conceptualize as multi-faceted process to measure the knowledge stock of team members, and what knowledge will perform best and what will be most virtuous, and how to utilize that knowledge in joint epistemic actions such as judgment/reasoning, intuition and communication actions for project related factors [17].

1.2 Problem Statement

The complex nature of software requires the participation of many people in development process. In global software development, the development teams belong to different geographical locations so the effective coordination, successful communication and better knowledge management among them is necessary [18]. Because of this complexity, it is important to effectively manage the knowledge stock (what knowledge they have) of team members for successful, on time and risk free development of software projects [19]. At the same time, the knowledge stock of software project team members is not enough for project success, the utilization and implementation of that knowledge in practical decisions is mandatory [17], which is what we say team wisdom. Team wisdom can be conceptualized as multifaceted process to measure the knowledge stock of team members which knowledge will perform best what will be most virtues and how to utilize that knowledge in project related decisions. Therefore, there is a need to explore the importance and impact of team wisdom on successful completion of software projects in GSD [17].

1.3 Aims and Objectives

Aim of this study is to:

- Identify the mechanisms of team wisdom in the context of GSD.
- Assess the impact of team wisdom mechanisms on the successful completion of software projects in GSD.

1.4 Research Questions

These are the research question addressed in this research:

RQ1: What are the mechanisms of team wisdom in global software development context?

RQ2: How does this team wisdom mechanisms effect successful completion of software projects in global software development?

1.5 Scope of the research

Scope of this research is limited to team wisdom mechanisms and their impact on successful completion of software project in global software development.

1.6 Research Methodlogy

This section describes the research methodology adopted for this study. SLR and interviews will be conducted in order to identify team wisdom mechanisms and their impact on software success in GSD. This study will use SLR protocols to identify the team wisdom mechanisms in GSD and then to find the impact of these mechanisms on successful completion of software projects interview of GSD experts will be conducted and the data will be analyzed by thematic analysis along with validation process of data by using member checking approach.

1.7 Thesis Organization

In this study chapter 1 contains the introduction of the research. Chapter 2 defines the literature review. Chapter 3 describes the used methodologies for this study. Chapter 4 consists of identification of team wisdom mechanisms by using systemic literature review protocol. Chapter 5 determines the impact of team wisdom mechanisms on successful completion of software project in global software development. Chapter 6 concludes the research.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

This chapter describes the theoretical framework of literature from different research papers by discussing global software development, wisdom, organizational wisdom, team wisdom, team wisdom in global software development teams, existing studies defining the impact of team wisdom on globally developed software projects, and summarizing it.

2.2 Global Software Development (GSD)

The globalization of business has become a stable and irrevocable trend from the last few decades [20]. Global markets have been constantly taking place of national markets by economic forces which results in generating high competition and a new form of collaboration across boundaries [21]. This alteration not only affects the marketing trends but the formulation of products and all other factors which are involved in production i.e. designing, testing, and speed-to-user [22]. Software act as an essential component of almost every business these days, the success ratio rapidly depends upon the software being used as a competitive weapon [23]. Over a decade, the hunt for low labor development cost and access to skillful resources, numerous organizations started adopting facilities of remotely located development teams for software projects [24]. Global software development (GSD) is the process or trend of developing software across the boundaries, where not even clients and developers also the team members for development located away from each other [25].

Researchers have defined many factors increasing the demand for this trend:

- The need for scarce resources of remotely located teams to get the advantage of successful and cost-competitive development [26].
- The rapid formulation of virtual organizations and teams to utilize trade opportunities [27].
- The extreme demand to enhance time-to-market in interminable development [28].
- The demand for flexible advantages of joint and investment opportunities [29].

The researchers also explore different challenges for remote project development:

- Lack of planning or division of work across the boundaries [30].
- Serious and persistent misconception because of cultural issues [31].
- Insufficient communication between team members [32].
- Knowledge sharing issue across boundaries [33].
- Management affairs in terms of project and process [34].
- Technological issues faced by global teams [35].

To overcome these issues and get the benefit of scarce resources around the globe researchers have been working for decades. They have introduced the concept of team wisdom to conquer these challenges [36].

2.3 Wisdom

The concept of wisdom was introduced around 5000 years ago, and since then it has been analyzed and discussed in a philosophical context, Later on, these philosophical theories affected the current literature of Psychology, psychologically, wisdom has been defined as the ability to make something more successful [37]. Wisdom adds value, it also includes the involvement of the role of mind which we say judgment [38]. Besides, wisdom has been played a major part in applying knowledge in a more useful way, it has been worked as the

better evaluation and implementation of experience and understating through good judgments [39]. Wisdom has been viewed as the implementation of intelligence but not something which is applied only to benefit an individual, but in that way, it becomes helpful for everyone [40].

The broad definition of wisdom has been defined as the actions and behaviors of individuals as if the act they perform wisely [41]. In addition to the definition of "wisdom," researchers have explored the idea of wisdom within the framework of Leadership (i.e. managerial wisdom), which can be defined as the ability to perform effectively, detain the definition of new knowledge and interpretation of that knowledge in a more comprehensive and unified manner [42]. Furthermore, wisdom has been defined as a collaborative and interactive procedure (i.e., organizational wisdom) [43].

2.3.1 Organizational Wisdom

The researchers claim that organizational wisdom has been described as an action-oriented procedure, which has been used for the implementation of organizational knowledge during the planning phase of any development project also while making decisions for the projects and during the stage of action or implementation [44]. Furthermore, a sophisticated and delicate way of using knowledge in actions and judgments comes under the umbrella of organizational wisdom [44]. In this way, the organizational wisdom has been defined by the researchers as the most suitable way for addressing the "knowledge work", knowledge related factors and efforts that demand excellent decision power and virtue ethical behaviors in firm operations [45].

2.3.2 Wisdom Hierarchy

Researchers have been defined wisdom as the ability to make the right use of knowledge through good judgment, in software term team wisdom is the method of assessing and utilizing team members' knowledge and expertise for project-related factors [46]. Since software development is a knowledge-based activity whose success mostly depends upon the

knowledge stock being shared among different team members and implantation of that knowledge for project-related factors [47]. The knowledge stock of projects firstly exists in the form of data and go through many processes [48]. The world we live in has diverse data, different processing steps convert this data into useful information [49]. But the information exists in a fragmented form which is not enough to take decisions like “how to do”. The abstraction, conversion, and applications [50]. of this fragmented information shows up as “knowledge” and then the use of specific knowledge beyond its literal meaning, which is what we say “wisdom” [51].

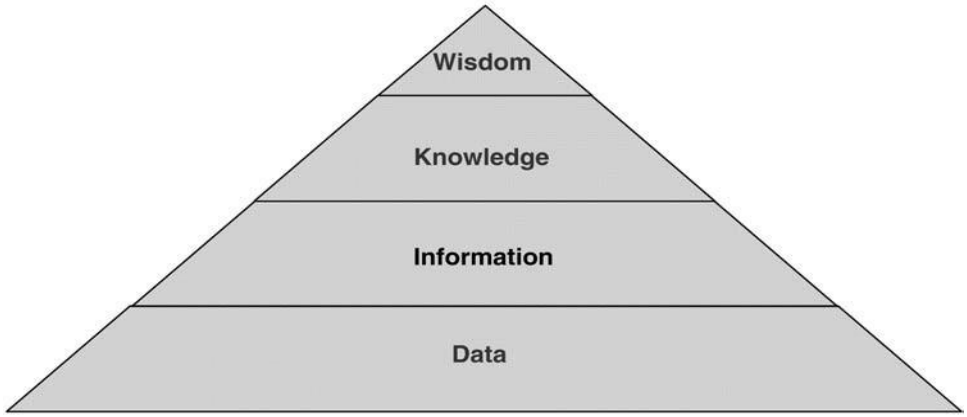

Figure 2.1: Hierarchy of DIKW [50]

2.3.3 Team Wisdom

A team can be referred to as a workgroup of complementary skills, who are responsible for the production goals and common purpose for which they are mutually committed [52]. Team wisdom can be defined as how the complementary skills of the individuals can be applied in the projects to get excellent outcomes [53]. In the software context the description of team wisdom as the multifaceted process to measure the knowledge stock of team members what knowledge will perform best and how to utilize that knowledge in project-related factors [54]. Team wisdom is the future of the organizations because of the fact, the production of the organizations depends upon the performance of the teams [55], so the utilization of that performance in project-related factors is most important and the reason behind this approach is that:

- Teams have diverse nature [56]
- Teams are adaptable [57]
- Teams can mutually work on challenging goals [58]
- Teams can smoothly overcome obstacles in performance [59]

Basic Dynamics of Team Wisdom: The researchers have been defined that the performance of the team depends upon the basic dynamics which are represented below [60].

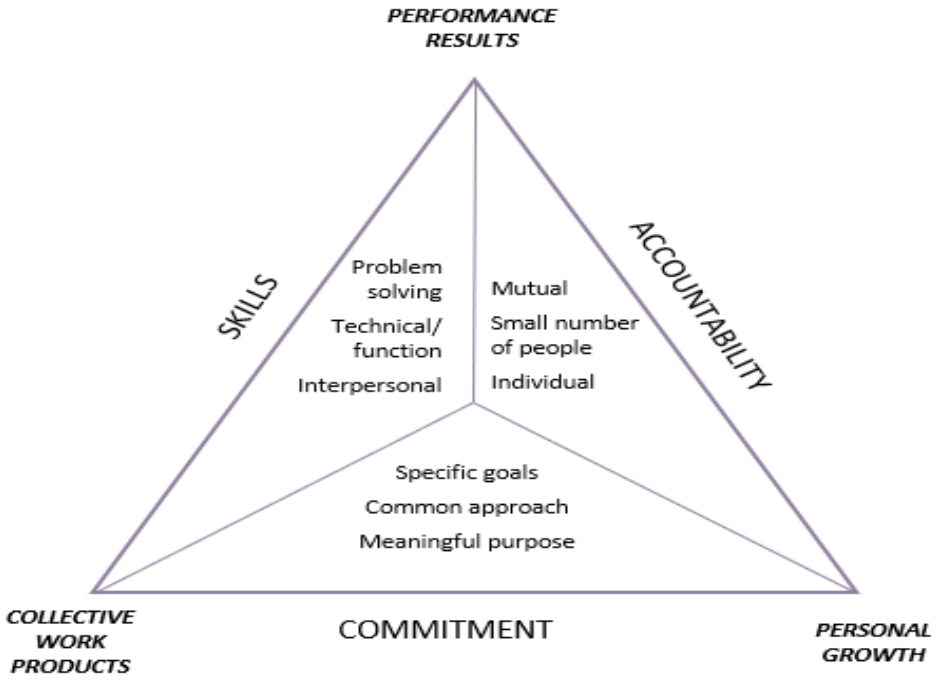

Figure 2.2: Basic dynamics of Team Wisdom [59]

To enable deliverables, the elements in figure are described through the outer triangle and to show the behaviors internal triangles being used. Basic dynamics of team wisdom are shown in Figure 2.2.

"Start with changing behaviors, not mindsets. It is much easier 'to act your way into new thinking' than to 'think your way into new actions'. Recurring and consistent performance results from behavior change will lead to lasting changes in the way people feel, think and believe in the long run" [59].

Literature defines six key factors which are involved in the development process of team performance in the development of software projects which are listed below:

Small in Number: Researchers have been described that communication among team members should be easy and frequent [61]. Open discussions should be arranged among them. If there is a need for more people to complete any project, rather than unmanageable teams the sub-teams should create [62].

Sufficient Levels of Expertise (skills): The categorizations of skills (problem-solving, technical, interpersonal) should be presented [63]. The individual and collective development of skills should be developed in all team members by themselves and others [64].

Surely Meaningful Purpose: The team should be clear about its purpose and must be understood in that way [65]. In order to explore its implications, the team should be frequent in defining it broadly with stakeholders [66]. The purpose should be significant and unforgettable so that its importance can reinforce in the organizations.

Determined Goals: In order to determine the right goals, the team members should express the goal in the same way in which they understand their relative priorities [67]. The explicit, easy, and measurable representation of the goal should be done so that the defined set of work-products of the team could be generated [68].

Defined Working Approach: The explicit and collective understanding of work should be done for the achievement of the required goals [69]. A consistent approach must be used on team members which must be improved and modified over time [70].

Sense of Mutual Responsibility: To form the part of approach and work-products, individual and collective responsibility should be felt for project purpose and goals [71]. The measuring criteria [72] clear about their individual and joint accountabilities [72]. They should have understood the sense that ‘only the team can fail’.

2.3.4 Team Wisdom in GSD Teams

The software industry has moved from the conventional co-located production form to a form in which teams are geographically dispersed and interact with each other [72]. In GSD, since software development teams are not geographically co-located, therefore they can't see or talk in person on daily basis. Team members are dispersed in GSD from neighboring buildings to be distributed across various continents [73]. This entails both outsourcing and dispersed teams within the same corporation that are allocated in various countries [74]. The software industry faces GSD challenges that can mitigate distributed development issues while still achieving advantages [74]. There are various solutions to tackle the various issues posed during the GSD.

GSD has many presumed advantages, such as specialized talent searching, expansion by acquisition, reduce cost for development, time to market, large customer range, which results in increased GSD teams [75]. They also faced several difficulties along these perceived advantages, e.t cross-site collaboration, distribution of amount of work, communication, coordination as well as control issues [69]. Major mechanisms described by GSD teams include monitoring of development projects and development teams, coordination, communication and collaboration of development teams [76]. Team building can be more challenging and can create language and cultural differences that impede successful communication when team members are geographically dispersed [77]. Team diversity and complexity of the projects create geographical temporal as well as cultural obstacles [67]. Researchers has define that the requirement understanding, establishment and team management, effective collaboration within teams, gaps within the level of process maturity and adequate selected development tools are core factors for any software organization [78]. Communication, teamwork and collaboration has been define as the essential enablers and at the core of software development process [65]. In GSD Cultural diversity within teams, mode of communication, type of task and leadership level of experience has been define as communication patterns [76]. Four success factors were defined by researchers, such as customer's authorities and requirement statements should be clear and consistent so that successful decision making can be done, interaction between members of one team with other team, immediately answer to asynchronous queries and the information of process and product should be provided continuously to the team during developments. These factors

helps in better communication between GSD teams [79]. Researchers also defined the common artifacts of communication which are scheduling and featuring of projects instead of code or providing interface [78]. They also define personal interaction within team members can results in better higher level of communication [87]. Researchers also identified synchronous and asynchronous collaboration mechanism, which are important to manage for regular interaction and coordination within team member [88]. The set of successful practices for GSD team's management has been given for better collaboration, including description of good skills and better abilities [88]. Also provide working environment for collaboration and practices for knowledge management [88].

Researchers also defined that the clear representation of roles and responsibilities of team members results in successful GSD projects. Existing studies of team wisdom in GSD are presented in Table 2.1.

Table 2.1: Existing Studies in the context of Team wisdom in GSD

Ref.	Title	Key factors	Advantages	Year
[80]	**Distributed Software Development with One Hand Tied Behind the Back: A Course Unit to Experience the Role of Communication in GSD**	Controlled experiment tool is used in this study guide to offer the basic organization of a tiny software project that is completed in remote workers.	Can demonstrate to learners that, irrespective of the communication methods employed, a lack of communication protocols has an influence on team cooperation and effectiveness.	2016
[81]	**Exploring the Relationship Between GSD, Knowledge Management,**	The link between four characteristics that have been deemed major predictors of GSD success is depicted in this	This increased collaboration and trust positively affect the shared understanding of requirements that is key to the success of requirement	2019

	Trust And Collaboration	conceptual study model.	engineering phase and overall software project.	
[82]	**Evaluation Model to Assess the Effectiveness of Coordination Processes in Global Software Development Projects: A Roadmap**	Proposes a road plan for developing an assessment model for GSD coordinating procedures, which includes indicators for each strategic and integrated approach.	This model can be used by managers as a guide to evaluate the coordination procedures across co - located and dispersed teams in a GSD context.	2021
[83]	**An Empirical Study to Investigate the Impact of Communication Issues in GSD in Pakistan's IT Industry**	For analyzing the effect of aforementioned factors on communication challenges in distributed software development, a conceptual model was being presented.	Reveals that geographic proximity, cultural distance, behavioral distance, teammates attitude, team challenges, organizational & technical issues, and access issues all have a strong effect on communication vulnerability in GSD.	2017
[84]	**Effective communication as critical success factor during requirement elicitation in global software development**	Examine how the importance of effective communication differs depending on the size of the company, the time period of the experiment, and the continent.	In GSD, place a heavy emphasis on collaboration and advanced devices and resources that can help with good communication.	2019
[85]	**Trust Development in Virtual teams to Implement**	Many communication hurdles that led to failure were being overcome.	Manages and increases the communication effectiveness of remote workers that design and produce high-quality	2017

	Global Software Development (GSD): A Structured Approach to Overcome Communication Barriers		major commercial products.	
[86]	**Global Software Development: Practices for Cultural Differences**	Explain how to promote team spirit by increasing cultural understanding, avoiding conflict, and harnessing diversity.	Providing solutions that improve multi-cultural software developers, so addressing a few of the GSD challenge factors and embracing cultural diversity.	2018
[87]	**Mitigation of Socio-Culture Distance Risks during Communication in GSD Projects**	A decision-making system based on the MCDM technique was proposed.	Present an exploratory analysis of socio-cultural distance problems and their accompanying mitigation techniques throughout GSD projects for effective communication.	2016
[88]	**Requirement Elicitation Framework for Global Software Development**	In a Distributed environment, a system for optimizing communication, identifying the appropriate elicitation approaches, and CBR supporting resource repository	Provides a framework for requirement engineers to follow when it comes to communication concerns, best practices, and appropriate elicitation approaches in GSD.	2019
[89]	**Ascertaining Quality Assurance Activities in**	Identify various parameters related to quality assurance in global software	The survey analysis can help understand the multifaceted dimensions of this issue as well as its	2016

	Global Software Development	development (GSD). The importance and efficacy of the parameters has been gauged on the basis of a survey results.	root causes. Software designers, developers and GSD clients can get benefitted from the survey analysis to better understand the challenges still being faced by the software development organizations while adopting GSD.	
[90]	**Dynamics of task allocation in global software development**	The structure for project scheduling in GSD is sketched out.	Substantiate Conway's law by demonstrating a link between numerous factors.	2016
[91]	**Leadership of Data Annotation Teams**	Gives a number of criteria for evaluating and monitoring the performance and efficiency of big annotation teams.	Showing a considerable increase in citation rate, cross agreement, and annotator use through conservative management best-practices	2018
[92]	**Latest Transformations in Scrum: A State-of-the-Art Review**	Since 2016, a research technique based on realistic Agile conversions has been developed to retrieve the literature, resulting in an in-depth perspective that is given in the article as a detailed rundown and the conclusions are explored.	Give a current objective overview from which advanced research efforts can be developed and implemented.	2017

[93]	**Transparency in Project Management – from Traditional to Agile**	Content analysis, analysis of secondary data, data aggregation, comparison, and the narrative approach were all used to conduct the research.	Honesty has been identified as a fundamental requirement and technique for managing project participants' relationships.	2018
[94]	**Global Software development: An Approach to Design and Evaluate the Risk factors for Global Practitioners**	Define a method for designing and assessing risk variables for global participants in GSD.	This work highlights the sequential and concurrent activities based on schedule and time for evaluating the risk.	2019
[95]	**Understanding the Different Levels of Challenges in Global Software Development**	Reexamine GSD issues and classify issues at the region, organization, and individual levels.	It will enable software firms to enhance their procedures and supervision at these levels by assisting academia in exploring into GSD challenges at organizational levels.	2019
[96]	**A systematic review of knowledge sharing challenges and practices in global software development**	Systematically recognizing and combining issues and strategies in knowledge sharing In addition, it is aimed to classify the most common issues and documented practices in various contexts.	Highlight the need of investigating sharing of knowledge in the case of small and medium businesses to minimize the possibility of findings being skewed by a particular empirical environment.	2016
[97]	**Why Does Site Visit Matter in**	Analyzing the activities occurring throughout short	Creating and maintaining social and professional links to support and	2016

	Global Software Development: A Knowledge-Based Perspective	integration of scattered individuals and analyzing the results of the visit in order to encourage and improve knowledge transfer.	improve knowledge exchange in GSD teams by creating and maintaining a common knowledge and awareness of the function and utility of site inspections.	
[98]	**A Project Management Framework for Global Software Development**	For Managing projects in GSD, a program management framework was proposed.	This framework combines PMBOK knowledge domains with areas of knowledge required for efficient GSD governance.	2018
[99]	**Challenges When Using Scrum in Globally Distributed Teams**	The qualities of a scrum team, the advantages of the scrum methodology, and the structure of a GSD Project are all discussed.	The interview of two experts working in agile development with GSD setups concentrates on the communication difficulties and gathers a large amount of information.	2016

2.4 Summary

In this chapter, literature review was made in order to define global software development along its demanding factors and challenges. The concept of wisdom and organizational wisdom then introduced and driven of wisdom were defined. Team wisdom along with six basic dynamics was discussed in detail. Then the theory of team wisdom in global software development teams was generated by literature. At the last existing studies defining the team wisdom mechanisms in globally developed software projects were presented in tabular form.

CHAPTER 3

METHODOLOGY

3.1 Overview

This chapter describes the research strategy adopted for this study, three main approaches of research: quantitative, qualitative and mix method, for identification of team wisdom mechanism from SLR, for the conduction of interviews data analysis, data validation and summary of the chapter.

3.2 Research Strategy

This research tries to figure out how Systematic Literature Review (SLR) and thematic analysis being used to identify team wisdom mechanisms and their impact on successful completion of software projects in global software development emerging trends. When doing any analysis, the most important question is to identify, how the study will be conducted and how the result will be gathered? It is mostly determined by the type of technique used. Researchers have a variety of options, and the approaches for data collection and analysis. The selection process can be influenced by a number of factors, including the research issue being investigated, prior research methods, and the researchers philosophical beliefs. The research approaches are divided into two categories which are qualitative and quantitative. The primary difference is that qualitative approaches use terms and open-ended questions, while quantitative approaches use statistics and close ended questions.

3.3 Quantitative Research

Quantitative research entails collecting information and data in quantitative and numerical form [100]. It employs an observational research strategy and includes statistics, computational methodologies, and mathematics in the development of theories [101]. It is a scientific/experimental procedure that does not dependent on personal opinions. Rather, before coming to a conclusion, this type of research largely relies on building theories about occurrences or phenomena via quantification. Because it is focused on statistical analysis [80], it takes less time. As a result, researchers are relieved of the stress of developing explanatory procedures in order to arrive at a conclusion [101]. Quantitative research focuses on appropriate values, which is much more accurate and clearer, rather than depending on opinions.

3.4 Qualitative Research

Qualitative research is considered as a technique of collecting non-numerical data in order to define and analyze the characteristics and behaviors of a specific research problem, with a focus on qualitative instead of quantitative elements of research [102]. Qualitative research is more interested in "why" and "how" things happen rather than how often they happen [103]. In qualitative inquiry, there is minimal or no mathematical or statistical involvement [103]. Subject areas can be investigated on a broader scale and in greater detail because of qualitative research depth. Due to it is involvement of human experiences and perspectives, qualitative data has more deep sense [104]. The researcher therefore will have a more solid platform to collect accurate data. Qualitative research also enables the researcher to present more generalized information while minimizing the range of opinions and ideas [105]. Like quantitative research techniques, qualitative approaches also use their own some inquiry techniques to analyze data [106]. According to some scholars, qualitative researchers have access to more than nineteen inquiry techniques [106].

3.5 Mix Method Research

Mixed methods research is a research method that combines quantitative and qualitative data collection, analysis, and synthesis [107]. This method of research is employed when the combination of two or more methods provides a greater grasp of the study problem rather than any method alone [108]. The researcher obtains broad scope of understanding and verification by combining quantitative and qualitative data and research, while mitigating the drawbacks of applying each approach separately [108]. Mix method research strengthens both quantitative and qualitative research by compensating for their flaws. It also gives the researcher a more complete and thorough knowledge of the study problem [108]. Mix method study also helps in the explanation of findings or the execution of causal processes. Figure 3.2 shows formulization of mix method research.

So now this study covered the main primary and secondary methods, it is time to concentrate upon selected methodological approach, which were selected for this review.

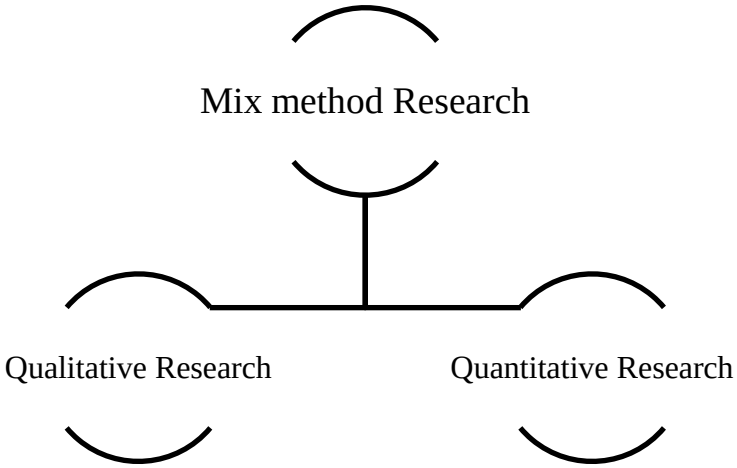

Figure 3.2: Mix Method Research

3.6 Selected Methodological Approach

The aim of this research was to define the mechanisms of team wisdom in a systematic way, as well as how these mechanisms affect software success by using thematic analysis in global software development.

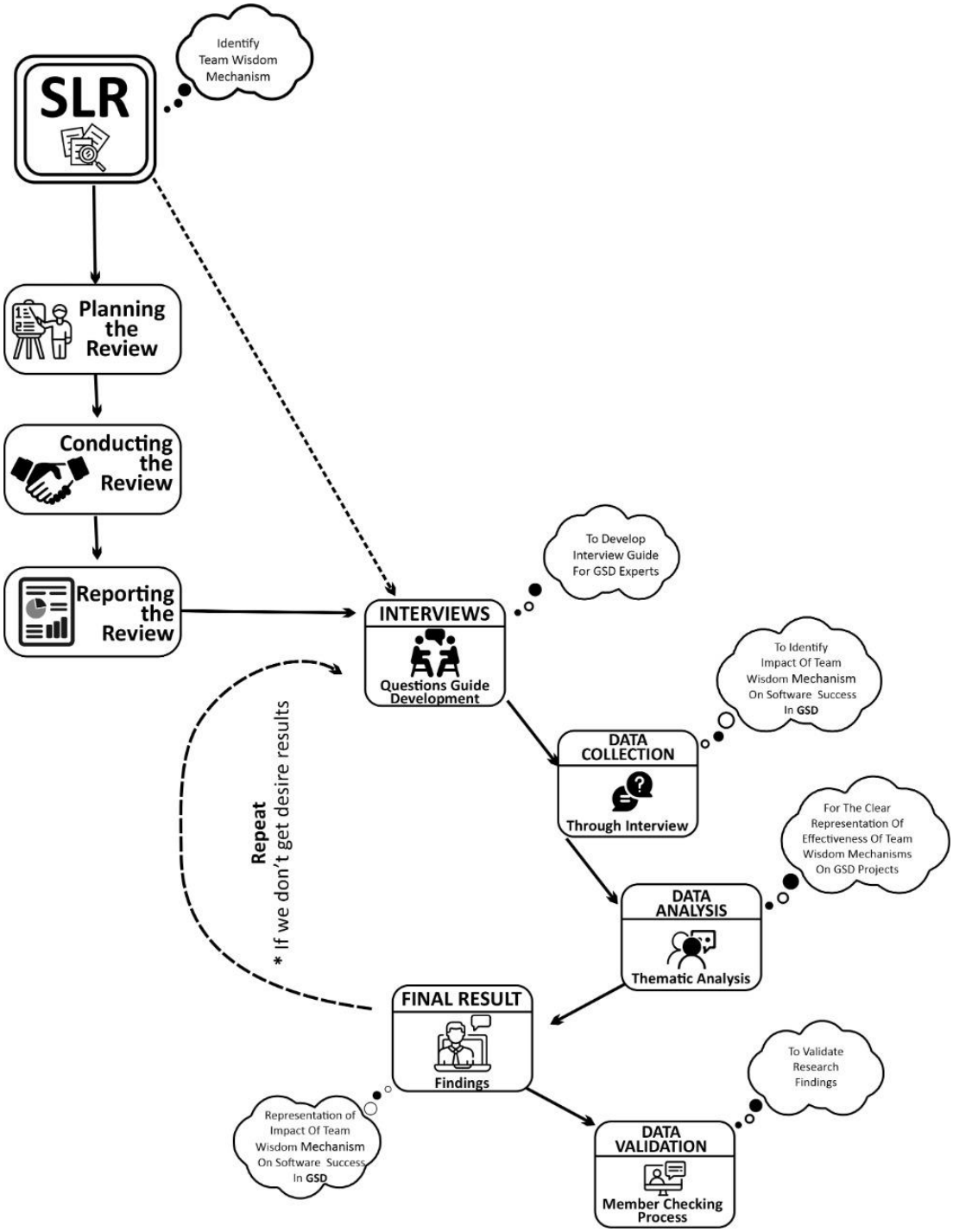

Figure 3.1: Research Methodology

To investigate the research target, a systematic literature review and thematic interview approach was used. In order to meet study objectives, qualitative data was gathered. Data from both primary and secondary sources was collected. The secondary data was gathered by doing a systematic literature study in order to identify team wisdom mechanisms, and the primary data was collected by conducting an interview to determine the impact of these mechanisms on software success in the global software development process. Figure 3.1

shows the detail steps taken for this study.

3.7 Systematic Literature Review (SLR)

SLR can be defining as a process for conducting a thorough and systematic review of existing literature in a particular research area. The purpose of doing an SLR include not just the information identified in the literature, but also the techniques used to access it, including the search terms used, as well as how and where the researcher searched [109]. SLR also concentrates on the factors that were used to analyze the literature that was found for acceptance or rejection in the research. Like any other literature review, it is conducted to provide a thorough understanding of a specific problem area, as well as to demonstrate what research has been conducted in this field and what methodological approaches and concepts are being applied [110]. It is mostly used to identify the gaps in the study and to put researchers in the right direction. A literature review establishes a strong base for knowledge advancement. An effective literature review helps in theory building, identifies areas where more study is required, and closes research areas where there is a lot of research already exist. Few researchers defined SLR as a process for discovering, analyzing, and synthesizing the current body of finalized and published work generated by research groups, academics, and practitioners which is systematic, clear, and consistent [111]. The goal of the SLR is to establish a research knowledge base. It helps the researcher in directing the research, assisting the gap analysis, and providing a solid foundation for actual research to fill any gaps and prove the hypothesis [112]. SLR is distinct from other types of literature reviews because it employs a much greater level of technique. The following are the main characteristics of an SLR [113]:

- It employs methods that are both explicit and clear.
- Its conformance to follow a set of research steps which are standard.
- It required that literature review must be comprehensive, consistent, and up-to-date.
- It necessitates user participation in order to ensure that results are valuable and relevant.

SLR try to discover as much related studies on a certain research subject as feasible, and then apply specified procedures to determine what can be confidently claimed based on these researches [114]. Methodologies must be not only precise, but also systematic, also with the goal of obtaining a wide range of consistent outcomes. SLR lessens the bias that might occur when other methods of assessing research findings are used. Researcher considered three primary reasons for doing SLR which are [115]:

Transparency: A well-defined research subject and clear search tactics aid in the clarification of subject and terminology concerns. Transparency refers to developing a clear design for the research as well as clear procedures and data for the search process [109]. This will make it much easier to navigate and grasp its contents, as well as appraise what the researchers have discovered and explicitly indicate why certain study materials were included and while others were eliminated [109]. It suggests that the researchers should be extremely clear about what they want to accomplish with their review of the literature, and demonstrate each phase of the approach so that audiences can comprehend the ideas and understand where the researcher is heading and why.

Authenticity: To be a credible research result, a review of the literature should strive to be objective in its assessment of the research [116]. When writing a systematic review, researchers must use a variety of perspectives to demonstrate clear justification for the selection of specific publications and theories. The following are some review-related pitfalls to avoid [117]:

- Selection biasness-including these materials that match your theory or ideological beliefs.
- Publication biasness-an excessive dependency on a single database or collection of publications as a source of study materials.

According to studies, to prevent publication bias, look for the articles researchers want to include in the SLR in extensive range of areas.

Auditability: Refers to keeping detailed records of the data extraction methods, which is a major part of a SLR. Others will be able to determine the findings if the researcher keep

accurate records of the search techniques [118]. The records would explain how the researcher found and selected the resources in the review, and they will lend the review an additional layer of credibility [119]. The review should be uniform and systematic constantly, which is why auditability is so important. The third and final phase of this research is to present a framework to manage requirements change in DAD efficiently by effectively coping up with influencing factors and giving the required level of importance to the prioritized categories. This has been performed using derived methodology and by conducting brainstorming sessions to come up with the right framework. The devised framework has been presented in Chapter 5.

3.7.1 Planning the Review

The first phase in the SLR is to establish a plan for the study, what are the main reasons for conducting this study and how it will be carried out? In review planning, the main step involved was defining the purpose of the study [120].

Purpose of the Study: The process of producing software projects in remote locations when vendors and clients are separated is known as distributed software development. It's an excellent platform to get high-quality software at a low labor cost. The popularity of GSD grew day by day as a result of its increased pace. Many organizations have begun to use GSD for high-quality and low-cost development. Due to its increasing demand, organizations began hiring team members for software development all around the world. Because the GSD team is made up of people from all over the world, so they have diverse knowledge and expertise. They face numerous challenges in terms of coordination, collaboration, communication, and knowledge sharing with their teammates as a result of their diversity. The world in which we live has a wide range of knowledge. Since GSD members come from a wide range of geographical areas, so it is important to manage and utilize the diverse knowledge of GSD team members. The technique of using knowledge wisely through good judgment is known as team wisdom. The goal of this research is to uncover team wisdom mechanisms in the context of distributed software development, as well as their impact on successful completion of software projects. SLR protocols used for this study are shown in Figure 3.3.

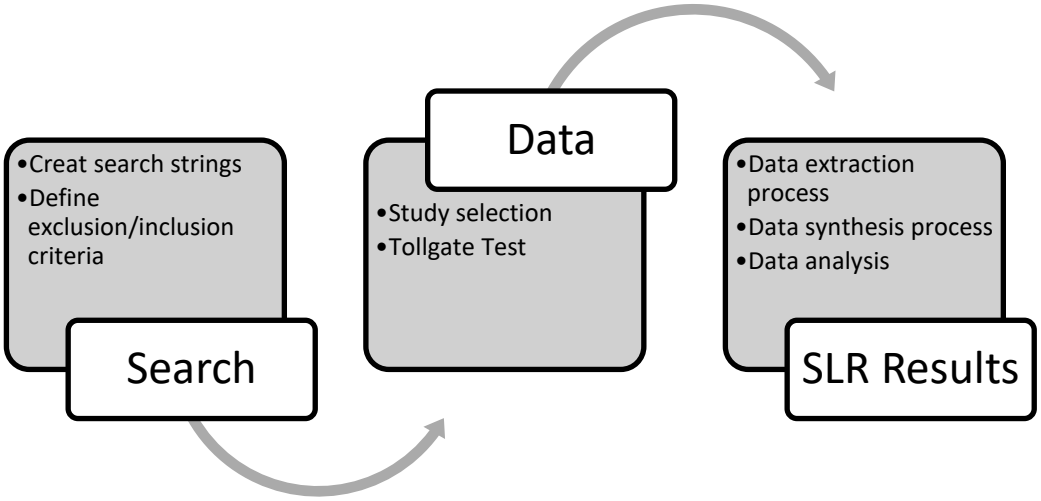

Figure 3.3: SLR Protocols

Research Questions: The research questions of this study were contained two parts, the first section focuses on identifying team wisdom mechanisms in distributed software development, while the second section focuses on determining the impact of those mechanisms on GSD projects. Table 3.1 contains a detailed description of the research questions. The first part of the research questions only used systematic literature review techniques to identify team wisdom mechanisms from the literature, and then the results of the SLR were used to develop a question guide for interviews with GSD experts in order to determine the impact of team wisdom mechanisms on distributed software development.

Table 3.2: Research Questions

RQ#	Research Questions	Description
RQ1	What are the mechanisms of team wisdom in global software development Context?	Try to come up with a definition for team wisdom in the context of global software. Explain the fundamental components of team wisdom that are required to define it. Define what the team wisdom mechanisms are, why they are important to define, and how they connect to the GSD.
RQ2	How does these team wisdom mechanisms effect software successes in global software development?	How will these team wisdom mechanisms affect software success? What impact they will impose on software projects of distributed software development.

3.7.2 Conducting the Review

Systematic literature review was conducted to find the research gap from the existing literature. Review was conducted for the searching of primary studies as well as selection of primary studies [100]. The data was extracted from the existing studies and then used to find the best possible solution. This can also be named as the method of the study.

3.7.3 Reporting the Review

Reporting the literature review involves the documentation of final results of methods to justify the solution [100]. Reporting the literature help to identify whether the proposed solution is justified or not [100]. The reporting review can help to investigate that whether the selected population is supporting the proposed idea.

3.8 Interviews

An interview is a research technique by asking open-ending questions with different respondents and gather all the data about the subject [121]. An interviewer understands the respondent views and opinion by asking the series of question and answers [122]. Interviews are same like focus group method to target the market but with totally different in the operations. Interviews have basic three types.

3.8.1 Structured Interviews

Structured interviews have been characterized as research instruments which are exceedingly strict in their functioning and allow the participants to collect and analyze results with little or no prompting [123]. They are also known as standardized interview, and its methodology is heavily quantitative. In this interview, questions are pre-determined based on the level of detail requested. In survey research, structured interviews are frequently employed in order to establish consistency throughout the interview process [124]. Depending on the sort of sample population, they might be closed-ended or open-ended. Closed-ended questions could be used to learn about a required specification from a list of possibilities, and open-ended queries can be used to learn more about a specific aspect of the interview [125].

3.8.2 Semi Structured Interviews

Semi-structured interviews give the researcher a lot of freedom to investigate the respondents while still adhering to the core interview structure [125]. Even though it is a supervised interaction between investigators and respondents, the researchers are given a lot of leeway [121]. In the existence of structure within that form of research interview, an investigator can feel assured that additional interview sessions will not be needed. The investigator can pursue any concept or make creative use of the whole interview if the structure is kept in mind [126]. In order to acquire data for a particular research, additional responder questioning is always required. When an investigator does not have any time to

conduct research but still needs extensive knowledge about a subject, a semi-structured interview is the ideal option [122].

3.8.3 Unstructured Interviews

Unstructured interviews, also known as in-depth interviews, are conversations that are performed with the goal of gathering data for a research study [127]. These interviews feature the fewest questions because they are more akin to a general conversation including an underlying theme [121]. The fundamental goal of most researchers who use unstructured interviews is to make a connection with the interviewees, which increases the likelihood that the participants will be completely honest in their responses [123]. Since there are no criteria for interviewer to follow, they are free to approach subjects in any appropriate method they see fit in order to gather information as much as possible for particular research area [122].

3.9 Method on Interviews

There are four different methods of conducting research interviews [102] presenting in Figure 3.4, each with its own set of advantages and disadvantages that can be chosen depending on the needs of the particular research.

Personal Interviews: Amongst the most common sorts of interviews is the personal interview, in which questions are being asked directly to the interviewee [128].An investigator can use a guiding online questionnaire to keep track of the responses. Investigator can build his questionnaire so that it captures the opinions or perspectives of the respondent [125].

Email or website Interviews: Because people are shifting to a more simulated environment, online research is becoming more popular, and it is important for each investigator to conform to this trend [124]. Nowadays, because of the growing number of people who have access to the Internet, email or web-based interviews have become one of

the most common types of interviews. Nothing beats an online survey for this [122].

Telephonic Interviews: To conduct efficient research, telephonic interviews are frequently used and convenient to integrate with online surveys [121]. They are frequently less expensive. In addition, the data may be gathered quickly through these type of interviews [125].

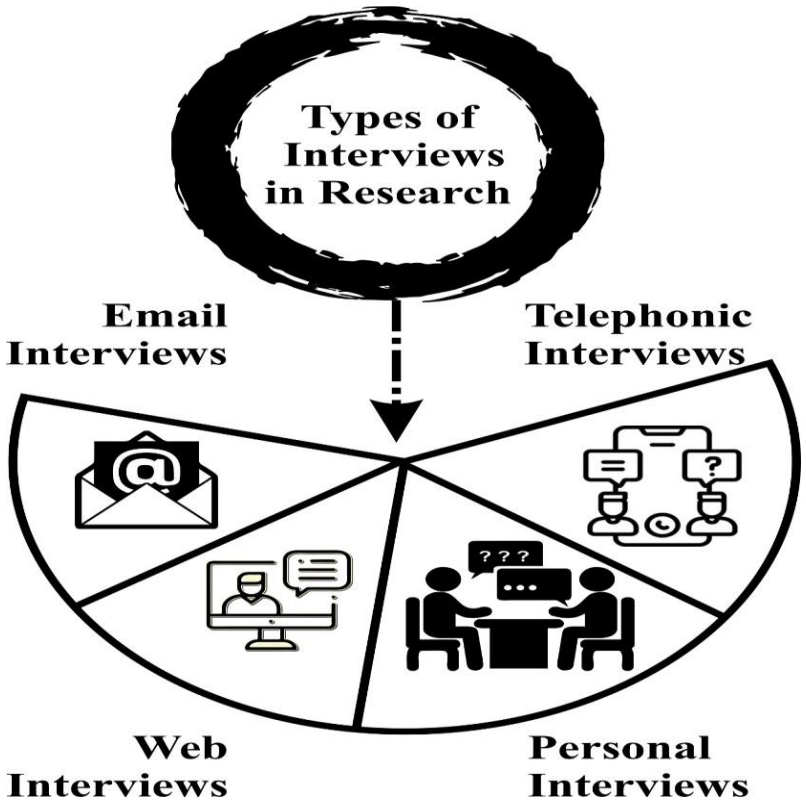

Figure 3.4: Methods of Interview

3.10 Interview Participants

For the interviews, eight active participants from the GSD organization were chosen. They were GSD experts with seven to 10 years of working experience in distributed development of software. The interviews were conducted through video conferencing because of Covid-19. There is no discrimination based on gender while choosing interview participants. This study included both female (2) and male (6) participants. Table 3.2 show the demographic profile of the respondents.

Demographic Profile: gives information on research respondents [108]. It is required to determine whether the people in specific research are a representation of the entire targeted population for study objectives.

Table 3.2: Demographic Profile of Interview Participants

Respondents	Designation	Experience
R1	Manager	7 years
R2	Senior developer	10 years
R3	Manager	8 years
R4	Senior developer	9 years
R5	Executive	11 years
R6	Manager	7 years
R7	Manager	8 years
R8	Manager	8 years

3.11 Thematic Analysis

Thematic analysis is a qualitative data analysis technique. It is typically used to analyze a group of texts, like interview transcripts. Virginia Braun and Victoria Clarke [103] invented this method for psychological studies. Thematic analysis, on the other hand, is a versatile method that may be used to a wide range of studies [103]. The researcher examines the data carefully in order to uncover recurring themes, concepts, ideas, and structures of meanings [129].

In this study we have used thematic analysis on interview extracts in order to find the impact of Team wisdom mechanisms on software success in global software development. Thematic analysis can be done in a variety of ways, but the most popular method follows a five-step process [104]:

1. Familiarization of data
2. Creating codes
3. Creating themes from codes
4. Naming themes
5. Writing up

Familiarization of Data: The very first phase in thematic analysis is the familiarization of data. Before begin evaluating individual items, it is essential to have a comprehensive picture of all the data which is gathered [104]. This may include translating audio, going through the material and taking preliminary notes, and general familiarization with the data.

Creating Codes: Next Phase of thematic analysis is creating codes from interview extracts. Coding is the process of marking bits of text generally phrases or sentences and creating concise labels or "codes" to explain their meaning [104]. In this analysis first, the codes were created.

Frequency Analysis of Codes: A frequency analysis is a table that represents a results data set and is used to arrange and summarize the findings [130]. It is a collection of qualitative or quantitative findings that a factor in a data collection accepts, as well as the number of times every value appears. It helps the researcher in different ways [105]:

- In a tabular structure, organize and summarize the data that has been analyzed.
- Evaluate the data.
- Identify extreme values in analyzed data set.

Creating themes from codes: Identifying themes entails articulating precisely what the researcher understands from every code, determining how it improves the understanding of the data and how it relates with the final results [109]. The process of labeling themes is developing a short and simple name for each theme.

3.12 Data Validation Process

Data validation is the process of validating research outcomes in order to ensure the credibility and accuracy of data [109]. In this study data validation was done by member checking process, which is also known as member validation process. A 0-3 scale was defined to check the validity of data. In this study member checking was used to analyze the interview results for validation and credibility of the findings. The summary of our findings in tabular form was sent to the few of interview respondents, in order to check accuracy of the findings.

3.12.1 Member Checking Process

Member checking which is also known as respondent validation is a qualitative approach for determining the validity and credibility of the results [131]. The term "credibility" refers to the ability to verify the accuracy of research outcomes. It implies proving that the results are accurate and genuine. Respondent validation is traditionally characterized as giving either a quick overview of the results or the entire findings to the research participants [111].

3.14 Summary

Methodological aspects of this study were explained in this chapter. The methods used to identify team wisdom mechanisms and their impacts on software success were discussed. To obtain a full understanding of selected methods, this study focuses on three main research approaches: qualitative and quantitative and mix method. The methodological approach selected for this study, which included a systematic literature review and interviews, was then fully explained along their types. Method used for analysis and validation which are thematic analysis and member checking process subsequently were also defined.

CHAPTER 4

IDENTIFICATION OF TEAM WISDOM MECHANISMS BY SLR

4.1 Overview

This chapter describes identification of team wisdom mechanisms by SLR team wisdom mechanisms identified by following SLR protocols. This study firstly identifies categories of team wisdom then major categories among these categories defined and explained and at the end the critical factor of team wisdom mechanisms has been analysed.

4.2 Method of the Study

This section contains details on how the study was carried out. This section consists of four basic steps.

- Searching of Articles
- Data Extraction process
- Data synthesis process
- Data analysis process

4.2.1 Searching of Articles

The five significant databases were chosen as key purposes because of their importance in this research. Selected databases are, “Science Direct, Google Scholar, IEEE Xplore, ACM Digital Library and Springer Link”. The process of testing and refining was used to create search terms. The search terms were tested, edited if needed and retested. Until the finding of satisfactory results, the results were being compared in iteration. The search terms were filtered for team wisdom mechanisms that would be applicable in a GSD environment. The finish factor for search terms filtering was that, when there will be approximately 10% from the top of 20 results of the search seemed related with SLR. By applying search terms shown in the Table 4.1 this technique was repeated across all repositories. The best-performing search strings made up of the two sets of search phrases. First column of Table 4.1 contains the type of key terms and the second one is related to used key terms.

Inclusion criteria: was defined by following points[119]:

- The published work of Conference Proceedings, Magazines and Journals after 2010.
- Studies concentrated on the importance of team wisdom in the area of GSD.

Exclusion criteria: was defined by following points [102]:

- The published work before 2010.
- Manuscripts which are written in any language excluding English.
- Technical reports will not be considered and will be excluded.
- Graduation projects of students, Master thesis of students and PhD dissertation.
- Other domains of studies like Civil Engineering.

4.2.2 Data Extraction Process

Tollgate method [100] was used in order to extract the relevant papers. It is the method which is used to extract the relevant articles for research study by following different levels. The below written steps were used in this process in order to extract most relevant papers of global software development and team wisdom. It is shown in Table 4.2.

Table 4.1: Search Terms for SLR

Type	Search Terms
1	Global software development AND team wisdom OR Distributed software development AND team wisdom OR team wisdom procedure in global software development OR team wisdom operations in global software development OR team wisdom processes in global software development.
2	Team wisdom in software engineering OR Team wisdom in Global software development OR Team wisdom in distributed software development.

Selection of articles: By tollgate method [100] 564 studies were selected at the first level by using above defined search strings. On the basis of their title and abstract 479 studies were selected. On 3rd level 212 studies were chosen on the basis of their introduction and conclusion.

Table 4.2: Data Extraction Levels

Levels	Extraction Criteria
L-1	Find related papers by using search terms.
L-2	Articles are accepted or rejected depending on their title and abstract.
L-3	Articles are accepted or rejected depending on their introduction and conclusions.
L-4	Articles are accepted or rejected depending on their full text.
L-5	Final primary research studies to be added in the SLR.

After this, the selection based on full text was made, which results in 81 primary studies. Then by following level five of tollgate method 31 primary studies were finally shortlisted. Figure 4.1 shows the percentage of selected article from different data bases.

Table 4.4: Final Selected articles from Data extraction process

Databases	L-1	L-2	L-3	L-4	L-5	Final Selected Articles (n=31)
Science Direct	108	94	33	11	6	19%
ACM	124	88	27	16	4	12%
IEEE	112	91	38	9	5	16%
Springer Link	98	63	21	12	4	12%
Google Scholar	234	143	93	33	12	36%
Total	564	479	212	81	31	100%

4.2.3 Data Synthesis Process

Data synthesis was accomplished by the researcher and as the outcome of data extraction phase, a list of categories for required data from the extracted papers were created.

After that a careful review of all categories were performed in order to compress the any researcher bias and to validate all categories. Major derived categories of team wisdom are presented in Table 4.5.

Group of Related Categories: Once the categories go through the reviewing process and get validated, the next step is the identification of relationships among all categories for that a group of related categories were constructed in order to get major categories. Initial categories presented in Table 4.5.

Team Experience: Project complexity, Management and monitoring of development projects, Management and monitoring of development Teams comes under the major category of team experience. Table 4.6 and Figure 4.2 present categories involved in team experience.

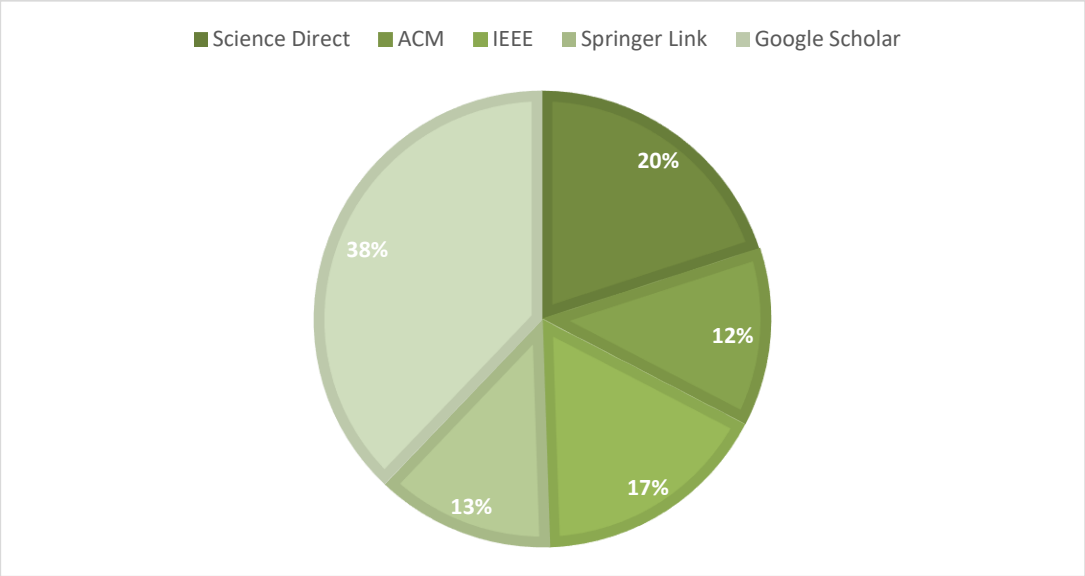

Figure 4.1: Appearance of articles in SLR from different data bases
Selected through tollgate method

Table 4.6: Team experience related categories

C. No	Related Categories
C3	Team Leadership Experience
C12	Project Complexity
C9	Management and Monitoring of Development Projects
C10	Management and Monitoring of Development Teams

Table 4.5: Initial Categories of Team Wisdom Mechanisms

C. No	Categories
C1	Effective Individuals' Interactions
C2	Work Division Among Team Members
C3	Team Leadership Experience
C4	Team Diversity
C5	Team Networking
C6	Coordination Among Teams
C7	Collaboration Among Team Members
C8	Communication Among Team Members
C9	Management and Monitoring of Development Projects
C10	Management and Monitoring of Development Teams
C11	Knowledge Management
C12	Project Complexity
C13	Team Honesty
C14	Team Transparency
C15	Effective Decision Making

C16	Diverse Knowledge of Team Members
C17	Diverse Skills of Team Members
C18	Cultural Diversity
C19	Language Diversity
C20	Team Intuition
C21	Team Reasoning

Team Networking: Coordination among teams, collaboration among team members, communication among team members and effective individuals interactions of GSD team members jointly produced team networking category in distributed software development. Team networking related categories shows in Table 4.7 and Figure 4.3.

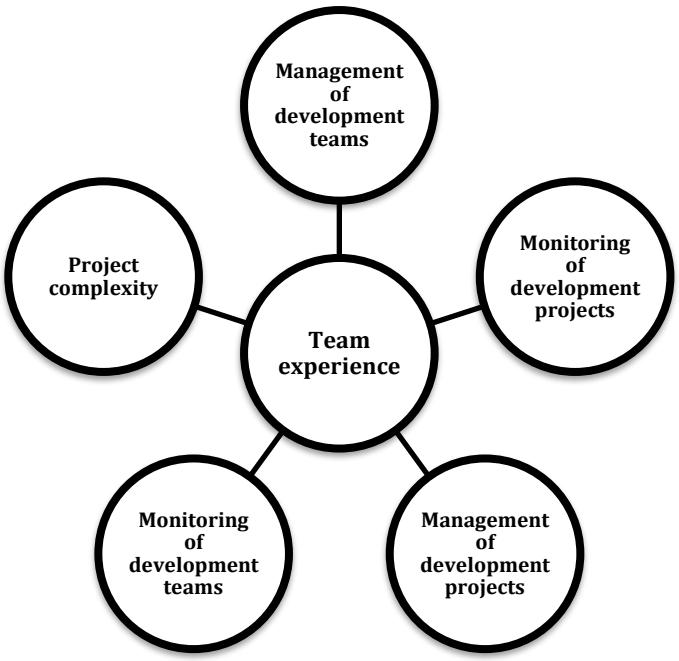

Figure 4.2: Categorization of Team experience

Table 4.7: Team Networking Related Categories

C. No	Related Categories
C5	Team Networking
C6	Coordination Among Teams
C7	Collaboration Among Team Members
C8	Communication Among Team Members
C1	Effective Individuals' Interactions

Team Diversity: Work division among team members, diverse knowledge of team members, diverse skills of team members along cultural and language diversity defined as basic parts of team diversity by primary studies. Table 4.8 and Figure 4.4 shows Team diversity relates categories.

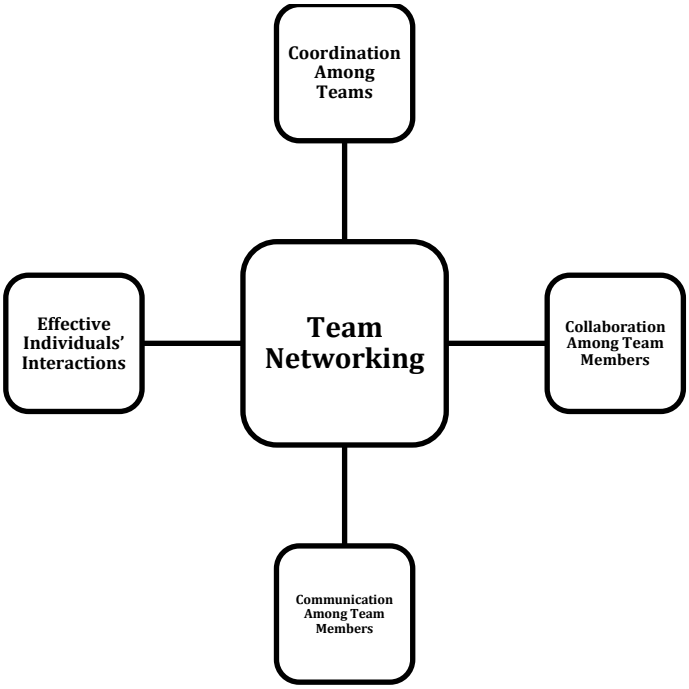

Figure 4.3: Categorization of Team networking

Table 4.8: Team Diversity Related Categories

C. No	Related Categories
C4	Team Diversity
C2	Work Division Among Team Members
C16	Diverse Knowledge of Team Members
C17	Diverse Skills of Team Members
C18	Cultural Diversity
C19	Language Diversity

Professional Ethics: Ethical behaviors of team members including team honesty and team transparence jointly can be named as professional ethics of team members in GSD. Table 4.9 and Figure 4.5 shows professional ethics related categories.

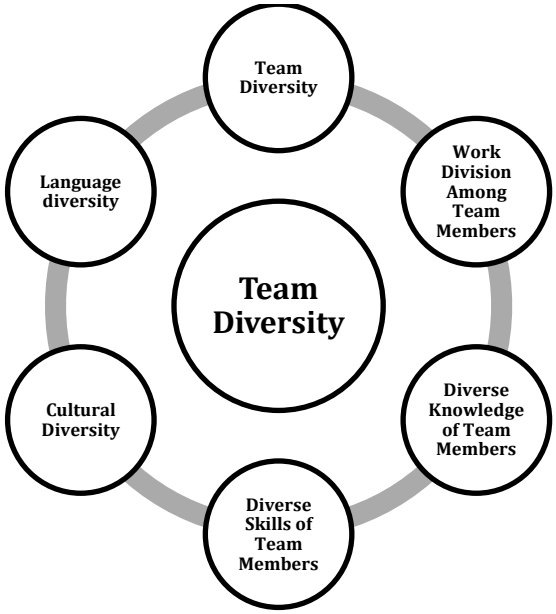

Figure 4.4: Categorization of Team Diversity

Table 4.9: Professional ethics related categories

C. No	Related Categories
C13	Team Honesty
C14	Team transparency

Team Prudence: Knowledge management and effective decisions making relates to team prudence in distributed software development teams. Table 4.10 and Figure 4.6 shows team prudence related categories.

Joint Epistemic Actions: Team intuition team reasoning and effective decision-making during project related factors can be said as joint epistemic actions of distributed software development team members. Table 4.11 and figure 4.7 shows joint epistemic related categories.

Figure 4.5: Categorization of Professional Ethics

Table 4.10: Team Prudence Related Categories

C. No	Related Categories
C11	Knowledge Management
C15	Effective Decision Making

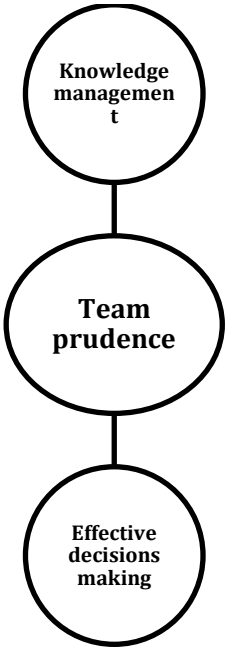

Figure 4.6: Categorization of Team prudence

Table 4.11: Joint Epistemic Related Categories

C. No	Related Categories
C20	Team Intuition
C21	Team Reasoning
C15	Effective Decision Making

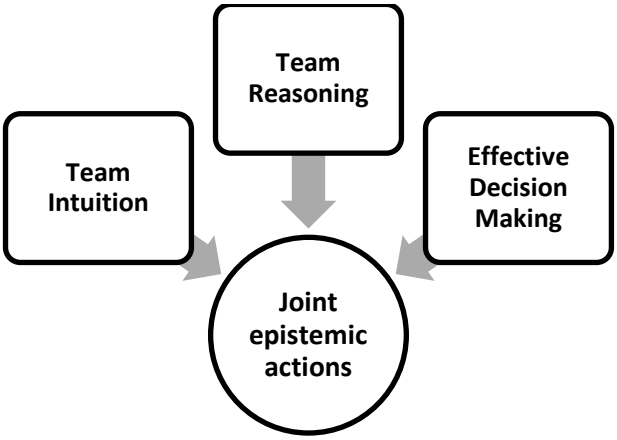

Figure 4.7: Categorization of Joint Epistemic Actions

Major Categories: The above major categories of team wisdom in GSD are derived from initial categories. Each major category represents the importance of wisdom related mechanisms in GSD. Table 4.12 and Figure 4.8 present major categories of team wisdom.

Table 4.12: Team Wisdom Mechanisms Major Categories

Sr. No	Major Categories
M1	Team Experience
M2	Team Diversity
M3	Team Networking
M4	Team Prudence
M5	Professional Ethics
M6	Joint Epistemic Actions

Figure 4.8: Categorization of Major Categories of Team Wisdom Mechanisms

4.2.5 Data Analysis

Frequency analysis process [102] was used to analyze team wisdom mechanisms in distributed software development; it is a technique which is used to investigate descriptive information, to make arrangement of data. Frequency and percentage of the team wisdom mechanisms shows through the frequency tables. The reason behind using these frequency analysis methods is, it helps to analyze nominal as well as numeric data.

Software development Team Wisdom: In general wisdom is the mechanism by which expertise and knowledge stock are combined and implemented in practical decisions. Because numerous teams are involved in the development process of GSD, it is essential for the successful completion of GSD projects to manage the knowledge stock of various team members, in this way team wisdom performs effectively.

As a multifaceted process, team wisdom can be conceptualized by quantifying the knowledge stock of team members and what knowledge can work better and what will be most virtues, and how to use that knowledge in shared epistemic activities like

judgment/reasoning, intuition, communication actions for project related factors. The Identified team wisdom mechanisms from SLR along with their frequency are written below. Table 4.13 presents frequency analysis of team wisdom mechanisms.

Table 4.13: Frequency analysis of team wisdom mechanisms

M. No	Mechanisms	F(n=31)	Percentage
M1	Team Experience	21	67%
M2	Team Diversity	18	58%
M3	Team Networking	17	54%
M4	Team Prudence	19	61%
M5	Professional Ethics	15	48%
M6	Joint Epistemic Actions	16	51%

Team wisdom is the way of improving production of teams by using different mechanisms. These mechanisms should be applied in all the GSD based software projects. These team wisdom mechanisms will play a crucial role to reduce the failure rate of softwares in GSD. Following are the three most widely used mechanisms according to the frequency analysis:

M1: Team experience

M2: Team prudence

M3: Team diversity

M1(Team experience, 67%) got the highest percentage, it means date 67% studies of SLR defined team experience as the part of team wisdom mechanism in development of software projects in globally distributed teams. Team prudence got the second highest percentage (61%) in team wisdom in GSD. The next mechanism for getting the next highest percentage (58%) is team diversity. Team networking had (54%) in the context of GSD. Joint epistemic actions of team members got the second lowest percentage (48%) in GSD. Figure

4.6 shows the percentage of team wisdom mechanisms by frequency analysis. The last and less cited team wisdom mechanism defined by researchers is M6 (Professional ethics, 48%).

Figure 4.9: Occurrence of Team Wisdom Mechanisms in selected SLR studies

The organizational management must incur higher attention to tackle these mechanisms which are identified critical. The selected primary studies also defined that if the less attention paid to the critical mechanisms or major categories of team wisdom in GSD then the organizational business can lead to decrement in project efficiency and performance. Key challenges rely on the individuals rank status in an organization, and maybe they differ from one person to another. Major concerns depend on the geographic regions wherein the workers are based and can differ over time. The following parameters are taken into account in this literature review to assess the criticality of the mechanisms. The mechanisms who got the frequency of equal or more than 55% that mechanism was considered critical. The mechanisms which were declared critical by SLR are:

M1: Team experience

M2: Team prudence

M3: Team diversity

4.3 Summary

In this chapter SLR was made in order to extract team wisdom mechanisms in the context of GSD from existing literature. This study defined the SLR in detail along with its importance and characteristics. Different steps of SLR were used to identify team wisdom mechanisms. Firstly, the searching process was made by using different key words by following inclusion and exclusion criteria. Data extraction was done by using tollgate method. By using this method 31 out of 564 primary studies were included in the SLR. Initial categories (21) of team wisdom mechanisms in the context of GSD were defined at the data extraction process. Then the six major categories were derived from initial categories, which were further named as team wisdom mechanisms. At last the critical mechanisms among these mechanisms were defined.

CHAPTER 5

ANALYSIS OF INTERVIEWS

5.1 Overview

This chapter describes the qualitative analysis of the interviews. Firstly the initial coding process of interview transcripts defined. Then the frequency analysis on extracted codes was performed. After that creating and naming process of themes was applied. The impact of team wisdom on successful completion of software projects in GSD describes in detail. The validation process of results then represents and reports the summary of the chapter.

5.2 Coding Interview Extracts

This study interviewed eight GSD professionals in order to determine the impact of team wisdom mechanisms on software success. In column two, the data obtained from interviews is written, and in column three, the initially constructed codes are written. And the column 1 contains the information of respondents. Table 5.1 present the coding process. This study highlighted several sentences in different numbers to correlate to different codes for this analysis. Every code corresponds to an idea or emotion stated in that section of the text. Being comprehensive at this point is the best approach.

Table 5.1: Coding Process of interview extracts

No.	Interview extracts of GSD experts	Codes
R1	Software team wisdom in my view is the process or way for effectively **[1]managing software projects and software teams**. I have 5 to 7 years of working experience in GSD. I prefer to do open experimentation kind of task on my own. I prefer to work in group environment. I am able to collaborate with many teams at the same time. **[2]Depending on priority of the task I decide which task we have to complete first**. **[3]Patience and understanding strategies I used in order to manage teams** to attain goals. One-time goal team is focused on one task and does not require much management, **[1]frequently recurrent team needs task lists and time lines** for better management. We try to have online meetings on **[4]every day or an alternative day** to bring everyone up. Based on seriousness I either refer to the previous work or internet if the team is not present. For remote teams a **[4]daily meet is required** to keep the members up to date. Not many social networks, a professional capacity communication network is enough. Having a social network won't make much difference. My team members use **[5]message updates and constant work reviews** to keep the team updated. There is also a daily scrum that keeps the different teams updated on the work scenario. Unfortunately, we Cannot put enough emphasis on boundary spanners**. [6]Boundary spanners enable the team communication to flourish and a respect relation among pears**. I would recommend **[3]being open in the workplace**. Rather than keeping to yourself, it is good to mingle. It breaks the ice among members. It is very essential. [7]A **good communication mechanism helps reduce the effort of communicating plans and allows the seamless flow of data**. We have GSD teams include members from different departments and units. I do fine with diverse team members as the main purpose is to focus on the task. Every individual is different so I cannot measure everyone the same. **[8]Diverse capabilities and capacities of GSD team members do not affect project related decisions.** The deciding factor is the	**[1]**Team management **[2]**Establish team's visions and missions **[3]**Establish relationship with stakeholders **[4]**Daily meetings **[5]**Updates on development process **[6]**Boundary spanners are important aspects **[7]**Good communication and collaboration strategies **[8]**Teams with diverse backgrounds **[9]**Knowledge management **[10]**Team virtue and ethics [11]Effective decision making

	logic and the weight of the suggestion put forth rather than the person putting it out there. **[8]Diversity provides a more diverse perspective**. Hence creates a more efficient system. -My team consists of both seniors and juniors. **[9]Each member has their own threshold**. Some have more, some have less. They are learning in their domain but juniors do have a long way to go. **[3]I encourage them** and give them time to resolve their own issues before asking for help from others. **[3]Having multiple perspectives helps**. In case of respect and listening to the processes. This is where rules and leadership apply. Seniors have more experience and knowledge; **[11]hence during learning and putting forth decisions**, leadership rules should be applied. Yes, absolutely in any GSD project team's ethics and virtues are important. **[10]Happy employees are more productive, accountable, and consistent**. I have seen many make mistakes and own up to them. Hence providing a good learning experience. Knowing that everyone has something new to tell. **[11]I weigh my options and choose a decision based on efficiency**. Projects rely on hard coded information, **[11]test results rather than gut feelings**. If I have a gut feeling, I test it out and produce evidence. **[11]A little bit of both team intuition and team reasoning**. Sometimes a hybrid approach is a better one.	
R2	S/W team wisdom is a **[7]good collaboration and communication between teams to produce successful projects** by mutual understanding and efforts. I have 9 to 11 years of experience working in GSD. Project management prefer on my own. All the time I prefer working in group environment, able to collaborate with many teams at the same time, **[2]by prioritization and comparing their benefits** I decide which team and which of its activities are the most important. Agile and Scrum and also by using project management tools (jira) I employ team management to attain goals. **[3]I try to develop positive relationship with team members** and **[3]always try to communicate everyone openly.** I manage **[1]one-time goals Effectively on my own and frequent, varied, and recurrent** by following agile steps, **[4]online daily**	[1]Team management [2]Establish team's visions and missions [3]Establish relationship with stakeholders [4]Daily meetings [5]Updates on development

	base meetings are good enough to bring every one up, I tackle problems on my own when the rest of my team is unavailable. **[12]social networks of team members with other project teams is beneficial**, because it makes you more comfortable to share problems while working in group environment. I always encourage my team to try their best **[12]to improve their communication and relationships with other employees**, it is very important for GSD teams **[7]to have enough resources and efficient** organizational communication mechanisms because **[7]communication is the main aspect in GSD for software success.** I team-up the individuals who have **[7]different educational backgrounds** by giving them small assignments to complete in group, so that they can learn new things from other teammates. **[7]Diverse capabilities** effects in many ways by conflicts among team members, they don't agree on a single decision, it also helpful to produce successful projects if all the **[7]team members are doing tasks on which they are good at** I make my team members **[9]to deliberate about what they are best at** give them assignments. **Strong leadership** is necessary in all steps and decision-making steps. Team's ethics and virtues are important in all GSD projects. **[10]Happy employees are more productive, accountable, and consistent**. I, so that effective production can be done give everyone chances to explain their points and come to a decision. **[11]Gut** feeling impose bad impact on project performance. **[11]Team intuition** is more preferable to use for software projects.	[6]Boundary spanners are important aspects [7]Good communication and collaboration strategies [8]Teams with diverse backgrounds [9]Knowledge management [10]Team virtue and ethics [11]Effective decision making [12]Build social networks of team members with other teammates
R3	Software Team wisdom in my opinion is **[11]effective decision-making during project related factors**. I have 8 years of working experience in GSD. I prefer doing exploratory kind of work on my own. Working in group environment is best for barnstorming and to better handle the problems. I am able to collaborate with many teams at the same time. **[1]0n the basis of task priority I decide which team and which of its activities are the most important**. I employ Planning, **[3]Understanding** and management in	[11]Effective decision making [12]Build social networks of team members with other teammates

	software projects to attain goals. Also, **[11]I try to avoid unnecessary involvement** in the project development phase so that our software team can work freely. **[1]Mostly we manage team with frequent, variant**, and recurrent **[2]goals by Prioritizing the task** and plan at earlier stage and then managing the timelines. I think **[4]After 24 hours/Every day or at least weekly meeting** should be held to bring everyone up in your teams. I tackle problems on my own when rest of team is not available. More, **[7]better and fast communication mechanisms required in remote teams**. I establish communication mechanisms across internal and external networks in my teams as much they required. **[12]I encourage my GSD team members to build social networks** in order to have better access to organizational resources and knowledge by giving them workshops on social networks. Our GSD teams do have people from different departments and units. I team-up individuals on task requirements. **[8]Diverse capabilities and capacities** do not affect much to project related decisions. **[9]Our team members have higher level knowledge about their areas**. I deliberate my team members about their best by **[8]highlighting their strengths and command on that skill** and contribution related to that area in previous projects. Team ethics and virtues are most important these days. **[10]I made virtuous and tolerant decisions** in my teams by being equal to everyone. **[11]Gut feelings** can lessen the project performance and can lead towards project failure. **[11]Team reasoning** is best for software projects success.	[2]Establish team's visions and missions [3]Establish a Relationship with Stakeholder [1]Team management [13]Leadership avoid micromanaging [4]Daily meetings [7]Good communication and collaboration strategies [8]Teams with diverse backgrounds [9]Knowledge management [10]Team virtue and ethics
R4	Software team wisdom deals with the **[3]collaboration and power relations between stakeholders**. I have 12 years of working experience in GSD. I prefer doing software project management on my own. Working in group environment is best for organization as well as team members because u learns new things and gets new ideas. Active, experienced and skillful teams are most important for software success. **[5]I checked daily progress reports in order to attain goals** and also, I do my homework in order to	[3]Establish a Relationship with Stakeholder [5]Updates on development process [2]Establish

	manage my teams in best way. [1]**I mange different kind of teams** by setting milestones and dividing work in sequence. when no one is available I do work on my own. [7]**More communications are required in remote teams** as they open new ways for success. Social networks of team members with other project teams not much affect software development. [7]**My teammates have good interpersonal and communication skills** which are backbone for working in GSD and for successful development. I encourage my team members by giving them motivation and by sharing positive stories with them through workshops and meetings. [7]**Efficient organizational communication mechanisms** are much more import for GSD team and GSD projects as they are essential enablers for project success. [8]**We have GSD team members from different departments and units**. I team-up diverse educational background team members on [8]**the basis of their knowledge and skills on which they are good.** [8]**Diverse capabilities and capacities** could become hurdle to attain goals if not mange in best way. But at the same time they can be beneficial because all team members think according to their expertise so they come with multiple ideas which can increase chances to achieve goals effectively. [9]**Our team members have good knowledge about their areas**. I deliberate my team members by making them confident about their best through workshops. [1]**Leadership should use SPM tools like JIRA or some others to maintain and keep track of project success**. Team ethics and virtues are must have in GSD teams. [10]**Happy employs are productive, accountable and consistent** that why we always try to aware about the professional ethics to our team members. I don't prefer applying [11]**gut feeling** as they can impact badly if I don't have any information, I would like to use internet resources to understand that. [11]**Team intuition** is best to use in software projects.	team's visions and missions [1]Team management [7]Good communication and collaboration strategies [8]Teams with diverse backgrounds [9]Knowledge management [10]Team virtue and ethics [11]Effective decision making
R5	SW team wisdom is [3]**productivity of team with good interpersonal relationships**. I have 11 years of working experience in GSD. I am best at leadership. In large scale projects I prefer to work in group environment. I can handle many teams at the same time. In my view [2]**those activates which gives more business and profit are most important**.	[3]Establish a Relationship with Stakeholder [2]Establish team

	I use [1]**project management tools and techniques** to attain goals. I [1]**give more time to team which have frequent varied and recurrent goals**. I my view even [4]**10 minutes online daily meeting** should have held or an alternative day based on the availability of every team member. I [1]**get work done through freelancing** by assigning someone tasks when no one is available in my team. [7]**Better communication** is the key for success for remote teams. I believe [12]**having social networks of team members with other project teams is beneficial for project success,** because it let them talk in friendly environment. I **t**hink [6]**boundary spanners are the most important part of any organization, because they create the bridge between individual and organization.** I think GSD teams must have [7]**enough resources and efficient organizational communication mechanisms** for success. Our GSD teams have diverse team members. [8]**I team-up individuals who have different educational background by giving them tasks on which they are good**, so that efficient production can be done. But [8]**diverse capabilities and capacities of team members** can reduce project quality if not managed in good way. It also affects software success because of having conflicts among ideas. I have expert level of GSD team members along few less experienced individuals. I prefer to [11]**involve them in project decision**. Not only in GSD in any organization ethics and virtues of team members are important, because I think [10]**happy employees are more productive, accountable and consistent**. [11]**Gut feelings** can impose negative affect on project success. [11]**Team reasoning** is more preferable to use while software development.	visions and missions [1]Team management [7]Good communication and collaboration strategies [12]Build social networks of team members with other teammates [6]Boundary spanners are important aspects [8]Teams with diverse backgrounds [10]Team virtue and ethics [11]Effective decision making
R6	S/w team wisdom deals with the [7]**collaboration** and [3]**power relationships between stakeholders**. I have 11 years of working experience in GSD. I assigned to lead the team in most software projects. In complex situation and on big projects I prefer to work in group environment. [2]**The activities which give more business and benefits are more important** in my view.	[7]Good communication and collaboration strategies [3]Establish a Relationship with

	[7]**As a team lead I always collaborate with many teams at the same time**. I check the priority of milestones which we are going to achieve. [7]**The team which is working on functional requirements is always the first priority.** [1]**I use project management tools and techniques to attain goals**. I think work with dedication and fluency also engages all the team members in multiple tasks. I divide tasks among all of them and [5]**check their performance continuously**. I think it is [4]**necessary to daily meet** with the rest of the team to bring everyone up. [1]**I always create backup plans so I always have someone who can do the work**. [7]**Communication is the main source especially in this pandemic situation in remote roles**. [12]**Social network with other teams increase productivity**. They try to focus on improving their communication and collaboration skills. [12]**I always motivate my team members to be more socialized**. Our GSD teams include members from different departments and units. [8]**In my opinion diverse capabilities effects decisions in positive way**. I give all of them equal importance**.** [8]**I don't think diverse capabilities affect software success in fact they open a new idea for development**. Our GSD team members have [9]**knowledge about their areas intermediate to expert level**. I analyze their skills according to their interest and results in any task assign to them. In complex situations and in big projects [1]**leadership should apply absolute principles to a complex and fuzzy reality in their teams**. In any GSD project team's ethics and virtues are important. Because [10]**I think happy employees are more productive, accountable, and consistent**. Whenever i have to take the virtuous and tolerant decisions in my team [10]**I arrange meeting of stakeholders and we vote for the best decision**. I [11]**practice before starting new project** and learn from all new projects. Because of [11]**the increase in advancements there is always something new to learn.** [11]**Team reasoning** is the best option.	Stakeholder [2]Establish team's visions and missions [1]Team management [5]Updates on development process [12]Build social networks of team members with other teammates [8]Teams with diverse backgrounds [9]Knowledge management [10]Team virtue and ethics [11]Effective decision making
R7	Software Team wisdom in my opinion is [11]**effective decision-making during project related factors**. I have 8 years of working experience in GSD. I prefer doing exploratory kind of work on my own. Working in group environment is best for barnstorming and to better handle the	[11]Effective decision making [7]Good

	problems. I am [7]**able to collaborate with many teams at the same time. 0n the [2]basis of task priority** i decide which team and which of its activities are the most important. Active, experiences and skillful teams are most important for software success. [5]**I checked daily progress reports** in order to attain goals, I mange [1]**different kind of teams by setting milestones and dividing work in sequence**. when no one is available I do work on my own. Better [7]**communication is the key for success for remote teams**. I believe having social networks of team members with other [4]**project teams is beneficial for project success**, because it let them talk in friendly environment. I think [6]**boundary spanners are the most important part of any organization**, because they create the bridge between individual and organization. I think GSD teams must have [7]**enough resources and efficient organizational communication mechanisms** for success. Our GSD teams have diverse team members. [8]**I team-up individuals who have different educational background** by giving them tasks on which they are good, so that efficient production can be done. But [8]**diverse capabilities and capacities of team members can reduce project quality if not managed in good way**. It also affects software success because of having conflicts among ideas. Our GSD team members have knowledge about their areas intermediate to expert level. [9]**I analyze their skills according to their interest and results in any task assign to them**. In complex situations and in big [1]**projects leadership should apply absolute principles to a complex and fuzzy reality in their teams**. Team ethics and virtues are must have in GSD teams. [10]**Happy employs are productive, accountable and consistent** that why we always try to improve the productivity of our employs. I don't prefer applying [11]**gut feeling** as they can impact badly if I don't have any information, I would like to use internet resources to understand that. [11]**Team intuition** is best to use in software projects.	communication and collaboration strategies [2]Establish team's visions and missions [5]Updates on development process [1]Team management [12]Build social networks of team members with other teammates [6]Boundary spanners are important aspects [8]Teams with diverse backgrounds [9]Knowledge management [10]Team virtue and ethics
R8	In my opinion software team wisdom is the group of individuals who take the responsibility for developing [11]**the**	[11]Effective decision

	software in order to give a specific outcome to the company. I have 11 years of experience working in GSD. I prefer Learning different latest software tools on my own. While working in the group environment I discuss more about the projects and listen to ideas coming from team members. [2]**To set the priority level of team and team activities** firstly we checked on which software development phase we are. [1]**To get teams focused on their goals**, we established company goals. If the team wants to achieve a bigger goal, then [1]**we break that goal into smaller goals**. [4]**Online meetings as often as daily** are recommended with the GSD team to bring everyone up. [1]**We always have a backup team**. [12]**Social networks** facilitate idea generation and creativity in teams. For [7]**internal communication**, instant chats and face to face meetings are used; and for [7]**external communication**, we preferred emails. [6]**Boundary spanners are also important asset** to the organization for [6]**obtaining valuable information** and interacting with individuals and groups outside the organization which help the innovation process. By [7]**creating collaborative workspace**, we encourage our GSD team members to [12]**build social networks** in order to have better access to organizational resources and knowledge. It is essential for knowing [9]**how to exchange information within groups or individuals**. We have GSD team members [8]**from different departments and units**. To team-up the individuals who have different educational backgrounds we provide diversity trainings. [8]**Team members with diverse backgrounds** will come up with diverse solutions, which lead to a more decision-making process and improved results. [8]**Diverse team members can improve performance** or software success with their diverse set of talents. Our GSD [9]**team members have knowledge in their domain** and we conduct trainings on different skills from time to time. [9]**We deliberate our team members** about what they are best at by motivating them and appreciating their good work.[1]**In crucial project decisions we only involve team leaderships**. First, [3]**every leader should understand about the organizational goals** and focusing on those goals	making [2]Establish team's visions and missions [1]Team management [7]Good communication and collaboration strategies [4]Daily meetings [12]Build social networks of team members with other teammates [6]Boundary spanners are important aspects [9]Knowledge management [8]Teams with diverse backgrounds [3]Establish a Relationship with Stakeholder [10]Team virtue and ethics

	transforms the organization or team. Secondly, [7]**leaders should collaborate and work together with team in order to achieve more**. In any GSD project team's ethics and virtues are important. [10]**Because I think happy employees are more productive, accountable, and consistent**. We make virtuous and tolerant decisions in our team by gathering the facts without jumping to the conclusion. [11]**Gut feeling** plays an important role in decision making, but it can be [11]**dangerously unreliable** in complicated situations. In my opinion [11]**team intuition** is more preferable.	

This study looked over each interview's text and identifies anything that stands out as pertinent or informative. New codes were added while reading through the text, in addition to marking all the words and phrases which really fit these codes. After finalizing codes, a list of codes was generated in order to get the clear representation of initially constructed codes. To extract findings, this study discovered a few initial codes from multiple codes. Then adjustment of multiple initial codes in to single theme was made. Down is the list of initial extracted codes:

- Team management
- Establish team's visions and mission
- Establish relationship with stakeholders
- Daily meetings
- Updates on development process
- Boundary spanners are important aspects
- Good communication and collaboration strategies
- Teams with diverse backgrounds
- Knowledge management
- Build social networks of team members with other teammates
- Leadership avoids micromanaging
- Effective decision making
- Team virtue and ethics

5.2.1 Frequency Analysis of Codes

In this study R1, R2, R3, R4, R5, R6, R7, R8 represent the interview participants in the following table, and the numeric values present the number of time each code was represented in the interview transcripts. Frequency analysis process presents in Table 5.2. At this stage, the frequency of each code was created during the first coding process in Table 5.1. Now this study evaluates and analyse the extreme values in the codes. This is presented in Table 5.3 and Figure 5.1.

Table 5.2: Frequency Analysis of Codes

Codes	R1	R2	R3	R4	R5	R6	R7	R8
Team management	2	1	4	3	1	3	2	3
Establish team's visions and mission	1	1	2	0	1	1	1	1
Boundary spanners are important aspects	2	0	1	0	0	0	0	1
Establish relationship with stakeholders	2	1	1	2	1	1	1	0
Daily meetings	2	1	0	1	1	0	1	1
Good communication & collaboration strategies	2	3	4	2	2	1	2	2
Teams with diverse backgrounds	3	3	4	1	2	2	1	2
Build social networks of team members with other teammates	0	2	1	2	1	1	0	2
Knowledge management	1	1	2	0	1	2	1	1

Team virtue and ethics	1	1	1	1	2	1	1	1
Effective decision making	1	2	1	1	2	1	1	3
Leadership avoid micromanaging	0	0	1	0	0	0	0	0

The Figure 5.1 clearly shows that team management got the extreme value in frequency analysis process; the next outliers are good communication and collaboration strategies and team diversity and so on.

Table 5.3: Extreme values by frequency analysis

Extracted codes	**Frequency**
Team management	19
Establish team's visions and mission	09
Establish relationship with stakeholders	10
Daily meetings	07
Updates on development process	04
Boundary spanners are important aspects	04
Good communication and collaboration strategies	18
Teams with diverse backgrounds	18
Knowledge management	09
Build social networks of team members with other teammates	09
Leadership avoids micromanaging	01
Effective decision making	12
Team virtue and ethics	09

5.2.2 Creating and Naming Themes from Codes

Since this study has come up with a final set of codes, it is time to give each one a name and define it. Below is the naming process for the themes that are simple to understand, meaningful, and relevant.

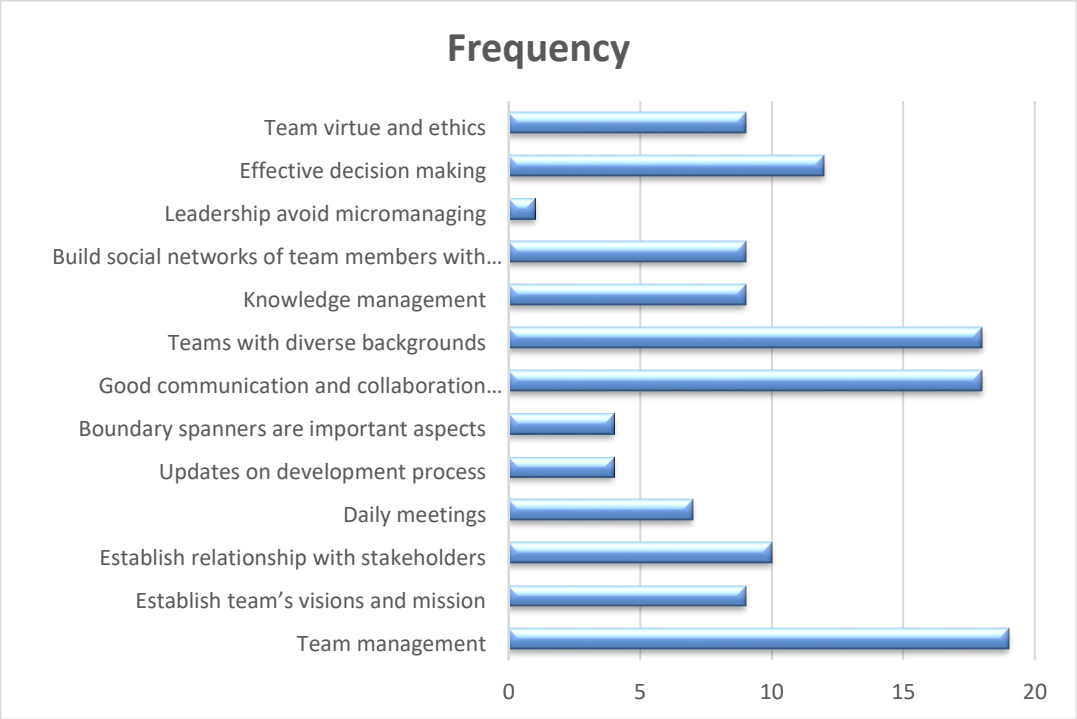

Figure 5.1: Extreme values by frequency analysis

5.3 Impact of Team Wisdom Mechanisms in GSD

Team wisdom in GSD is the process of effectively managing as well as developing good collaboration, communication and coordination strategies among GSD teams. It is also defined as effective decision making while project related factors. This research identifies the impact of applying team wisdom mechanisms which are Team experience, Team networking, Team diversity, Team prudence, Professional Ethics and joint epistemic actions of team members. In Table 5.5 R presents the no of respondent and T presents the number of themes which are related with team wisdom mechanisms. The value of 0 is assign to the most effective team wisdom mechanism in GSD, value of 1 is used for effective, 2 is used

for moderate value, 3 is used for less effective values. The majority of the same values in a single column were considered as the final results.

Table 5.4: Creating and Naming Themes

No.	Initial Codes	Themes	T. No
1 **2** **12**	Team management Establish team's visions and mission Effective decision making	Team Experience	M1
6 **4** **5** **3**	Updates on development process Daily meetings Establish relationship with stakeholders Good communication and collaboration strategies	Team Networking	M2
8 **10**	Teams with diverse backgrounds Build social networks of team members with other teammates	Team Diversity	M3
9	Knowledge management	Team Prudence	M4
13 **11**	Team virtue and ethics Leadership avoids micromanaging	Professional Ethics	M5
12	Effective decision making	Joint Epistemic Action	M6

Table 5.5 shows the impact of generated themes on software success. Now, the study explains the identified themes from the codes in depth in order to provide a clear picture of how these themes, which are team wisdom mechanisms, affect software success in distributed software development.

Table 5.5: Impact of Generated Themes on Software Success

Respondent	M1	M2	M3	M4	M5	M6
R1	0	0	2	3	3	1
R2	0	1	1	2	1	1
R3	1	0	2	2	3	3
R4	0	0	1	2	1	2
R5	0	1	1	3	3	2
R6	1	0	2	2	2	2
R7	0	0	0	2	3	2
R8	0	0	1	1	2	1
Results	**Most Effective**	**Most Effective**	**Effective**	**Moderate**	**Less Effective**	**Effective**

5.3.1 Team Experience

In any organization, the most important asset is the people who worked really hard for any development process. The same can be said for global software development teams. Team experience in team wisdom context defined by the respondents the responsibility of effectively managing Software teams, establishing goals and objectives of software teams and making effective decision at right time. Individual talent and team performance are both important factor of team wisdom for project success in GSD. Software teams with high levels of engagement and motivation are more likely to achieve their goals and perform well. That is why Team wisdom mechanisms which are team experience is the important factor in development project of GSD teams. It also got the highest impact on software success defined by the industrials. The large bulk of industry experts agree that this team wisdom mechanism has a beneficial impact on software success. They also stated that the fundamental pillar for software success is active, experienced, and skillful teams. Few others have also stated that teams who are more focused on their goals are more productive, accountable and consistent. Establishing team vision and missions in GSD teams declared as

the important aspect by industrial experts in the term of success in distributed development of software projects. They stated that it is critical to ensure that all team members in GSD understand exactly what goal they are pursuing and why it is vital to both the distributed software firms and the team. Because when people understand the importance of a common objective and their role in it, they are more willing to work toward it.

5.3.2 Team Networking

The success of GSD projects is determined by a variety of factors. The factors which are involved in team networking are considered to be the next most important factors by industrial experts in the development process of GSD teams. Since majority of the respondent define team wisdom as the process of effective collaboration, communication and coordination among team members of GSD teams. So, these Factors jointly stated as team networking in GSD context. Team networking includes good collaboration and communication, daily meetings, boundary snappers; updates on development process and build social networks with stakeholders. Talented developers are undoubtedly one of the most important factors of software success in GSD. However, even if GSD organizations have a wonderful team, if they do not collaborate effectively, they will not get the outcomes they want. The majority of participants agreed that effective communication and collaboration tactics aid in the successful development of GSD projects. They stated that collaboration is crucial to the project success. A team seems to be similar to a clock, with every team member acting as a gear. Each gear must do its job in order for the clock to work. GSD teams also come under this concept.

Since, there is a tremendous amount of data flow when designing software. Therefore, efficient and consistent team communication is essential in GSD teams. Time, cost, and energy are all can be saved through effective communication. Constant communications with stakeholders on a regular basis help not only to include all stakeholders in the GSD project but also to keep them informed, keep track of the progress, make effective decisions and ensures that everyone works on the same page. The experts also said that it is important to keep an ear to the floor all through the GSD project to ensure that all parties involved are on the same page and fully understand the requirements. And

collaboration is the key for the achievement of this goal, because the chances of development process of GSD teams success are substantially higher when they communicate in shorthand. the importance of these factors on global software development of software projects defined by the following points:

Because GSD employees address problems jointly, team collaboration speeds up software development process and enables teams to deliver software to the market quicker.

Innovative thinking and efficient brainstorming are aided by team collaboration, because it enables teams to examine challenges from a variety of perspectives.

Collaborative GSD teams arrange online meetings on a frequent basis to ensure that everyone understands where they are going. When team members skip meetings in distributed development of software projects, the GSD teams are unable to discuss critical topics and slow down the process of making choices. As a result, the development process of GSD projects takes longer and the GSD teams missed deadlines.

Every person engaged is aware of the projects entire scope and their responsibilities. This helps each member of the team to work more efficiently, saving time, money, and effort. When GSD team members unable to convey their understanding of the software solution's aims and objectives, they may cause the risk of developing wrong products.

5.3.3 Team Diversity

Few respondents declare team wisdom as the way managing diverse capabilities and capacities of team members. The also declared that the diverse capabilities and capacities of the global software developers affect software success positively and it can become more beneficial by developing the social networks of team members with other teams. Having a diverse GSD team for GSD projects, with people of all nations, genders, and ages, as well as varying levels of skill, allows teams to come up with fresh ideas and approach problems from different angles. Which affects GSD projects success positively.

5.3.4 Team Prudence

Software team wisdom also defined as knowledge sharing between team members by industrial experts. GSD teams knowledge sharing and management fall under the category of team prudence. One of the most crucial factors in GSD teams is team prudence. It helps management in allocating work among team members based on their knowledge and expertise. The successful development of GSD projects is dependent on efficient work allocation between team members. The other factor is sharing knowledge about projects between teams.

When a team fails to interact with one another, a hostile work environment develops. It may also have a negative impact on beginners to the GSD project. This study analyzes from the interviews that most of the team members in GSD projects do not share their knowledge with beginners. In result, newcomers will struggle to incorporate into the development process and will be unable to provide valuable input in a timely manner. This may cause development to be delayed, and the GSD project may not be completed on time.

5.3.5 Professional Ethics

Professional ethics of the team members in distributed development of software projects plays a vital part in development process. Professionals are proficient of using their knowledge and making decisions in their field. The individual and organizational principles that regulate behavior within the context of a specific field are referred to as professional ethics. Virtues and ethics of team members are important in any development project. GSD experts declared that happy employees are more productive. The main ethical issue identified by the experts in global software development teams, are honesty of the team members, transparency, loyalty of the team mates, confidentiality and respect of the distributed development teams. If these issues are not addressed properly, they can lead to plenty of problems for GSD projects, including software failure. In the GSD organizations, a dishonest team can do a huge amount of damage to the project by following ways:

- If GDS team members are not honest with their organization and lack professional ethics, they will adopt informal methods to achieve their goals and make informal strategies to do so. Corruption can sometimes result from dishonesty. These informal managerial methods cause software failure. Because successful leadership is based on transparency, employees will have more trust in the leadership if they are open about all of their actions.
- Confidentiality refers to the rules, commitments, and limitations that limit information access to a single person or locale. A global software project leader as well as their senior teammates must be the trustworthy individuals because they have access to a great deal of information regarding active projects, their timelines, and budgets, as well as organizational weaknesses and strengths.
- Respect is a sense of admiration for someone or something because of their qualities, accomplishments, and talents. The leadership and senior team serve as a gateway between employees and customers; they must appreciate their workers in order to attain excellent performance. However, the leadership at some GSD organizations does not care about respect of their employees. They just set deadlines and expect things to be completed by that time. They do not understand that appreciating someone can help them to get even more work done.

5.3.6 Joint Epistemic Actions

Joint epistemic actions of GSD team members play a crucial role in decision making of GSD projects. Effective decision-making aids in the timely and successful execution of software projects. The majority of respondents stated that relying on gut feeling when making decisions will have a negative impact on project development. The majority of GSD professionals agreed that using team reasoning when making critical decisions about GSD projects will be beneficial for global software success.

Global software development is the process of developing software around the world where vendors and clients are away from each other. Because of the diversity of the team members, they face a lot of issues which further led to software failure. This analysis will help the leadership as well as team members to effectively perform the development of GSD projects.

5.4 Member Checking on Interview Results

In this study member checking is used to analyze the interview results for validation and credibility of the findings. This summary of the findings in tabular form was sent to the few of interview respondents, in order to check accuracy of the findings. If the majority of the respondents in the Table 5.6 provided the same value as the interview result, the results will be accepted. If the majority of respondents provide different values than the interview results, that one will be eliminated.

5.4.1 Member Checking Results

Most of the values of team wisdom mechanisms in GSD context got accepted by member checking. Since five mechanisms of team wisdom which are team experience, team diversity, team networking, team prudence and joint epistemic actions of team members got accepted by the respondent validation process. Only one value which is professional ethics is defined as moderate value by respondent validation. Table 5.6 shows member checking process.

Table 5.6: Member Checking Process of Interview results

Team wisdom (M)	**R1**	**R2**	**R3**	**R4**	**R5**	**Validation**
Team Experience	Highly effective	Highly effective	Highly effective	Highly effective	Highly effective	Accept
Team Networking	Highly effective	Highly effective	Effective	Highly effective	Highly effective	Accept
Team Diversity	Effective	Highly effective	Moderate	Effective	Effective	Accept
Team Prudence	Moderate	Effective	Moderate	Effective	Moderate	Accept
Professional Ethics	Moderate	Moderate	Less Effective	Moderate	Moderate	Reject
Joint Epistemic actions	Highly effective	Moderate	Effective	Highly effective	Effective	Accept

5.5 Summary

This chapter discussed and applied the thematic analysis method in detail which is used to analyse interview transcripts of GSD experts in order to identify the impact of team wisdom mechanisms on software success in GSD. Firstly, the study analyzed the interview transcripts of 8 GSD experts then the five steps of thematic analysis have been applied one by one. The formalization with data was done, and the code has been generated from interview transcripts then from theses code's themes were generated. This study also identified the frequency of initially generated codes. The naming process of themes were performed, at the end the final report about how these themes which are related to team wisdom mechanisms effects software success in detail has been defined. The respondent validation process also applssied to check the accuracy and validity of the data.

CHAPTER 6

CONCLUSION AND FUTURE WORK

6.1 Overview

This chapter wraps up the research work conducted for measuring the impact of team wisdom on successful completion of software projects in global software development. First section described the conclusion of the research topic. Then shows research contribution for this study and then recommendations made for future studies are presented.

6.2 Conclusion

GSD is the process of developing software projects around the world where vendors and clients are away from each other. Due to emerging trends of software development many organizations started adopting GSD in order to develop software products. Since different team members from different location took part in development process so the effective collaboration, coordination and communication among them are mandatory. Due to the diversity of team members, there is also a need to effectively understand and utilize the diverse capabilities and capacities of software developers. Team wisdom works best in this way; team wisdom is used for effective decision-making during project related factors. The whole thesis was based on two research questions.

RQ1: What are the mechanisms of team wisdom in global software development context?

The systematic literature review was done in order to identify team wisdom mechanisms. This study reviewed 31 out of 564 papers from literature. On the basis of the

results extracted from Literature team wisdom mechanisms identified which are team experience, team networking, team diversity, team prudence, professional ethics and joint epistemic actions.

RQ2: How does these team wisdom mechanisms effect successful completions of software projects in global software development?

This study used interview process to find the impact of team wisdom mechanisms on software success. The 8 GSD experts who have 7 to 10 years of working experience in GSD were interviewed in order to extract data. Then thematic analysis approach was performed on interview transcript to identify the impact on software success. For the validation process of RQ2 member checking which also known as respondent validation is was used.

6.3 Research Contribution

Research contributions are listed below. This research benefits society in a variety of ways.

- This study supports industrial people to effectively perform decision making process for software projects in globally developed softwares.
- This study contributes to effectively understand the professional ethics of team members in distributed software development.
- This study helps to boost team performance in GSD by applying team wisdom mechanisms.
- This study could be helpful for researchers to understand the concept of team wisdom in GSD context in the future research.

6.4 Limitations

- In this study the validation of SLR results can challenged because this study only used SLR protocols to identify team wisdom mechanisms in the context of GSD.
- The validation process for results of interviews could be challenged as they only involve same respondents from interviews.

6.5 Future Work

Team wisdom is a comparatively modern concept in global software development. This study concludes that team wisdom mechanisms helpful in successful completion of software projects in global software development. However, the way these mechanisms interrelate is limited. This study recommended to identify the interconnection of team wisdom mechanisms interrelate in the context of global software development.

This study also suggests the use of machine learning algorithms with team wisdom for better task allocation of team members in global software development.

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APPENDIX

QUESTION GUIDE

Title: Impact of Team Wisdom on successful completion of software projects in global software development.
Date:
Time:
Interviewer: Tahira Younas

Interviewee:

Research Introduction: Wisdom refers to how people make right use of their knowledge through their practical actions, judgments, and ethical decisions. Software development project team wisdom is a process for how team members best use the stock and flow of their knowledge through collective judgment, virtue-ethics, emotions/feelings, and effective decision-making during their project-related efforts.

Organization: National University of Modern Languages, Islamabad

Researcher: I am Tahira Younas student of department of engineering and computer science, NUML. Conducting my MS research on the impact of Team Wisdom in GSD.

QUESTIONS:

Team wisdom:

1) Software development project team wisdom is a process for how team members best use the stock and flow of their knowledge through collective judgment, virtue-ethics, emotions/feelings, and effective decision-making during their project-related efforts. What is Software Team wisdom in your opinion?
2) Here are some team wisdom mechanisms identified by literature, rank them according to their impact on project performance.

− 1 is most important

− 6 is least important

- ☐ Team experience
- ☐ Team networking
- ☐ Team diversity
- ☐ Team prudence (Knowledge)
- ☐ Professional ethics

- ☐ Joint epistemic actions of team members (team reasoning, team intuition, team esthetic capacity)

Team experience:

3) How much experience do they have working in GSD?
4) What kind of work do you perform best on your own?
5) When do you prefer working in a group environment?
6) Are you able to collaborate with many teams at the same time?
7) How do you decide which team and which of its activities are the most important?
8) What strategies do you employ in team management to attain goals?
9) How do you manage one-time goal team or a team with frequent, varied, and recurrent goals?

Team networking:

10) How often do you think it is necessary to meet with the rest of the team to bring everyone up?
11) How do you tackle problems when the rest of your team is unavailable?
12) Is there any more communication required to participate to a remote team?
13) How do you believe having social networks of team members with other project teams is beneficial?
14) How far do your team members go in terms of establishing communication mechanisms across internal and external networks?
15) How much emphasis do you place on the importance of boundary spanners?
16) How do you encourage your GSD team members to build social networks in order to have better access to organizational resources and knowledge?
17) What do you think how essential it is for GSD teams to have enough resources and efficient organizational communication mechanisms?

Team diversity:

18) Do your GSD teams include members from different departments and units?
19) How do you team-up the individuals who have different educational backgrounds?
20) In your team, how diverse capabilities and capacities of GSD team members effects project related decisions?
21) How do you think the diverse skills of team members effect software success?

Team prudence:

22) To what extent do your GSD team members have knowledge about their areas?
23) What do you do to make your team members to deliberate about what they are best at?
24) Do you involve your team members while making any crucial project decisions?
25) Could you please explain when and how leadership should apply absolute principles to a complex and fuzzy reality in their teams?

Professional ethics:

26) Do you think in any GSD project team's ethics and virtues are important?
27) Do you believe that happy employees are more productive, accountable, and consistent?

28) Do you think your team members are concerned about others and learn from their mistakes?
29) What do you do to make virtuous and tolerant decisions in your team?

Joint-epistemic actions:

30) What impact can gut feeling impose on project performance while you don't have enough information?
31) Do you believe your team members have aesthetic capacity when it comes to project related factors?
32) In your opinion, which is more preferable to use for software projects: team reasoning or team intuition?

Thank you so much for giving your valuable time!