Empirical Investigation of Human and Social Factors Influencing the Productivity of Software Development Teams in Pakistan

By

Fatimah Ali

(Registration No: 00000329654)

A thesis submitted to the National University of Sciences and Technology, Islamabad,

in partial fulfillment of the requirements for the degree of

Master of Science in

Software Engineering

Supervisor: Dr. Wasi Haider Butt

Department of Computer and Software Engineering

College of Electrical and Mechanical Engineering

National University of Sciences & Technology (NUST)

Islamabad, Pakistan

(2024)

Annex A

THESIS ACCEPTANCE CERTIFICATE

Certified that final copy of MS/MPhil thesis written by NS **Fatimah Ali** Registration No. 00000329654, of College of E&ME has been vetted by undersigned, found complete in all respects as per NUST Statutes/Regulations, is free of plagiarism, errors and mistakes and is accepted as partial fulfillment for award of MS/MPhil degree. It is further certified that necessary amendments as pointed out by GEC members of the scholar have also been incorporated in the thesis.

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DEPARTMENT OF COMPUTER AND SOFTWARE ENGINEERING
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To my parents, whose endless support and prayers have guided me, and to my husband, whose unwavering encouragement has been my strength. This achievement is a tribute to their constant support and love.

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Abstract

Software development stands as the most important pillar of the IT industry, having a significant influence on the progress and betterment of our daily lives. In this context, the productivity of software development teams emerges as a linchpin in the software industry's advancement. This research aims to study the impact of various factors on the productivity of software development teams, with a focus on the Pakistani software development industry. Employing a survey-based methodology, we draw upon a framework adapted from Kitchenham et al., encompassing six critical steps: defining objectives, survey design, instrument construction, evaluating instrument validity and reliability, administering the instrument, and analyzing results.

Our Framework includes critical factors under study including communication, commitment, motivation, job satisfaction, emotional intelligence, collaboration, cohesion, leadership, and autonomy among others. From studying the importance of these factors and analyzing of results, our research aims to furnish insightful recommendations and practical strategies to enhance the performance of development teams within the Pakistani context. Our overarching objective is to contribute meaningful insights that can be effectively applied to enhance the outcomes of software development projects in Pakistan.

Keywords:

Productivity of Software Developoment, Social and Human Factors (SHFs), Leadership, Communication, Collaboration, Motivation, Experience, Project Management, Autonomy, Emotional, Intelligence, Commitment, Empathy

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CHAPTER 1: INTRODUCTION

Software development is a complex process that can be defined as a set of activities from computer science involving creating, designing, deploying, and supporting the software (IBM, 2024). Software Applications have revolutionized every aspect of life by making repetitive and complex tasks easier, faster, and convenient for individuals. In modern times, software applications serve as basis for all the technological advancements, economic growths, innovations and generally the progress and society. Development of these software applications facilitates the creation of digital solutions for streamlining the complex and repetitive tasks, enables better and faster modes of communication, helps the economies grow rapidly and enhances the productivity across the diverse range of sectors (Kazman & Pasquale, 2020).

The complex and time intensive nature of most of software development projects necessitate the utilization of team-based work as standard approach (He, et al., 2014). The productivity of software development projects largely depends on the productivity of software development teams which is impacted largely by teams social and human factors along with technical knowledge and management skills (Cooke, et al., 2010), (Kosa & Yilmaz, 2015), (Matturro, et al., 2019). The scope of this research is to study the impact of Social and Human factors on productivity of software development teams in Pakistan. Introduction to Software development industry in Pakistan, Productivity in Software Development and Social and Human Factors is given in Background Knowledge Section.

1.1 Background Knowledge

1.1.1 Software Development Industry in Pakistan

Software Development Industry in Pakistan is experiencing rapid growth making significant and valuable contributions towards economic growth of the country. Forecasts from Statista show that Revenue in the software development market will reach USD 1.03 Billion in 2024 (Statista Inc., 2024). With a projected annual growth of 18.4% it is expected to cross 2 billion USD by 2028. Major contributor to this rapid

growth of IT industry in Pakistan is skilled professionals available at very low rate, resulting in reduction in costs of software development and increase in revenue.

A major share of Country's Software development volume is driven by projects from the international market. Pakistan provides an ideal source for offshore IT outsourcing services. This is supported by world-class IT graduates. However there have been some challenges limiting the growth of the IT sector in the country. These challenges include absence of a comprehensive digital strategy, lack of payment service providers, conversion of incubators, lack of enforcement of intellectual property protection, lack of management and organization structure in small software development houses in the country (Masood, 2022).

1.1.2 Productivity in Software Development

It is difficult to define and measure productivity especially for the non-routine and knowledge-based creative tasks such as Software Development. In the area of software development researchers and practitioners find it challenging to define productivity in the software development industry. Due to ever changing and evolving requirements, almost all the successful software systems need to be updated, this is known as software evolution. In any software development project, new development or evolution, it is very important to minimize the cost of development and maximize the benefits achieved from the software system. The ratio of output to input can be referred as productivity in software development project, given that calculating outputs is a complex task (Wagner & Deissenboeck, 2019). However, productivity is not only limited to financial aspects, but it also includes the time taken for development or updating and satisfaction of the people involved.

Caitlin introduced a framework for defining and measuring productivity in software development, based on three dimensions. These three dimensions are Velocity, Quality and Satisfaction. Velocity measures the duration of a software development project or how fast the project has been completed. Quality refers to the achievement of desired functionality of software as per requirements. Satisfaction defines the satisfaction of customer and development team with the project itself (Sadowski, et al., 2019). Satisfaction includes mostly social and human factors of productivity while Quality and Velocity are majorly dependent on technical factors.

1.1.3 Factors having Influence on the Productivity of Software Development

Since the 1970s, researchers have studied the productivity of software development and factors influencing it. These factors can be classified into 2 broad categories, technical factors, and soft factors. Both these categories are further divided into several categories. Researchers have adopted various approaches for their classification. Wagner and Murphy-Hill combined such categories and compiled a checklist for these factors, (Wagner & Murphy-Hill, 2019). In our study, we are not limiting to the factors of this checklist, other studies are also considered and finally 13 factors are selected. The details are discussed in the literature review section.

Table 1.1: List of Factors Influencing Productivity in Software Development.

Category	Sub-Category	Factors
Technical Factors	Product Factors	Developed for Reusability, Development Flexibility, Execution Time Constraints, Main Storage Constraint, Precedents, Product Complexity, Product Quality, Required Software Reliability, Software Size, User Interface, Technical Dependencies
	Process Factors	Agile, Architecture Risk Resolution, Completeness of Design, Early Prototyping, Hardware Concurrent Development, Outsourcing and Global Distribution, Platform Volatility, Process Maturity, Project Duration, Project Type
	Development Environment	Documentation match to Life-cycle Needs, Domain, Programming

		Language, Use of Software Tools, Use of Modern Development Practices
Soft Factors	Corporate Culture	Credibility, Fairness, Respect
	Team Culture	Camaraderie, Clear Goals, Communication, Psychological Safety, Sense of Superiority, Support for Innovation, Team Cohesion, Team Identity, Turnover
	Individual Skills	Analyst Capability, Application Domain Experience, Developer Personality, Developer Happiness, Manager Capability, Platform Experience, Programmer Capability
	Work Environment	E-factor, Layout and Design of office space, Ease of work in the office environment, Time management and Distribution of load, Communication facilities.
	Project	Average Team Size, Requirements Stability, Schedule

1.1.4 Social and Human Factors

Social and Human Factors (SHF) refer to the attributes of an individual that distinguish them based on their behavior, considering both their social interactions and personal characteristics (Oliveira, 2017). Software development is a human activity and therefore Social and Human Factors are of critical importance in software development.

Thus, studying these factors can drastically impact the efficiency and productivity of software development (Boehm, 1984), (Wagner, 2019). In related literature, researchers have identified different categories of such factors, which are discussed in Chapter 2: Systematic Literature Review. In this study we present a framework consisting of 13 Social and Human factors with their impact on productivity of software development teams. These 13 Social and Human Factors are Communication, Commitment, Motivation, Job Satisfaction, Emotional Intelligence, Collaboration, Team Cohesion, Autonomy, Empathy, Leadership, Innovation, Expertise in software development, expertise in project management.

Communication: The exchange of information, ideas, and feedback among team members to facilitate effective collaboration and coordination in the development process.

Commitment: The dedication and willingness of team members to contribute their time, effort, and expertise towards achieving project goals and objectives, without leaving the team during a project.

Motivation: The drive and enthusiasm that inspires individuals to actively engage in their work, pursue excellence, and overcome challenges in the pursuit of project success.

Work Satisfaction: The level of fulfillment and positive feelings experienced by team members in relation to their roles, responsibilities, and contributions to the project.

Emotional Intelligence: The ability of team members to perceive, understand, and manage emotions effectively, both within themselves and in their interactions with others.

Collaboration: The process of working cooperatively to achieve common goals and objectives, often involving sharing knowledge, skills, and resources.

Team Cohesion: The degree of unity, mutual trust, and shared commitment among team members.

Empathy & Interpersonal Relationships: The ability of team members to understand and relate to each other's perspectives, feelings, and experiences.

Leadership: the process of guiding, inspiring, and empowering team members to achieve common objectives.

Innovation: The process of generating and implementing new ideas, solutions, and approaches to address challenges, improve processes, and create value.

Autonomy: The degree of independence and empowerment granted to the members of team so that they can manage work independently and set goals for optimized performance.

Capabilities and Experience in Software Development Process: The proficiency, skills, and knowledge possessed by team members in various aspects of the software development process.

Capabilities and Experience in Software Development Project Management: the proficiency, skills, and knowledge of team members in overseeing and coordinating software development projects, encompassing areas such as planning, scheduling, budgeting, risk management, stakeholder communication, and team leadership.

1.2 Motivation

Keeping in view the current economic situation of the country, the software industry has the potential to make the most important contributions to the economic growth of the country. As shown in the figure 1.1, Pakistan's software industry is rapidly growing an expected to achieve the revenue of 2 billion USD by year 2028 with average annual growth of 18.4% (Statista Inc., 2024). Today is the age of technology and software development. By improving the productivity of our software industry, we can stand competitive in the rapidly advancing world of technology. Therefore, the improvement of software development teams' performance and productivity is directly relevant to the most important national need of the country.

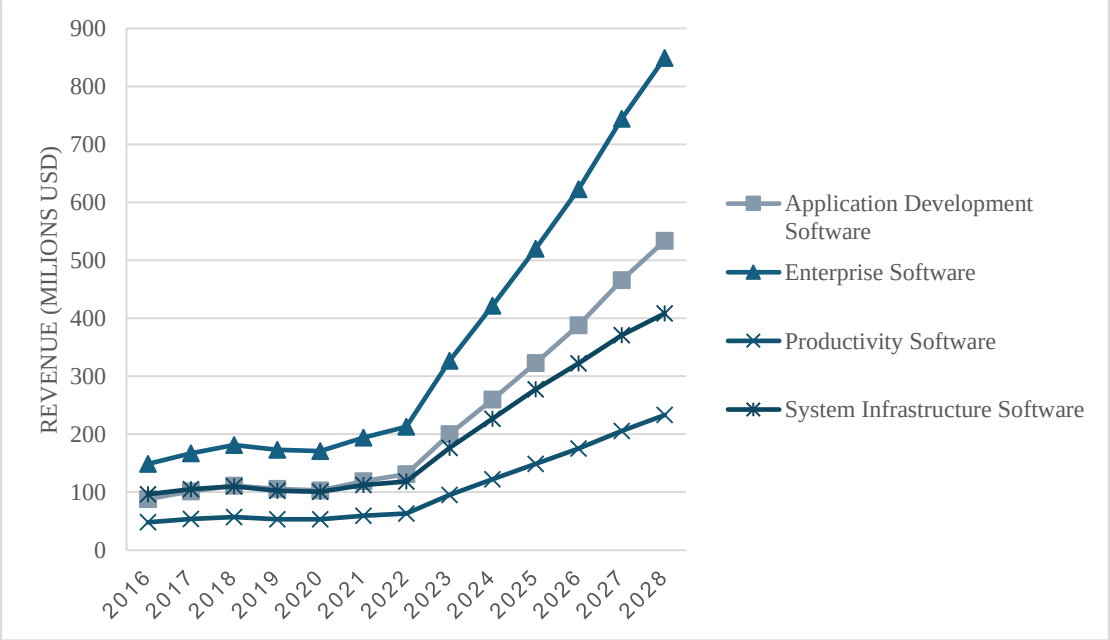


Figure 1.1: Projected Growth of Pakistan's Software Development Industry

Today is the age of technology and software development. By improving the productivity of our software industry, we can stand competitive in the rapidly advancing world of technology.

By recommending practical strategies for improving the productivity of development teams based on analysis of results, this study can help in improving human resources development and strategic policy formulations.

1.3 Objectives

This study aims to have productive impact on areas of Software development industry practices, corporate training programs, human resources management, organizational leadership, policy formulation, cross cultural collaboration, project management, academic research, professional development programs and quality assurance and testing. Below are the main objectives of this research.

- Study the importance of social and human factors in the performance of software development teams.

- Analysis of current considerations of these factors by software developing teams and their challenges.
- Recommend practical strategies for improving the software development teams' performance by considering the social and human factors.

1.4 Thesis Structure

This thesis is structured as per NUST's guidelines. Chapter 1 presents an introduction to the topic with objectives and background knowledge. Chapter 2 contains the systematics literature review for identifying the most important factors to affect the productivity of software development teams. Chapter 3 presents the methodology used for this research. Chapter 4 discusses the designed framework while chapter 5 presents the analysis of collected data from survey and discussion on framework considering collected data. Finally, chapter 6 presents the conclusion of the study with practical implications and future recommendations, along with limits and threats to validity of this study.

CHAPTER 2: SYSTEMATIC LITERATURE REVIEW

A systematic review is a structured approach for assessing and analysing all existing research related to a specific research question, topic, or phenomenon. The goal of systematic reviews is to provide an objective and thorough evaluation by employing a reliable, methodical, and transparent process. (Kitchenham, 2004). The methodology for systematic literature used in this study was proposed by Kitchenham in 2004 and is currently one of most widely used methods for performing systematic literature review especially in the field of software engineering and computer science. According to this method, below are important steps for carrying out the systematic literature review.

1. Planning the SLR
2. Conducting the SLR
3. Reporting the review
4. Results and Discussion for SLR

2.1 Planning the SLR

The first phase of systematic Literature Review is Planning the Systematic Literature Review. This phase consists of 4 steps.

1. Research Questions Formulation
2. Data Sources and Search Strings
3. Inclusion Criteria
4. Exclusion Criteria

2.1.1 Research Questions

Keeping in view the objectives of our study proposed in the first chapter, we formulate the research questions for our systematic Literature Review.

RQ: What are the key Social and Human Factors that influence the productivity of software development teams?

The main objective of our study is to investigate the most impactful human and social factors for improving the productivity of software development teams. Therefore, we

conduct a systematic literature review to understand the most impactful factor that influences productivity of software development teams. In later stage of our study, we will see the effect of these factors in productivity of software development teams in Pakistan.

2.1.2 Data Sources and Search String

Appropriate and highly related electronic data repositories have been identified. The mentioned repositories are related enough that the research objective may be fulfilled. The electronic data repository is enlisted in Table 2.1.

Table 2.1: Data Sources for Systematic Literature Review

Electronic Data Repositories	**Access Link**
ACM Digital Library	https://dl.acm.org/
IEEE Digital Library	https://ieeexplore.ieee.org/
Springer	https://link.springer.com/
Science Direct	https://www.sciencedirect.com/
Wiley Inter Science	https://onlinelibrary.wiley.com/

With the help of our main objective and research question, search strings were formulated. Some keywords along with their alternatives were used for formulating the search strings. Final search strings have been developed using logical AND, OR operators as shown in Table 2.2.

Table 2.2: Search Strings for SLR

Keywords ID	Alternatives Keywords
K1	(“Impact of” OR “Effect of” OR “Influence of”)
K2	(“Social factors” OR “Human Factors” OR “Social and Human Factors” OR “Soft Factors” OR “People Factors”)
K3	(“Commitment” OR “Communication” OR “Motivation” OR “Team Cohesion” OR “Work Satisfaction” OR “Leadership” OR “Technical Experience” OR “Project Management Experience” OR “Autonomy” OR “Innovation” OR “Empathy and Interpersonal Relationships” OR “Collaboration” OR “Emotional Intelligence”)
K4	(“on Productivity of Software Development Teams” OR “on Software Development Teams”)

The final search strings were formed as following combination.

(K1) AND (K2) OR (K3) AND K4.

2.1.3 Inclusion Criteria

The inclusion criteria have been established to ensure that only relevant literature is included in the systematic review. The criteria are outlined below.

- Paper to be included should be published as journal, conference, workshop, or a book chapter.
- The paper should discuss either productivity of software development teams or factors affecting it.

- Papers that have been published after 2000. It is important to note that initially criteria were set to 2009 (for ensuring the studies from last 15 years only). But due to lack of literature on some important factors during this period, duration was increased to 2000. However, most of the papers are selected from 2009 onwards.
- Studies that have been published in English language.

2.1.4 Exclusion Criteria

Below are the criteria for exclusion of studies.

- Papers that are pre-prints or not peer reviewed.
- Papers that are not contributing to current study objectives.
- Papers that do not discuss productivity or factors of productivity of software development.
- If duplication of any study is found the most current and complete published version will be used and the rest will be discarded.
- Any papers published in languages other than English are excluded from the literature review.

2.2 Conducting the Review

The articles were searched using search strings and inclusion and exclusion criteria. 211 studies were selected initially. Then using the inclusion and exclusion criteria, only relevant studies were selected for the systematic literature review. As discussed in the inclusion criteria, “Team Cohesion” and “Empathy and Interpersonal Relationships” are two criteria which were considered very important factors affecting the productivity of software development teams. But due to lack of literature after 2009, some papers for these factors were included from 2000s. Figure shows the year wise distribution of selected studies, depicting that most of selected papers are as per original criteria of 2009. The final number of selected papers is 52. Out of these 52, 49 studies are within original criteria making it 95% within the original criteria. Only 3 studies (5%) are from extended criteria.

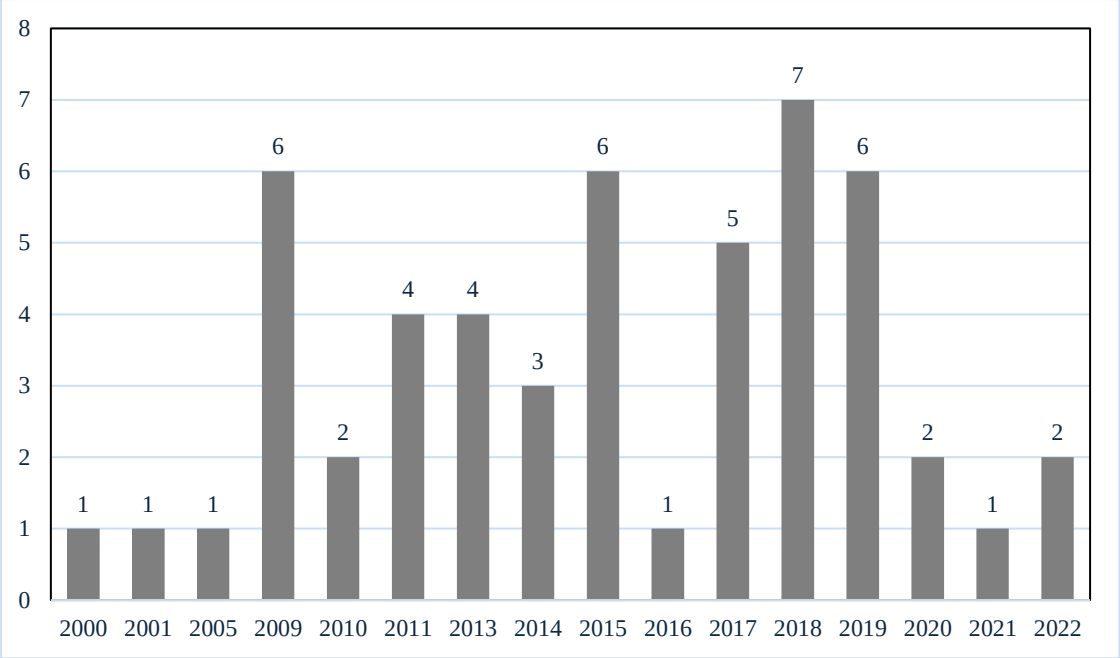


Figure 2.1: Yearly Distribution of Selected Literature

2.3 Reporting the Review

The selected studies consist of factors affecting the productivity of Software development teams. Some of these factors have more impact than others, this is discussed in detail in the coming section of Result for Systematic Literature Review. Researchers have focused on some of the factors more as compared to the other factors. For example, Communication, Motivation and Leadership are the factors which are researched very commonly. Table shows a summary of the selected factors and relevant studies exploring these factors. The importance of these factors in productivity of software development teams can be judged by the number of studies available and how frequently researchers have focused on these factors.

Table 2.3: Reviewed Literature against each Factor

Factor ID	**Productivity Factors**	**Explored Studies**
PF1	Communication	(Lima, et al., 2015) (Wagner & Ruhe, 2018) (Wagner, 2019) (Wagner & Murphy-Hill, 2019) (Wagner & Deissenboeck, 2019) (Yilmaz, et al., 2015)
PF2	Commitment	(Wagner & Ruhe, 2018) (Wagner & Murphy-Hill, 2019) (Pai, et al., 2015) (Melo, et al., 2013)
PF3	Motivation	(Yilmaz, et al., 2015) (Sampaio, et al., 2010) (Sharp, et al., 2009) (Hantos & Gisbert, 2000)
PF4	Work Satisfaction	(Graziotin, et al., 2018) (Murphy-Hill, et al., 2021)
PF5	Emotional Intelligence	(Girardi, et al., 2022) (Graziotin, et al., 2015) (Gunsel & Acikgoz, 2013) (Rezvani & Khosravi, 2019) (Kosti, et al., 2014)
PF6	Collaboration	(Kang, et al., 2011) (Muric, et al., 2019)
PF7	Team Cohesion	(Estabrooks, 2001) (Kakar, 2018)

PF8	Empathy and Interpersonal Relationships	(Elizalde & Bayona, 2018) (Gunbayi, 2009)
PF9	Leadership	(Peltokorpi & Hasu, 2014) (Akman, et al., 2011) (Modi & Strode, 2020) (Gracia & Russo, 2019) (Augustine, et al., 2005) (Melo, et al., 2013) (Moe, et al., 2009) (Ringstad, et al., 2011) (Strode, 2015) (Srivastava & Jain, 2017) (Yang, et al., 2009) (Van Kelle, et al., 2015) (Riaz, et al., 2018) (Dubinsky & Hazzan, 2010) (Hoda, et al., 2013) (Holtzhausen & de Klerk, 2018) (Gren, et al., 2017)
PF10	Innovation	(Edison, et al., 2013) (Shahzad, et al., 2017)
PF11	Autonomy	(Noll, et al., 2017) (Johannsen & Zak, 2020) (Chaves, et al., 2022) (Cruzes & Dyba, 2011)
PF12	Technical Experience	(Sampaio, et al., 2010) (Melo, et al., 2013) (Trendowicz & Munch, 2009) (Raza & Faria, 2014) (Kropp & Meier, 2016)
PF13	Project Management Experience	(McAvoy & Butler, 2009) (Fatema & Sakib, 2017) (Fatema & Sakib, 2018)

2.4 Discussion for SLR

RQ: What are the most important factors to affect productivity of software development teams?

As discussed in the introduction part, factors affecting the productivity of software development teams can be categorized into 2 broad categories. Technical and soft factors. The scope of this study is limited to social and human factors which are only within the category of soft factors. Therefore, we're only exploring literature having discussions on these topics. Below are the most found factors as discussed in the reviewed literature.

1- Communication: Researchers have discussed the impact of communication or ease of communication is considerably high. The easier and effective the communication within the team and with customers will be, more productive and high-quality software development is expected (Lima, et al., 2015). It is considered that having very minimal and only important communication is good for productivity. However, Stefan and Melanie conclude that with increase in number or stack holders and team members, there is increased need of improvement in communication for having positive impact on the productivity (Wagner & Ruhe, 2018). Murat et al discuss the empirical evidence for positive impact of communication on productivity. They conclude that verbal communication is more impactful and has greater significance as compared to non-verbal communication. They proposed this difference exist because meanings of non-verbal communication are not standard globally (Yilmaz, et al., 2015).

2- Commitment: Employees who stay committed to their teams during the project impact positively on the productivity of the team. The turnover of the team is the opposite of commitment. More the employees leaving a team during the project, lower will be the productivity of the team (Wagner & Ruhe, 2018), (Pai, et al., 2015). When a team member leaves the team or the company, it is not only the productivity that is reduced, rather knowledge of team about project is also negatively impacted, thus further reducing the team effectiveness (Melo, et al., 2013).

3- Motivation: Motivation is the most important factor that influences the productivity of software development teams positively (Yilmaz, et al., 2015). Motivation is a very

important and broad term when it comes to productivity of software development teams, it includes parameters such as defining the goals clearly, considering the interest of team members in goals of the software project and provision of required resources for the project (Sampaio, et al., 2010). Involvement of team members at every crucial step such as designing, goal setting, product execution and celebration of success enhances the motivation in teams and hence productivity of the team (Sharp, et al., 2009), (Hantos & Gisbert, 2000).

4- Work Satisfaction: This is a very important human factor. In some cases, it is also referred to as job satisfaction, employee satisfaction or work satisfaction. It shows the workers happiness and contentment with their job. It does not only limit to monetary benefits that software developer is getting from the job of development, rather it also covers the satisfaction of employees for their job timing needs, work-life balance needs, improvement of their knowledge, vertical growth, cognitive and behavioral components. Dissatisfaction from work results in a negative influence on developers resulting in both internal and external consequences. Internal consequences include low motivation, work withdrawal, mental unease or disorder and low cognitive performance. The external consequences include low productivity, low quality of code, the broken flow, negative influence on their team members, consequently further denting the team productivity (Graziotin, et al., 2018), (Murphy-Hill, et al., 2021).

5- Emotional Intelligence: It is well established fact that emotions have significant influence on cognitive skills. Software development being an intensive set of exercises including problem solving, creativity and designing is greatly impacted by low cognitive skills resulted by emotions. Emotional intelligence is the ability of a person to minimize the impact of emotions on the job (Girardi, et al., 2022). Graziotin et al studied the effects of this factor for self-assessed productivity (Graziotin, et al., 2015). The emotional recognition of the software development team members have positive impact for the individual team members and it also effects the teammates, making it the important factor to reduce the time to market and improving the functionality of the software products (Gunsel & Acikgoz, 2013), (Rezvani & Khosravi, 2019). Kosti et al categorized the software developers into two types: one with the more intense personalities and the others. The impact on productivity is due to the nature of the team members having more intense emotional intelligence. Work preferences of team

members are dependent on the personality types and there is a little connection between productivity and self-compassion (Kosti, et al., 2014).

6- Collaboration: Software development is a process that includes several components which are interlinked and dependent on each other. Usually, teams are formed in a way that members are specialists in a particular area of the project. Therefore, to successfully achieve the common goals of the team, it is important to ensure proper collaboration amongst the team members. The performance of the team may be slightly affected by the level of collaboration with other team members (Kang, et al., 2011). The advantages of collaboration have been well established. But the most important advantage is that collaboration in team members also improves the individual performance and productivity in teams (Muric, et al., 2019).

7- Team Cohesion: Team cohesion is the dynamic process that has it effect on the performance and productivity of the group by ensuring the team members stick together in pursuit of common objectives of the team, as well as individual goal and milestones (Estabrooks, 2001). Team Cohesion is a complex factor to influence productivity. Kakar studies the impact of team cohesion on knowledge sharing and productivity of software development projects. This study shows that too low or too high levels of team cohesion have adverse effects on decreasing the productivity of software development projects (Kakar, 2018).

8- Empathy and Interpersonal Relationships: Interpersonal relationships are a very important concept when it comes to the performance of team members. If the interpersonal relationships are not good, it can lead to many other problems such as stress at job, ultimately resulting in low performance and decreased productivity of the team members (Elizalde & Bayona, 2018), (Gunbayi, 2009). There are only a few studies that discuss the impact of interpersonal relationships on software development, however it is important to note that all the research on this factor always indicate its positive impact on improving the productivity of software development teams.

9- Leadership: one of the most addressed topics in the productivity and performance of software development teams is leadership (Peltokorpi & Hasu, 2014), (Akman, et al., 2011). However, there is difference of opinion of researchers about the type of leadership and leadership characteristics which are essential for improving the

productivity of software development teams (Modi & Strode, 2020). Some notable and important studies regarding leadership approaches are given in the table below. Gracia and Russo studied the effect of different leadership approaches on software development teams. They identified three styles of leadership have considerable positive impact on the productivity of software development teams: Transactional Leadership, Transformational Leadership and Empowering Leadership (Gracia & Russo, 2019).

Table 2.4: Leadership styles from reviewed Literature

Leadership Style	**Description**	**Supporting Studies**
Adaptive Leadership	Leading the team in small groups and nurturing them. Establishing the rules, guiding vision and management of these rules with a lighter touch.	(Augustine, et al., 2005)
Shared Leadership	Role of team lead is implemented on rotation basis.	(Moe, et al., 2009) (Moe, et al., 2009) (Ringstad, et al., 2011) (Strode, 2015) (Srivastava & Jain, 2017)
Transformational Leadership	This style of leadership focuses on long term engagement and commitment. It shares long term goals, visions, motivations and inspirations.	(Yang, et al., 2009) (Van Kelle, et al., 2015) (Riaz, et al., 2018)
Ad-hoc Leadership	The approach of leadership is characterized by the interactions between the change leader and the	(Dubinsky & Hazzan, 2010)

	team. This is usually during the transition processes.	
Mentor	This type of leadership is based on a mentor in the team who guides, supports and trains the team for different tasks and processes.	(Hoda, et al., 2013)
Servant Leadership	Servant leadership is a philosophy based on the concept that the goal of a leader is to serve. The main goal of leader is thriving or growing of the organization rather than individual team members growth.	(Holtzhausen & de Klerk, 2018)
Situational Leadership	This type of leadership helps the leaders to change their approach according to the needs of their team. They often use a mix of other leadership approaches according to the situation which makes it more effective.	(Gren, et al., 2017)
Expert Leadership	In this approach a person with the most competence of technical knowledge, industry experience and managerial skills is selected as the leader. They are considered to have the most competent characteristics at every phase of software development.	(Srivastava & Jain, 2017)

Super Leader	This concept is based on individual self-leadership. It is often described as "leading others to lead themselves".	(Srivastava & Jain, 2017)

10- Innovation: Technology advancement is taking place rapidly and this rapid transformation requires the software development teams to stay updated on the latest developments and innovative solutions to stay competitive and enhance their productivity. The advancement of a team according to latest innovative methods depends on the organizational culture and encouragement to share latest and innovative knowledge with the team members (Shahzad, et al., 2017). Edison et al studied innovation measurement in the software development industry. They explored the impact of different type of innovations on software development: Product Innovation, Process Innovation, Market Innovation and Organization Innovation (Edison, et al., 2013).

11-Autonomy: Autonomy is the ability of a team member to work independently and make informed decisions independently. Autonomy is a crucial element for the individual's performance, well-being, motivation and psychological health (Noll, et al., 2017). Productivity of software development projects is greatly influenced by autonomy of team members. In self-reported data, employees misattribute their own actions with autonomy, consciously or unconsciously. Johannsen and Zak conducted a neuroscience experiment to investigate the impact of autonomy on project-based teams. Their findings indicate that autonomy can significantly improve productivity (Johannsen & Zak, 2020). Some researchers consider autonomy as one of the most important motivational factors for team members of software development projects. Professionals having attributes of autonomy are more tolerant towards motivational changes (Chaves, et al., 2022), (Cruzes & Dyba, 2011).

12-Technical Experience: By technical experience we refer to the capabilities and experience in the software development process. It includes the knowledge of analysis, design, development and testing of software projects. Numerous studies have indicated this factor to be most impactful when it comes to productivity of software development teams (Sampaio, et al., 2010). Experience of different skills has different influences.

But the most important skill to have experience and knowledge is programming language. The team members who have more experience of selected programming languages and technologies being used for software development have proven to be the most effective factor for improving productivity of software development team (Melo, et al., 2013), (Trendowicz & Munch, 2009). Technical experience is one of the factors which only have positive impact. There can be no negative influence of experience on productivity (Raza & Faria, 2014), (Kropp & Meier, 2016).

13- Software Project Management Experience: This factor refers to the capabilities, knowledge and experience of team members and leaders in areas of software project management. Having better understanding of software project management, positively impacts the productivity of software development teams (McAvoy & Butler, 2009). For project managers to have experience and knowledge in project management also impacts and help other factors to increase their influence on productivity (Fatema & Sakib, 2017), (Fatema & Sakib, 2018).

CHAPTER 3: METHODOLOGY

This chapter presents the systematic method adopted to conduct this study and discuss the impact of Social and Human Factors (SHF) on the productivity of software development teams in the context of Pakistan. In the coming sections of this chapter, we discuss the research design, data collection methods, sampling techniques, framework development, survey design and data analysis procedures adopted throughout this study.

3.1 Research Design

The research design is a plan which describes the methods and procedures for conducting a study. In this research, we have adopted a mixed-method approach which combines qualitative and quantitative research methods. Below are the phases involved in this study.

- **Systematic Literature Review:** A systematic literature review was performed to identify the most crucial social and human factors affecting the productivity of software development teams. The systematic literature review was presented in chapter 2 of this thesis. We have identified the 13 most impactful social and human factors.
- **Framework Development:** After identifying the most impactful social and human factors, we have designed a framework to visually represent the relationship between these factors and their collective effect on productivity of software development teams. The framework was developed using a combination of theoretical knowledge from literature and practical considerations from developers' point of view.
- **Survey Design:** We developed a questionnaire, in order to collect data about the perspective of Software Development professionals about the impact of Social and Human factors on Productivity of Software Development. The questionnaire includes structured questions on a Likert scale and personal data of respondents. In section 3.2, we present the detailed methodology for carrying out the survey.

3.2 Methodology for Survey

The survey method we are using for this research was introduced by Kitchenham and Pfleeger (Kitchenham & Pfleeger, 2008). Kitchenham and Pfleeger process suggests carrying out the survey study in below mentioned six phases (Kitchenham & Pfleeger, 2008).

1. Objective Definition
2. Design of Survey
3. Instrument Construction
4. Evaluation of the Instrument for Reliability and Validity
5. Data Collection
6. Analysis of Result

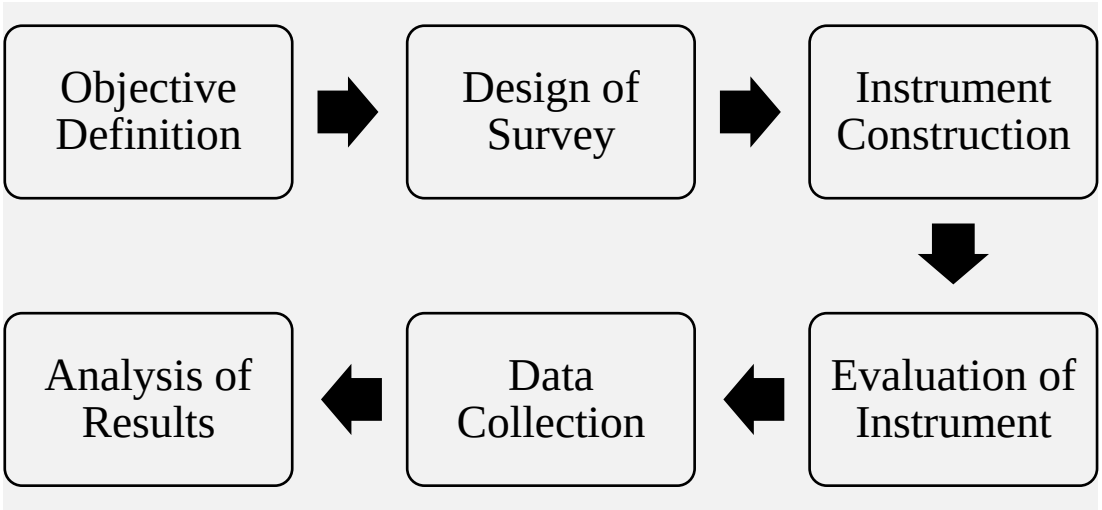


Figure 3.1: Kitchenham and Pfleeger method for Survey based studies

3.2.1 Survey Objective

The objectives of conducting this survey are given below:

- Collect Data from software development professionals of Pakistan to understand their perspective about impact of social and human factors on productivity of software development.
- Analysis of collected data to validate the developed framework.

- Comparison of selected factors and study their correlations using factor analysis.

3.2.2 Survey Design

The survey is based on a questionnaire. Below are the important considerations in conducting the survey.

Target Population

Target Population for this study consists of software development professionals, including developers, testing professionals, project managers, team leaders and relevant roles within software development teams.

Sample Size

For deciding the sample size, we used a non-probability quota sample technique. The questionnaire was kept on "accepting the responses" mode until the required number of responses were enough to ensure precision of 12 points and confidence level of 95%. Below formula was used for the sample size calculations (Anderson, et al., 2014).

$$\text{Sample Size} = \frac{Z_{\alpha}^{2} \times S^{2}}{e^{2}}$$

In this equation, for a confidence of 95%:

$$Z_{\alpha}^{2} = 1.96$$

$$S^{2} = 3048.996$$

$$e^{2} = 12$$

Thus:

$$\text{Sample Size} = 81 \text{ respondants}$$

3.2.3 Instrument Construction

The survey instrument is a structured questionnaire designed to measure the identified factors and their impact on productivity. The questionnaire consists of 96 questions in total, divided into three sections:

1. **Demographic Information**: Includes questions on age, gender, role, years of experience, etc.

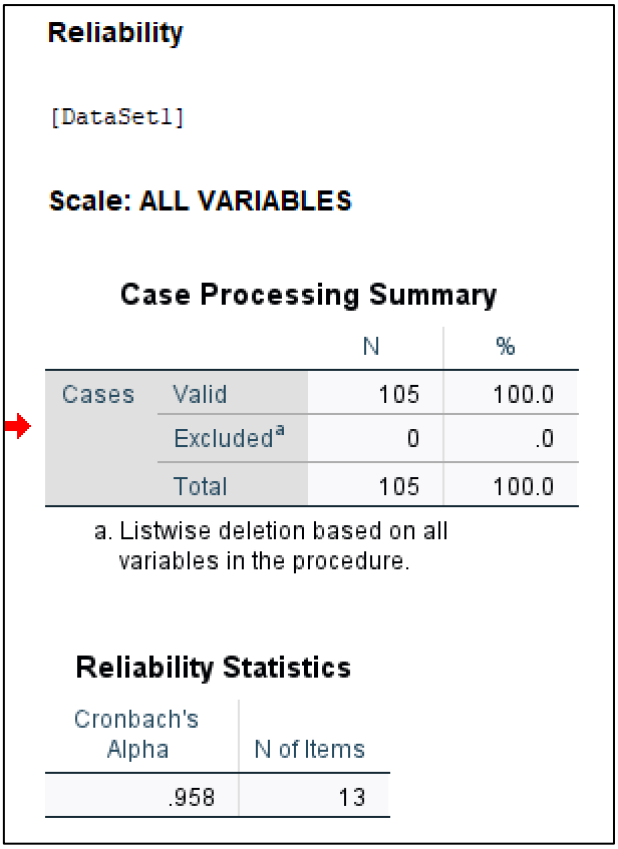
2. **Factor Measurement**: Includes questions related to each of the identified factors (e.g., Communication, Commitment, Motivation) measured on a 5-point Likert scale.

3. **Productivity Measurement**: Includes questions measuring perceived team productivity and data about the organizations of respondent.

3.2.4 Evaluation of Instrument

For making the study credible, it is important to ensure that the survey instrument is reliable and valid. Validity is measure of how much survey instrument measures for what it is designed and intended. This study ensures validity of content reviewing the literature and mapping the questions with measures to validate the designed framework. We use the factor analysis technique to measure the validity of the survey instrument.

Reliability is defined as the consistency of the survey instrument. In our study, we use Cronbach's alpha method to measure the internal consistency. We used IBM SPSS to measure the Cronbach's alpha coefficient for collected data. Figure 3.2 shows a screenshot from SPSS after calculating the value for Cronbach's alpha is 0.958, showing excellent internal consistency.



Reliability

[DataSet1]

Scale: ALL VARIABLES

Case Processing Summary

		N	%
Cases	Valid	105	100.0
	Excluded[a]	0	.0
	Total	105	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.958	13

Figure 3.2: Cronbach's alpha calculation for Internal Reliability using SPSS

For any survey involving human participants, ethical considerations are paramount, therefore, while conducting the survey, we ensured ethical practices are followed. This study adheres to ethical guidelines, including:

- **Informed Consent**: Participants are informed about the purpose of the study, their voluntary participation, and their right to withdraw at any time.
- **Confidentiality**: Ensuring the anonymity and confidentiality of participants' responses.
- **Data Protection**: Secure storage and handling of collected data to prevent unauthorized access.

3.2.5 Data Collection

The questionnaire was distributed electronically to the target population using online survey tool Google Form. Initially, a pilot run was executed to ensure the clarity and reliability of the survey questions. A total of 23 professionals responded during the pilot

run of the questionnaire. With the feedback received from the professionals, a few minor changes were made in the questions and their phrasing. Finally, the questionnaire was distributed to the software development professionals and a total of 105 responses were received, over a period of 5 weeks.

3.2.6 Data Analysis

Data analysis is the most important phase during this research. In the first step, the profile of respondents is analyzed. In the second step, we carried out the analysis on two levels, descriptive and inferential levels. In the first analysis of descriptive analysis, we study the characteristics of responses by software development professionals against each of the selected Social and Human Factors (SHF). For each factor, the scores obtained by addition of responses are used to create quantitative variables. In the second level, inferential, we study the correlation between these factors. For this purpose, Spearman-Brown correlation coefficient is used with a significance level of 5%. Analysis of data and discussion are presented in chapter 5.

3.3 Chapter Summary

This chapter outlined the research methodology employed in this study, including the research design, data collection methods, sampling techniques, framework development, survey instrument, data collection procedure, data analysis, validity and reliability, and ethical considerations. The next chapter will detail the development of the framework, followed by the Analysis and Discussion in Chapter 5.

CHAPTER 4: PRODUCTIVITY OPTIMIZATION FRAMEWORK

4.1 Introduction

This chapter details the development of a comprehensive framework designed to enhance the productivity of software development teams by leveraging critical social and human factors. The framework integrates thirteen identified factors: Communication, Commitment, Motivation, Job Satisfaction, Emotional Intelligence, Collaboration, Empathy, Team Cohesion, Leadership, Innovation, Autonomy, Expertise in Software Development, and Expertise in Project Management. This chapter will elaborate on the theoretical foundation, conceptualization, and construction of the framework, culminating in a visual representation.

4.2 Theoretical Foundation

The development of the framework is grounded in existing literature and empirical studies that highlight the significance of social and human factors in team performance and productivity, as discussed in the literature review section. Below are important considerations for designing this framework.

- **Agile methodologies** and their emphasis on collaboration and communication (Gregory et al., 2016).
- **Emotional intelligence** as a determinant of team dynamics and conflict resolution (O'Neill et al., 2019).
- **Leadership styles** and their impact on team motivation and cohesion (Moe et al., 2020).
- **Team cohesion and collective efficacy** as critical components of successful teamwork (Chowdhury & Paul, 2021).

4.3 Conceptualization of the Framework

The conceptual framework is designed to illustrate the relationships between the identified factors and their collective impact on team productivity. The following

subsections describe each factor in detail, its significance, and its expected influence on productivity.

4.3.1 Communication

Definition: The exchange of information, ideas, and feedback among team members.

Significance: Effective communication is crucial for coordinating tasks, resolving issues, and fostering a collaborative environment. Poor communication can lead to misunderstandings, errors, and decreased productivity.

Influence on Productivity: Clear and frequent communication improves team coordination, enhances problem-solving, and accelerates decision-making processes, leading to increased productivity.

4.3.2 Commitment

Definition: The dedication and loyalty of team members towards their work and team goals.

Significance: Committed team members are more likely to invest effort and time into their tasks, contributing to the overall success of the project.

Influence on Productivity: High levels of commitment result in increased motivation, lower turnover rates, and greater persistence in the face of challenges, thereby enhancing productivity.

4.3.3 Motivation

Definition: The drive and willingness of team members to achieve goals.

Significance: Motivation is a key factor in determining the amount of effort team members are willing to put into their work.

Influence on Productivity: Motivated individuals are more productive, creative, and resilient, leading to better performance and outcomes.

4.3.4 Work Satisfaction

Definition: The contentment and fulfillment team members feel about their work.

Significance: Satisfied team members are more likely to stay with the team, contribute positively, and perform at their best.

Influence on Productivity: High work satisfaction reduces turnover and absenteeism, and enhances morale and engagement, thereby improving productivity.

4.3.5 Emotional Intelligence

Definition: The ability to recognize and manage one's own emotions and the emotions of others.

Significance: Emotional intelligence helps in navigating interpersonal relationships, managing stress, and resolving conflicts effectively.

Influence on Productivity: Teams with high emotional intelligence create a supportive environment that fosters collaboration and innovation, leading to higher productivity.

4.3.6 Collaboration

Definition: The ability to work together effectively towards common goals.

Significance: Collaboration leverages the diverse skills and perspectives of team members, leading to better solutions and outcomes.

Influence on Productivity: Effective collaboration ensures that tasks are completed efficiently, knowledge is shared, and team synergy is maximized, thereby boosting productivity.

4.3.7 Team Cohesion

Definition: The bond and unity among team members.

Significance: A cohesive team is more likely to work well together, support each other, and achieve common goals.

Influence on Productivity: Strong team cohesion enhances communication, collaboration, and morale, leading to higher productivity.

4.3.8 Empathy & Interpersonal Relationships

Definition: The ability to understand and share the feelings of others and build positive relationships.

Significance: Empathy and good interpersonal relationships foster a supportive and respectful team culture.

Influence on Productivity: Empathetic team members are better at conflict resolution and collaboration, which positively impacts team dynamics and productivity.

4.3.9 Leadership

Definition: The approach leaders take to guide and manage the team.

Significance: Effective leadership provides direction, motivation, and support to team members.

Influence on Productivity: Good leaders enhance team morale, motivation, and cohesion, driving the team towards higher productivity.

4.3.10 Innovation

Definition: The ability to generate new ideas and solutions.

Significance: Innovation is critical for problem-solving and staying competitive in the software development industry.

Influence on Productivity: Encouraging innovation leads to creative solutions and continuous improvement, boosting productivity.

4.3.11 Autonomy

Definition: The level of independence and self-direction granted to team members.

Significance: Autonomy empowers team members to take initiative and make decisions.

Influence on Productivity: Autonomous teams are more innovative, motivated, and responsible, leading to higher productivity.

4.3.12 Capabilities and Experience in Software Development Process

Definition: The technical skills and expertise in software development practices.

Significance: Skilled and experienced team members can handle complex tasks more efficiently.

Influence on Productivity: High technical capabilities and experience ensure quality and efficiency in the development process, enhancing productivity.

4.3.13 Capabilities and Experience in Software Development Project Management

Definition: The skills and expertise in managing software development projects.

Significance: Effective project management ensures that projects are well-planned, executed, and delivered on time.

Influence on Productivity: Strong project management capabilities streamline processes and minimize delays, leading to increased productivity.

4.4 Framework Construction

The framework integrates the identified factors into a cohesive model that illustrates their interrelationships and collective impact on productivity. The construction process involves the following steps:

Identifying Key Relationships: Mapping out how each factor influences others and their combined effect on productivity.

Creating a Visual Representation: Designing a diagram that visually represents the framework and the flow of influence among factors.

4.5 Visual Representation

The framework diagram (refer to Figure 4.1) depicts the relationships between the factors, with arrows indicating the direction of influence. The central role of leadership is highlighted, showing its impact on commitment, communication, and team cohesion. The diagram illustrates how these factors interact and contribute to the goal of enhancing productivity.

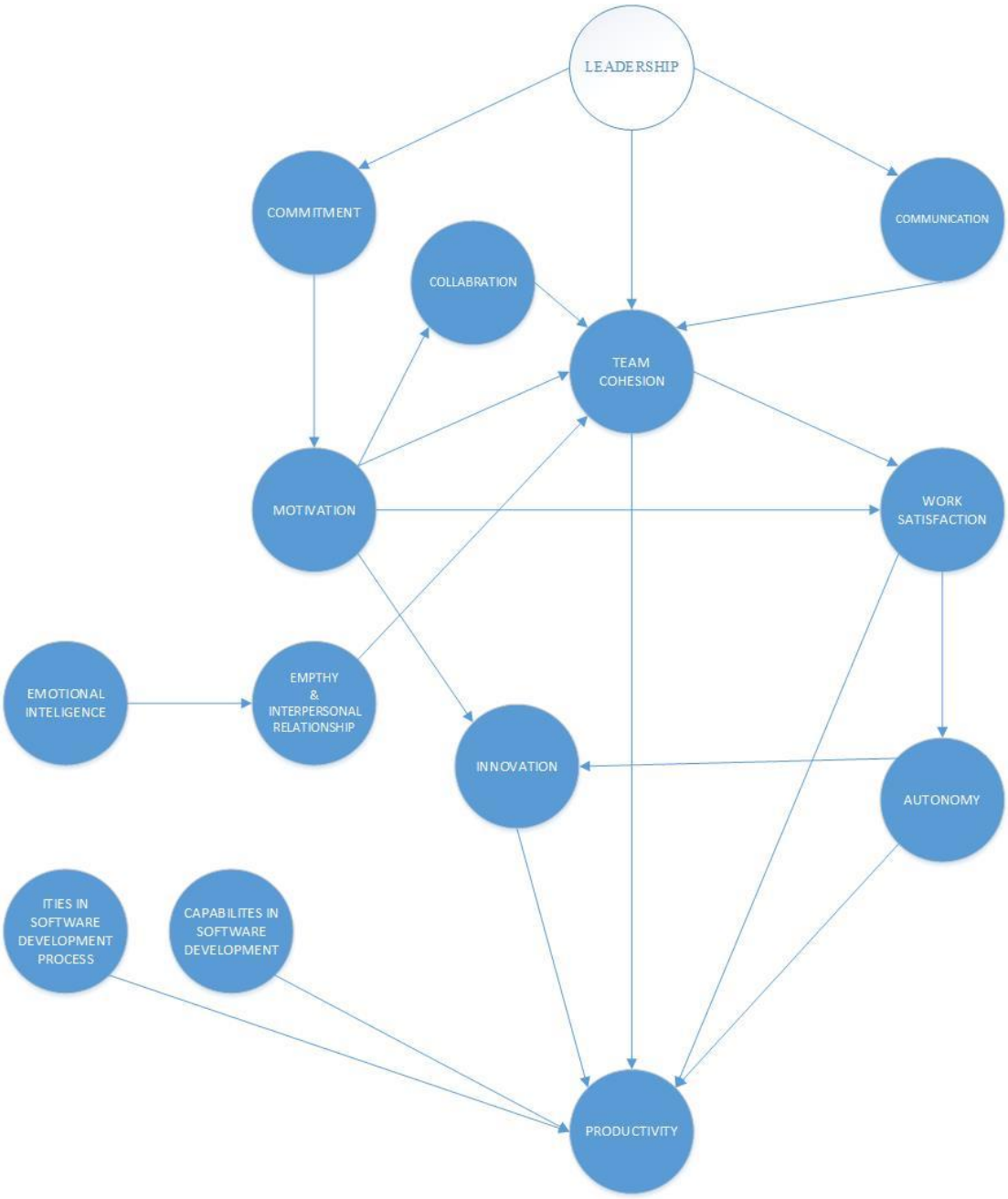


Figure 4.1: Framework for productivity improvement based on SHFs

4.6 Application of the Framework

The developed framework will be applied in the following ways:

Survey Design: Using the framework to design survey questions that assess each factor and its influence on productivity.

Data Collection: Conducting surveys with software development teams to gather data on the identified factors.

Data Analysis: Analyzing the survey data to test the hypothesized relationships and validate the framework.

Implementation: Providing recommendations for teams and organizations to enhance productivity based on the framework.

4.7 Chapter Summary

The framework development process has integrated theoretical foundations and empirical evidence to create a comprehensive model that illustrates the influence of social and human factors on the productivity of software development teams. The next chapter will detail the survey design and implementation process, including the formulation of survey questions and the methodology for data collection and analysis.

CHAPTER 5: ANALYSIS AND DISCUSSION

In the previous chapter, we have discussed the Framework for studying the impact of 13 selected factors on productivity of software development. In this chapter we present the Analysis of collected responses and discuss the practical implementation of obtained results in form of our framework to improve the productivity of software development teams in Pakistan. The analysis and discussion will be performed in 3 major phases.

- **Respondents Profile Analysis:** Section 5.1 presents the analysis and discussion on the profile of respondents.
- **Descriptive Analysis:** In section 5.2, we present the descriptive analysis and discussion on collected data against each of the factors.
- **Inferential Analysis:** Section 5.3 presents inferential analysis and discussion on implementation of designed framework in practice.

5.1 Respondents profile analysis

The questionnaire was responded by software development professionals from different cities of Pakistan. Most number of respondents were from Lahore with a percentage of 62% followed by second most respondents from Karachi with a percentage of 19%. Islamabad and Rawalpindi have a combined 16% respondents. The lowest number of respondents were from Peshawar with only 3 responses, as shown in Figure 5.1.

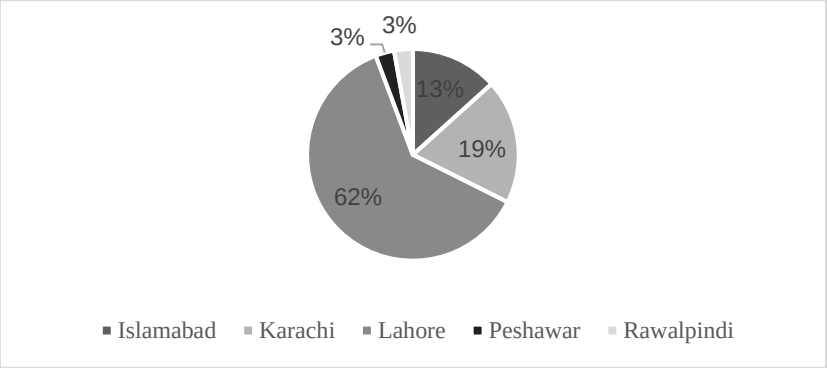


Figure 5.1: City-wise distribution of survey respondents

A significantly high prevalence of males, accounting for 69% of the observed population, was noted in the study. This finding underscores the gender disparity within the software development field, where the ratio of male to female professionals is disproportionately high. Specifically, for every woman working in this sector, there are approximately three men. This imbalance highlights a broader industry trend where men dominate the workforce in software development. The results suggest that more efforts are needed to increase female representation in this field to achieve greater gender parity. Table 5.1 shows the gender wise distribution across different cities.

Table 5.1: Gender-vise distribution of respondents across different cities

City	Total Respondents	Female Count	Female %	Male Count	Male %	Female to Male Ratio
Islamabad / Rawalpindi	17	4	24%	13	76%	1:3.3
Karachi	20	8	40%	12	60%	1:1.5
Lahore	65	21	32%	44	68%	1:2.1
Peshawar	3	0	0%	3	100%	0:3
Total	105	33	31%	72	69%	1:2.2

In the questionnaire we collected the data of the highest level of academic qualification for the respondents. The majority of the professionals working in the field of software development are graduates with bachelor's degrees. Graduate developers are 67%, 31% of respondents have master’s degrees and only 2 percent of specializations in their respective fields.

The respondents are professional software developers with ages between 23 and 39 years old. The average age of respondents is 29.095±3.487. The highest length of service of respondents in the field of software development is 16 years, with an average of 3.37±2.44 years. Table 5.2 shows the age and professional experience of respondents.

Table 5.2: Age and experience profile of survey respondents

Parameters	Average	SD	Range	Percentile			Skewness
				25	50	75	
Age	28.1	3.5	23-39	25	28	30	1.06
Experience in Current Company	3.4	2.4	1-16	2	3	4	2.71
Total Experience	4.9	3.2	1-16	2	4	6	1.41

5.2 Descriptive Analysis

The data was collected from respondents on a Likert scale of 1-5, 1 being Strongly Disagree to 5 being Strongly Agree. Then percentages of each response and frequencies were analyzed to study the perspective of software development professional on the selected Social and Human factors to understand the impact of these factors. Below is descriptive analysis of all the 13 factors.

5.2.1 Communication

The main purpose of software development is to facilitate the users of that software. Therefore, for a software product to be useful it must be in accordance with the requirements of users. For this purpose, communication is the key element during the software development process. Communication between team and users, and within the teams, is of key importance. For a smooth and savvy development practice, team members must have effective and timely communication of the requirements, progress, ideas and any issues that may arise during the process of development. We used 6

questions in our questionnaire to understand the perspective of software development professionals about communication within a team and its impact on productivity. In these questions we asked the developers about the importance of general communication, communication of project objectives and activities, clarity of roles, progress and milestones and definition of a communication protocol. The tendency of all the responses is towards strong agreement on the importance of these items related to this factor. It is important to highlight that when asked about the impact of communication, 73.3% respondents strongly agree with its impact on productivity of software development team, the remaining 26.3% also responded as agree. Table 5.3 shows the percentages of frequencies of responses from all 105 respondents. The importance of communication is realized from the fact that not even a single respondent marked any response to be strongly disagree in all 6 questions under this factor.

Table 5.3: Percentage responses to question items under the factor of Communication

Questions	**Percentages**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
To improve the productivity of the software development process, communication between team members is an important support.	73.3%	26.7%	0.0%	0.0%	0.0%
The project objectives and their respective activities must be explicit and clear to all team members, to improve the productivity of the software development process.	67.6%	32.4%	0.0%	0.0%	0.0%

To improve the productivity of the software development process, each task must have a clearly identified person in charge.	60.0%	28.6%	7.6%	3.8%	0.0%
Team members must maintain fluid communication to improve the productivity of the software development process.	70.5%	23.8%	5.7%	0.0%	0.0%
To improve the productivity of the software development process, team members must be informed in a timely manner about the progress of goals and the achievement of objectives.	61.0%	33.3%	5.7%	0.0%	0.0%
To improve the productivity of the software development process, it is necessary to define a communication protocol between the members of the work team and external personnel.	68.6%	25.7%	4.8%	1.0%	0.0%

5.2.2 Commitment

As we have previously discussed, Commitment can be defined as the dedication and willingness of team members to contribute their time, effort, and expertise towards achieving project goals and objectives, without leaving the team during a project. Commitment is the responsibility of every individual to continue and carry on the work once they have signed up for the project. Thus, the collective commitment of the team defines the pace and quality of the project, which are directly related to the productivity of the team. The respondents agree to the fact that to achieve the objectives of the project, fulfilling the responsibilities and carrying out the assigned tasks impacts the productivity of the project.

Table 5.4: Percentage responses to question items under the factor of Commitment

Questions	**Percentages**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
To improve the productivity of the software development process, the work team must carry out the necessary tasks for the success of the project in accordance with the stated objectives.	48.6%	48.6%	2.9%	0.0%	0.0%
The members must have a level of responsibility that facilitates assuming their tasks in favour of the objectives of the work team, with the purpose of improving the productivity of	58.1%	39.0%	2.9%	0.0%	0.0%

the software development process.					
improve the productivity of the software development process, the team must be clear about their responsibility for task completion and be willing to help when required.	56.2%	39.0%	4.8%	0.0%	0.0%
All team members must take responsibility for the results obtained, fulfil their duties and be able to admit their mistakes to improve the productivity of the software development process.	68.6%	24.8%	4.8%	1.9%	0.0%
To improve the productivity of the software development process, team members must fully and punctually complete assigned tasks.	56.2%	31.4%	12.4%	0.0%	0.0%

5.2.3 Motivation

Motivation means the drive and enthusiasm that inspires individuals to actively engage in their work, pursue excellence, and overcome challenges in the pursuit of project success. As per this definition, motivation is what makes people do the necessary action and fulfill their responsibilities. Among the items of motivation questions, there are certain notable disagreements by respondents. For example, 10.5% of respondents strongly disagree and 14.3% of the respondents disagree with the statement that

motivation is concerned with the good furniture, computer equipment and optimal environment. However, the most important and notable highlight of this section is the fact that almost all the respondents tend to agree on the point that they must be rewarded for successful achievement of the objectives and goals. With this item in questionnaire, 57.1% responded strongly agree and 38.1% responded with agree. This not only shows the importance of motivation towards productivity of software development, but also the driver of motivation among software development professionals is not having better furniture or environment, rather getting better rewards for their performance.

Table 5.5: Percentage responses to question items under the factor of Motivation

Questions	**Percentages**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
To improve the productivity of the software development process, positive attitudes, resulting from the achievement of project objectives, are essential.	57.1%	37.1%	5.7%	0.0%	0.0%
The tasks assigned to the team members must be perceived as interesting and challenging to improve the productivity of the software development process.	47.6%	29.5%	7.6%	8.6%	6.7%

It is encouraging for team members to be rewarded for activities performed, and this improves the productivity of the software development process.	57.1%	38.1%	4.8%	0.0%	0.0%
To improve the productivity of the software development process, good furniture, computer equipment and optimal environmental conditions must be available.	38.1%	27.6%	9.5%	14.3%	10.5%
To improve the productivity of the software development process, team members must feel that the tasks they perform are useful to achieve the objectives.	55.2%	31.4%	7.6%	5.7%	0.0%

5.2.4 Work Satisfaction

Along with the professional objectives and goals, the professionals in the field of software development have their own interests and objectives. According to the definition of work satisfaction, software development professionals are likely to be more satisfied with their job if the goals and objectives of their project and their responsibilities in the project are in line with their own interests and passions. The activities carried out by the professionals must contribute to their personal and professional growth. A total of 92.6% of the respondents agreed with this statement,

highlighting the impact of work satisfaction on productivity. This is actually directly linked to other factors as well. The first item in this factor and in the factor of motivation are of similar nature and got similar responses from the respondents. We used 7 items to collect data for Work Satisfaction, the percentage frequences of the responses to these 7 items is given in Table 5.6. One of most notable points in this factor is that all the respondents agreed that acquiring additional knowledge by completing the objectives and goals of the project enhances their work satisfaction.

Table 5.6: Percentage responses to question items under the factor of Work Satisfaction

Questions	**Percentages**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
To improve the productivity of the software development process, team members must feel that the tasks they perform are useful to achieve the objectives.	50.5%	41.0 %	5.7%	2.9%	0.0%
The activities carried out by the team members must contribute to their personal and professional growth to improve the productivity of the software development process.	59.0%	33.3 %	7.6%	0.0%	0.0%

To improve the productivity of the software development process, team members must be satisfied with the equitable distribution of work.	49.5%	35.2 %	10.5%	4.8%	0.0%
To improve the productivity of the software development process, team members must be satisfied with the activities they perform on the project.	57.1%	32.4 %	7.6%	2.9%	0.0%
To improve the productivity of the software development process, the tasks assigned to each of the members of the team must correspond mostly with what each one wants to do.	52.4%	22.9 %	21.9%	2.9%	0.0%
To improve the productivity of the software development process, tasks must be assigned according to the profile of each of the team members.	57.1%	28.6 %	14.3%	0.0%	0.0%
Team members should feel satisfied with the possibility of acquiring additional	55.2%	35.2 %	6.7%	2.9%	0.0%

knowledge about software development to improve their productivity.					

5.2.5 Emotional Intelligence

Emotional Intelligence is the ability of team members to understand and relate to each other's perspectives, feelings, and experiences. In our questionnaire this factor had the greatest number of question items and respondents tend to agree to all those statements in general. 55.2% of the respondents strongly agree with the statement that every member in the team must be able to know how to manage their emotions in order to improve their productivity, and 28.6% of them responded to this item by marking agree. Similarly, 72.4% of the respondents strongly agree that team members should have ability to resolve the conflicts among themselves for improving the productivity of the team, while 21% of the respondents marked “agree” to this item on the Likert scale. It is also important to note that a total of 91.4% of respondents agree with the impact of recognizing the emotional state of their colleagues. Table 5.7 shows the details of percentage frequencies of responses against each question under the factor Emotional Intelligence.

Table 5.7: Percentage responses to question items under the factor of Emotional Intelligence

Questions	**Percentages**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
To improve the productivity of the software development	51.4%	39.0%	8.6%	1.0%	0.0%

process, each of the team members must be able to adapt to the changes inherent in the project.					
To improve the productivity of the software development process, each of the team members must express their disagreement in a timely manner and to the right person.	64.8%	24.8%	8.6%	1.9%	0.0%
To improve the productivity of the software development process, team members are required to get things done, even when things get tough.	54.3%	33.3%	5.7%	6.7%	0.0%
It is necessary for team members to know how to manage their emotions appropriately to improve the productivity of the software development process.	55.2%	28.6%	10.5%	5.7%	0.0%
To improve the productivity of the software development	54.3%	25.7%	15.2%	4.8%	0.0%

process, it is important that each member of the team listens to criticism and acts accordingly in a reasoned manner.					
To improve the productivity of the software development process, the work team must have the ability to resolve conflicts appropriately.	72.4%	21.0%	3.8%	2.9%	0.0%
To improve the productivity of the software development process, team members must know how to recognize the emotional states of their colleagues and act empathetically.	55.2%	36.2%	7.6%	1.0%	0.0%
To improve the productivity of the software development process, team members must build relationships based on trust and respect.	62.9%	29.5%	7.6%	0.0%	0.0%

5.2.6 Collaboration

Software development is a collaborative process in which teams usually collaborate with each other to achieve common goals. These Collaborations can be between different organizations, between different teams of same organizations or between individuals within a team. Since we're focusing on the productivity of software development teams and software development process, therefore, our questions are designed keeping this definition in mind. A total of 93.3% of the respondents showed agreement to the collaboration being impactful in improving the productivity of software development process. There is a small disagreement noticed when it comes to knowledge sharing and supporting other team members in their task with a maximum disagreement of 3.8% and no strong disagreement. However, in all the items under this factor, general tendency of perspective is towards agreement of its importance in the software development productivity, as shown in Table 5.8.

Table 5.8: Percentage responses to question items under the factor of Collaboration

Questions	**Percentages**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
To improve the productivity of the software development process, team members must work collaboratively to achieve project goals.	60.0%	33.3%	3.8%	2.9%	0.0%
There must be trust among the members of the team for the performance of their	57.1%	29.5%	13.3%	0.0%	0.0%

functions and protection of common interests, which helps to improve the productivity of the software development process.					
To improve the productivity of the software development process, team members must be willing to help, support, and support their peers.	62.9%	28.6%	5.7%	2.9%	0.0%
To improve the productivity of the software development process, it is necessary for each of the team members to share their knowledge, information and experience with their colleagues.	53.3%	30.5%	12.4%	3.8%	0.0%

5.2.7 Team Cohesion

Team Cohesion is the degree of unity, mutual trust, and shared commitment among team members. According to its definition, this is the factor that ensures the whole team puts their efforts into achieving the goals and objectives of the project. The first item under this factor highlights an interesting fact. Software development professionals have perception about the rate at which individual members work in a team. The

response shows that it is not mandatory that all the team members work at the same rate. The frequency of strong agreement is not even 50% under this item, but frequency of the strong disagreement is 6.7%. Similarly, when it comes to knowing what other colleagues are doing, software development professionals believe that it is not important to know what other team members are doing, with the highest of strong disagreement at 10.5%, and 20% for disagreement. However, when it comes to putting best effort for the goals of achieving the goals, a total of 92.4% agreement shows the impact of putting best effort to improve the productivity of software development projects.

Table 5.9: Percentage responses to question items under the factor of Team Cohesion

Questions	**Percentages**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
To improve the productivity of the software development process, it is necessary for team members to work at similar rates.	43.8%	21.0%	16.2%	12.4%	6.7%
It is important that the members feel identified with the team participating autonomously and motivated, which helps to improve the productivity of the	50.5%	33.3%	13.3%	2.9%	0.0%

software development process.					
To improve the productivity of the software development process, each of the team members must put their best skills at the service of the project objectives.	61.0%	31.4%	7.6%	0.0%	0.0%
To improve the productivity of the software development process, each team member should enjoy performing tasks with their peers.	54.3%	25.7%	13.3%	5.7%	1.0%
Activities must be executed in a timely manner and with the participation of all those responsible to improve the productivity of the software development process.	58.1%	30.5%	8.6%	2.9%	0.0%
To improve the productivity of software development	29.5%	21.9%	18.1%	20.0%	10.5%

teams, each member must know what each of their colleagues is doing.					

5.2.8 Empathy and Interpersonal Relationships

A positive and healthy interaction between the team members is an important factor in achieving the goals, as previously discussed in the literature review section. Empathy means the ability of a team member to consider themselves in the position of other colleagues to understand their situation better and improve their interaction and relationship, thus creating a positive atmosphere for better productivity. We used 9 items to collect data about this factor from the software development professionals. A total of 94.1% of the respondents showed agreement with the statement that for better productivity, a better environment is important for the developers, with none of the respondents showing disagreement at all. On contrast, under another item where we inquired about good personal relationships between the team members, more than 15% showed disagreement. The explanation for this contrast can be considered by the fact that the software development professionals prefer more of a professional relationship, rather than personal relationships. This is also evident from the last item under this factor that respecting the coexistence of the team members improves the productivity of software development process, with frequency of agreement response to be 97% without any disagreements. Respondents showed 72% agreement with the fact that as far as everybody is performing their work at their best, personal relationships are not important, with only 12% responses in disagreement.

Table 5.10: Percentage responses to question items under the factor of Empathy and Interpersonal Relationships

Questions	**Percentages**

	Strongly agree	Agree	Neutral	Disagree	Strongly Disagree
To improve the productivity of software development teams, it is beneficial for their members to participate in social activities, inside and outside the work environment.	45.7%	31.4%	7.6%	15.2%	0.0%
To improve the productivity of software development teams, their members may have little or no relationship with each other, if they do their jobs.	50.5%	21.9%	16.2%	10.5%	1.0%
To improve the productivity of software development teams, each of its members must recognize that not fulfilling their tasks can affect the performance of their colleagues and the team.	47.6%	36.2%	13.3%	2.9%	0.0%
To improve the productivity of software	47.6%	29.5%	13.3%	9.5%	0.0%

development teams, it is necessary that their members receive training in interpersonal relationships, assertive management of emotions, teamwork and quality.					
To improve the productivity of software development teams, there must be good personal relationships between its members.	41.9%	29.5%	11.4%	3.8%	13.3%
To improve the productivity of software development teams, their members must be able to put themselves in the other's shoes and collaborate with them if necessary.	46.7%	38.1%	8.6%	6.7%	0.0%
To improve the productivity of software development teams, each member must participate in the activities carried out in their work area.	54.3%	27.6%	14.3%	3.8%	0.0%
To improve the productivity of software	62.9%	31.4%	5.7%	0.0%	0.0%

development teams, their members must ensure a pleasant work environment.					
To improve the productivity of software development teams, their members must respect the coexistence agreements that were agreed upon.	53.3%	42.9%	3.8%	0.0%	0.0%

5.2.9 Leadership

Leadership is the process of guiding, inspiring, and empowering team members to achieve common objectives. A leader is expected to influence other team members positively to achieve the common goals of the team effectively. This definition is summed up in 7 items we used for the data collection. Respondents showed total agreement to this definition of leadership and its impact on productivity of software development team with 95% frequency of responses for strongly agreement and agreement combined on the Likert Scale. 92% of the respondents believed that a leader's role is to guide and coordinate the activities of software development team to enhance the productivity of the team.

We also inquired about the leadership selection among the team members. More than 75% of the respondents believed that in a team any person should have qualities to lead the team. However, this is the item showing most disagreement as well, with 14.3% of the respondents showing their disagreement to this statement. A leader should be concerned about both the project outcomes and human relationships in the team. Only 2.9% of respondents showed disagreement with this statement, and others showed general agreement towards this item. The items in this factor not only depict the role of leadership in software development processes, but also the perspective of professionals about the characteristics of a leader in their team. No disagreements were responded to

the fact that the leader should be fair in treatment towards the team and demands of efforts from the team members.

Table 5.11: Percentage responses to question items under the factor of Leadership

Questions	**Percentages**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
To improve the productivity of software development teams, any of its members may have qualities to lead the activities within the project.	53.3%	21.9%	10.5%	14.3%	0.0%
To improve the productivity of software development teams, each of its members must feel that they can offer solutions to problems within the project.	54.3%	33.3%	4.8%	6.7%	1.0%
The leader must promote positive attitudes and build trust among the members of the software development team to improve productivity.	61.9%	33.3%	4.8%	0.0%	0.0%

To improve the productivity of software development teams, work decisions should be made in group discussions and not unilaterally.	64.8%	20.0%	13.3%	1.9%	0.0%
The leader must coordinate and guide the activities of the software development team towards the objectives and goals of the project to improve productivity.	56.2%	36.2%	7.6%	0.0%	0.0%
To improve productivity, the leader must be equitable in his treatment and demands towards the members of the software development team.	61.0%	28.6%	10.5%	0.0%	0.0%
To improve the productivity of software development teams, the leader must be concerned with both project outcomes and human relationships.	50.5%	34.3%	12.4%	2.9%	0.0%

5.2.10 Innovation

Innovation refers to the process of generating and implementing new ideas, solutions, and approaches to address challenges, improve processes, and create value. The innovative mindset is what impacts the introduction of new and improved software. And this was evident from the responses of the items under this factor that no respondents showed strong disagreements to any of items. This is the only factor under which, all the items were responded around 10% as neutral, and nearly 90% agreement for all the items. Most important item is the inquiry about whether innovative ideas must be encouraged to optimize the productivity of the software development team, which shows 88% total agreement of respondents.

Table 5.12: Percentage responses to question items under the factor of Innovation

Questions	**Percentages**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
To innovate in the process and improve the productivity of the software development teams, the suggestions, complaints and/or claims of the client must be taken into account.	49.5%	41.9%	8.6%	0.0%	0.0%
The company's policies must encourage the incorporation of innovation in projects to improve the productivity of	50.5%	37.1%	9.5%	2.9%	0.0%

software development teams.					
To improve the productivity of software development teams, the use of solutions that have not been successfully tested should be avoided.	49.5%	41.0%	8.6%	1.0%	0.0%
To improve the productivity of software development teams, their members must be able to take on new challenges and develop various skills.	51.4%	41.9%	6.7%	0.0%	0.0%
To improve the productivity of software development teams, their members must be supportive and receptive to new ideas.	54.3%	31.4%	11.4%	2.9%	0.0%
To improve the productivity of software development teams, the leader must encourage its members to put their own ideas into practice and find new ways to deal with problems.	44.8%	43.8%	8.6%	2.9%	0.0%

5.2.11 Autonomy

Autonomy is the degree of independence and empowerment granted to team members to make decisions, set goals, and manage their work. In our questionnaire, we have included 5 items to collect the data for this factor. There is generally agreement of respondents towards importance of autonomy with some degree of disagreement. A total of 85.6% of respondents showed agreement with the item where we asked whether team members should be allowed to organize themselves to establish and meet the objectives of the project.

It is important to highlight that 90% of the respondents believe that members can take corrective actions on their own if something goes wrong. Only 1% of the respondents showed disagreement with this statement. However, to any of the items under this factor, none of the respondents marked strong disagreements, showing the impact and influence of autonomy on productivity of software development process.

Table 5.13: Percentage responses to question items under the factor of Team Autonomy

Questions	**Percentages**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
To improve the productivity of software development teams, their members must be empowered to make decisions regarding the project and their way of working within it.	43.8%	32.4%	20.0%	3.8%	0.0%
To improve the productivity of software	59.0%	26.7%	11.4%	2.9%	0.0%

development teams, their members can organize themselves to establish and meet their objectives.					
To improve the productivity of software development teams, their members consider that they can make decisions about the methods, techniques and strategies, among others, to carry out the tasks.	46.7%	32.4%	18.1%	2.9%	0.0%
To improve the productivity of software development teams, each of its members must rely on their abilities to perform the tasks they are responsible for.	59.0%	31.4%	7.6%	1.9%	0.0%
To improve the productivity of software development teams, their members may take corrective action on their own initiative.	57.1%	33.3%	8.6%	1.0%	0.0%

5.2.12 Capabilities and Experience in Software Development

This is an important factor to have an influence on productivity of software development process. The members of the team having more capabilities can achieve better performance and hence improve productivity. However, having prior experience with similar software development projects is an item where respondents showed a mixed opinion. Only 48.6% of respondents showed strong agreement with the statement "having worked in similar context" improves the productivity of software development process. 94% of the respondents in total showed agreement that having knowledge of programming languages being used in the software development process is important to improve productivity.

We included 7 items in total, under this factor and respondents showed only 1% strong disagreements in total. 91.4% of the participants showed that knowledge or experience of software development methodologies have an impact on the productivity of software development.

Table 5.14: Percentage responses to question items under the factor of Capabilities and Experience in Software Development Process

Questions	**Percentages**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
To improve the productivity of software development teams, their members must be updated in terms of better tools and practices for performing tasks.	50.5%	41.0%	7.6%	0.0%	1.0%
To improve the productivity of software	48.6%	36.2%	9.5%	5.7%	0.0%

development teams, their members must have knowledge of the subject or have worked in similar contexts.					
To improve productivity, it is required that the members of the software development team have knowledge or experience in the use of tools and programming languages necessary for the project.	53.3%	41.0%	2.9%	2.9%	0.0%
To improve the productivity of software development teams, their members must have knowledge or experience in the analysis, design, construction or implementation of software.	54.3%	28.6%	11.4%	5.7%	0.0%
To improve the productivity of software development teams, their members must have logical reasoning and systemic thinking skills.	62.9%	27.6%	3.8%	5.7%	0.0%

To improve the productivity of software development teams, their members must have the ability to implement efficient solutions that meet project requirements.	46.7%	40.0%	11.4%	1.9%	0.0%
To improve the productivity of software development teams, their members must have knowledge or experience in the use of software development methodologies.	51.4%	39.0%	6.7%	2.9%	0.0%

5.2.13 Capabilities and Experience in Project Management

This is an important factor because it considers the proficiency, skills, and knowledge of team members in overseeing and coordinating software development projects, encompassing areas such as planning, scheduling, budgeting, risk management, stakeholder communication, and team leadership. In our questionnaire, this consists of 4 question items, where the strong agreement across all the items is around half of the total respondents. Under the item where we inquired about the importance of managing the agreed times, 49.5% of the respondents showed strong agreement and 40% showed agreement. This highlights the fact that managing the agreed times is of absolute importance to achieve the project goals in time and keep the performance of the team productive. Similarly, 84.5% of the respondents agreed with the statement that the use of project management tools and techniques is of vital importance in improving the team's productivity. This shows the trend of software development professionals pursuing certifications in project management. A similar trend is seen in the responses

under item that highlights the importance of use of metrics that allow monitoring of the project. However, regarding disagreement of items, this item has largest disagreement of 7.6% among all the 4 items but no strong disagreement seen in any of items under this factor.

Table 5.15: Percentage responses to question items under the factor of Capabilities and Experience in Project Management

Questions	**Percentages**				
	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**
To improve the productivity of software development teams, their members must properly manage the agreed times.	49.5%	40.0%	4.8%	5.7%	0.0%
Each of the members of the software development team must have the ability to plan, execute or control the activities of the project to improve productivity.	48.6%	36.2%	12.4%	2.9%	0.0%
The members of the software development team must have knowledge or experience in the use of project management tools and techniques to improve productivity.	54.3%	22.9%	20.0%	2.9%	0.0%

To improve the productivity of software development teams, their members must have knowledge or experience in the use of metrics that allow monitoring of the project.	47.6%	34.3%	10.5%	7.6%	0.0%

5.3 Inferential Analysis

In this section, we present the inferential analysis of the data collected in form of responses from the software development professionals of Pakistan. For any item we assigned the scores of 1-5 on a Likert scale of Strongly Disagree to Strongly Agree. The assigned scores are: Strongly Agree: 5, Agree: 4, Neutral:3, Disagree:2 and Strongly Agree:1.

Since we have multiple items under each of the factors, we calculated the sums of scores for each item under a factor to finally have 13 quantitative variables. Table 5.16 shows the combined data for these 13 variables which represent 13 Social and Human factors. Theoretical range is calculated from theoretical minimum and theoretical maximum score possible for a factor. In our case, for any item minimum possible score is 1 (corresponding to strongly disagree), therefore for any factor theoretical minimum for any factor is number of question items under this factor. Similarly, theoretically maximum score is 5 (for Strongly Agree), therefore, theoretical maximum is product of maximum and number of questions under that factor. For example, we have 6 items under the factor of Communication, therefore theoretical minimum is 6, and theoretical maximum is 6x5=30.

On the other hand, Empirical ranges are calculated from the actual scores given by respondent to items of a particular factor. In all the factors, theoretical and empirical minimum have different values, however, theoretical maximum and empirical maximum tend to converge in all the cases. This shows, total score tends to fall towards

agreement of importance of Social and Human Factors in improving the productivity of software development process. Another statistics tool used is skewness of the data as shown in Figure 5.2. For all the factors considered, skewness is in negative. This shows that most of the data lies towards the left of the mean value.

Table 5.16: Descriptive Statistics for Social and Human Factors

Factor	No. of Factors	Theoretical Range	Mean	Standard Deviation	Empirical Range	Skewness
Communication	6	6-30	27.68	2.35	22-30	-0.571
Commitment	5	6-25	22.56	1.86	19-25	-0.789
Motivation	5	6-25	21.11	2.76	15-25	-0.116
Work Satisfaction	7	6-35	30.74	3.79	21-35	-0.696
Emotional Intelligence	8	6-40	39.98	4.76	24-45	-0.569
Collaboration	4	6-20	17.79	2.39	11-20	-0.960
Team Cohesion	6	6-30	24.78	3.65	17-30	-0.191
Empathy	9	6-45	38.09	5.77	27-45	-0.451
Leadership	7	6-35	30.84	3.93	22-35	-0.688
Autonomy	5	6-25	26.28	3.18	18-30	-0.502

Innovation	6	6-30	21.75	2.95	15-25	-0.528
EXP SD	7	6-35	30.62	4.31	14-35	-1.202
EXP PM	4	6-20	17.14	2.85	8-20	-1.177

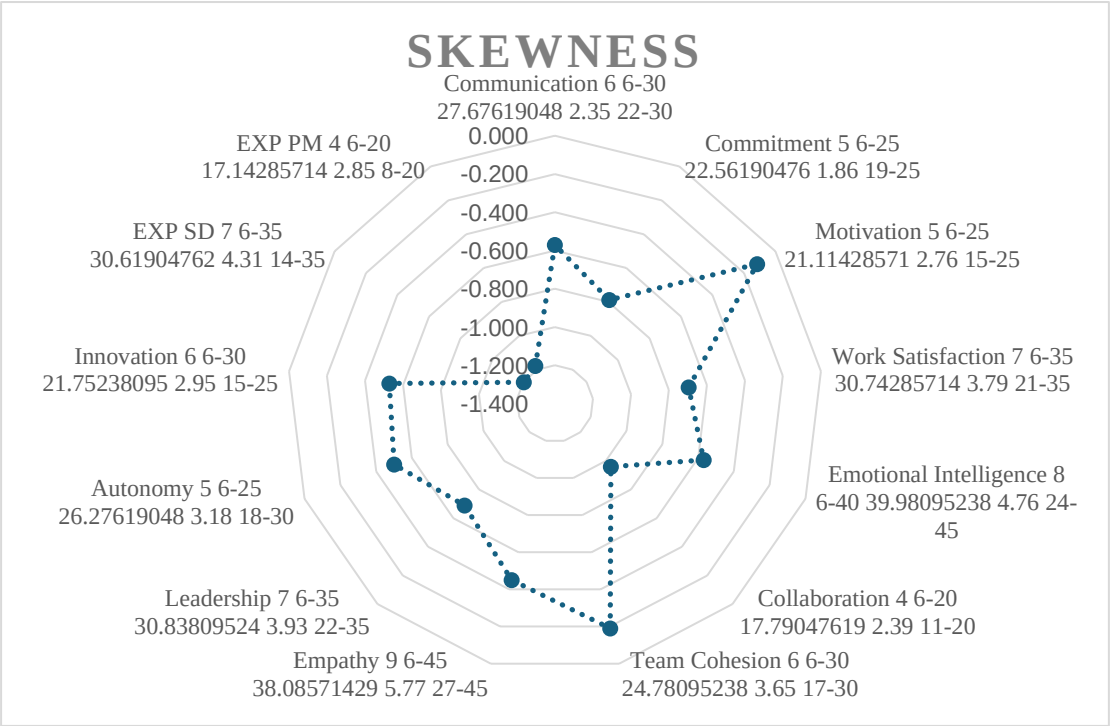


Figure 5.2: Responses Skewness for selected SHFs

From a statistical point of view, these results look promising and show the impact of these 13 factors on productivity of software development teams. But from a practical point of view, it is difficult to account for implementation of all these factors. Therefore, it is important to categorize these factors by reducing the dimensions. For that reason, Exploratory Factor Analysis (EFA) was performed using IBM SPSS.

Bellow settings are used in the SPSS for performing the Exploratory Factor Analysis, resulting in high internal consistency, and now factors were discarded.

- Extraction Method: Principal Component Extraction
- Normalization: Varimax Normalization

- Lading value >0.4

All 13 factors had loading value more than 0.5, therefore none of these factors were discarded. The correlation matrix between these factors is given in Table 5.17. All the correlation factors between these 13 factors are above 0.3, which shows a trend of linearity between these factors. Which means, with the increase of one factor, the other one also increases having impact on the productivity of software development.

Table 5.17: Correlation Matrix for Social and Human Factors

	PF1	PF2	PF3	PF4	PF5	PF6	PF7	PF8	PF9	PF10	PF11	PF12	PF13
PF1	1.000	0.515	0.408	0.372	0.543	0.563	0.420	0.503	0.531	0.391	0.501	0.406	0.390
PF2		1.000	0.346	0.409	0.639	0.515	0.465	0.491	0.543	0.455	0.585	0.374	0.322
PF3			1.000	0.682	0.639	0.508	0.586	0.633	0.547	0.612	0.496	0.605	0.559
PF4				1.000	0.796	0.537	0.753	0.676	0.703	0.810	0.610	0.804	0.807
PF5					1.000	0.738	0.769	0.771	0.779	0.851	0.767	0.726	0.718
PF6						1.000	0.496	0.565	0.624	0.651	0.627	0.530	0.543
PF7							1.000	0.813	0.754	0.785	0.720	0.801	0.731
PF8								1.000	0.720	0.763	0.761	0.693	0.606
PF9									1.000	0.717	0.744	0.802	0.749
PF10										1.000	0.717	0.757	0.718
PF11											1.000	0.609	0.676

PF12												1.000	0.848
PF13													1.000

Table 5.18: Initial and Extracted values of SHFs calculated in SPSS

Factor	**Initial**	**Extraction**
Communication	1.000	0.781
Commitment	1.000	0.773
Motivation	1.000	0.832
Work Satisfaction	1.000	0.837
Emotional Intelligence	1.000	0.870
Collaboration	1.000	0.681
Team Cohesion	1.000	0.816
Empathy	1.000	0.740
Leadership	1.000	0.793
Autonomy	1.000	0.808
Innovation	1.000	0.797

EXP SD	1.000	0.836
EXP PM	1.000	0.829

The solution of EFA was found to be satisfactory with Kaiser-Meyer-Olkin (KMO) model reached a value of 0.919 and the significance level of 0.000, as shown in Table 5.19.

Table 5.19: KMO and Barlett test for EFA

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.919
Bartlett's Test of Sphericity	Approx. Chi-Square	1343.447
	df	78
	Sig.	0.000

5.4 Validation of Framework

The correlation analysis presented in Table 5.17 presents the validation for our framework by illustrating the relationship between the 13 identified factors. Our framework hypothesizes that these social and human factors are related to each other and their relation influences productivity. Therefore, to get meaningful interpretation from their grouping, we present the discussion on correlation matrix. Finally, this practical interpretation can provide tremendous improvements in the productivity of software developments. Below are Key relationships and their practical implications.

Communication has a moderate positive correlation with Motivation (r=0.543) and Work Satisfaction (r=0.563). Data also shows strong influence of leadership on communication. This supports our frameworks' premise that effective communication enhances motivation and satisfaction among team members, thereby boosting

productivity. It encourages the organization to establish regular team meetings and use collaborative tools to ensure clear documentation of the process, tasks and progress. This helps in enhancing clarity, reducing misunderstandings and ensures everyone is on the same page, leading to smoother workflows and higher productivity.

Commitment has a strong positive relationship with motivation (r=0.639) and team cohesion. This supports our framework that committed team members result in greater team cohesion and autonomy. It is beneficial for team as well as individual performance by leveraging process expertise to enhance productivity (r=0.585). Motivation has a strong relationship with Emotional intelligence (r=0.682) and work satisfaction (r=0.639). These relationships validate our framework's assertion that motivated team members are emotionally intelligent, satisfied with their work and are most productive.

Similarly work satisfaction shows a very strong relationship with emotional intelligence (r=0.796), innovation (0.851) and project management (0,767). This emphasis the importance of work satisfaction of team members for facilitating the innovation and better project management. Collaboration is related to team cohesion strongly (r-0.24). Team cohesion also has great relationships with empathy and interpersonal relationships. Leadership is the most important factor discussed in the study and presented by the factory analysis and correlation matrix. It has a strong positive impact on almost all the factors such as innovation (r=0.717), process capabilities (0.744) and project management capabilities (0.802). This validates the assertion of our framework that effective team leadership impacts productivity directly and indirectly by improving other factors as well. From a practical point of view, it is important for organizations to encourage effective communications, facilitate leadership, offer incentives and provide opportunities for professional development and growth. This ensures that the team stays motivated, satisfied with their work and ensures team cohesion, all to enhance the productivity of the team.

CHAPTER 6: CONCLUSION

6.1 Summary of Findings

This thesis aimed to investigate the effects of various social and human factors on the productivity of software development teams. Through the development and validation of a comprehensive framework, this study identified and analysed 13 critical factors: Communication, Commitment, Motivation, Job Satisfaction, Collaboration, Team Cohesion, Emotional Intelligence, Empathy, Leadership, Innovation, Autonomy, Expertise in Software development and Expertise in Project Management. The findings from the correlation analysis demonstrated significant interrelationships among these factors, providing robust support for the proposed framework.

6.2 Practical Implications

The validation of the framework through empirical data suggests that the identified factors are not only interrelated but also collectively contribute to the productivity of software development teams. Implementing this framework in real-life software development environments can offer the following practical advantages:

1. **Enhanced Communication**: Regular team meetings, the use of collaborative tools, and clear documentation can reduce misunderstandings and ensure smooth workflows.

2. **Increased Commitment**: Fostering a culture of accountability and recognizing achievements can heighten dedication and improve performance.

3. **Higher Motivation**: Offering incentives and professional growth opportunities can encourage team members to strive for excellence.

4. **Improved Work Satisfaction**: Ensuring a good work-life balance and providing constructive feedback can enhance engagement and productivity.

5. **Emotional Intelligence**: Training programs to develop emotional intelligence can foster better interpersonal relationships and a more harmonious work environment.

6. **Collaboration**: Encouraging teamwork and collaboration through team-building activities and collaborative tools can lead to better problem-solving and innovation.

7. **Team Cohesion**: Strengthening team cohesion through regular interaction and mutual support can lead to a more unified and productive team.

8. **Leadership**: Effective leadership development programs can enhance innovation and guide the team towards achieving project goals.

9. **Innovation**: Encouraging creativity and providing resources for innovation can lead to new and effective solutions in software development.

10. **Autonomy**: Allowing team members autonomy in their tasks can boost their creativity and job satisfaction.

11. **Process and Project Management Capabilities**: Providing training in software development processes and project management can enhance overall team efficiency and productivity.

6.3 Limitations and Threats to Validity

Despite the significant findings, this study has certain limitations and threats to validity that need to be acknowledged:

1. **Sample Size**: The study was conducted with a limited sample size, which may not fully represent the diverse range of software development teams.

2. **Self-Reported Data**: The data collected through surveys are self-reported, which may introduce biases such as social desirability bias.

3. **Cross-Sectional Study**: The study design is cross-sectional, capturing data at a single point in time, which may not reflect changes over time.

4. **Context Specificity**: The findings may be context-specific and may not generalize to all software development environments, especially those with different cultural or organizational contexts.

6.4 Future Recommendations

Based on the findings and limitations of this study, the following recommendations are made for future research and practical applications:

1. **Longitudinal Studies**: Future research should consider longitudinal studies to examine how the relationships among the identified factors evolve over time and their long-term impact on productivity.

2. **Larger and Diverse Samples**: Conducting studies with larger and more diverse samples can enhance the generalizability of the findings across different contexts and cultures.

3. **Experimental Designs**: Implementing experimental designs can help establish causal relationships between the factors and productivity outcomes.

4. **Contextual Factors**: Investigating how different organizational contexts, such as remote versus in-office work, affect the relationships among the identified factors.

6.5 Conclusion

In conclusion, this study successfully developed and validated a comprehensive framework that highlights the critical social and human factors influencing the productivity of software development teams. The findings underscore the importance of addressing these factors to enhance team productivity. By implementing the practical recommendations outlined in this study, software development organizations can create a more productive, innovative, and satisfying work environment for their teams. Future research should continue to build on this framework, addressing the limitations and exploring new avenues to further understand and improve team productivity in software development.

CHAPTER 7: REFERENCES

Akman, I., Misra, S. & Cafer, F., 2011. The Role of Leadership Cognitive Complexity in Software Development Projects: An Empirical Assessment for Simple Thinking. *Human Factors and Ergonomics in Manufacturing,* 21(5), pp. 516-525.

Anderson, D. et al., 2014. *Statistics for Business and Economics.* 3rd ed. Hampshire: Cengage Learning.

Augustine, S., Payne, B., Sencindiver, F. & Woodcock, S., 2005. Agile project management: steering from the edges. *Communications of the ACM,* 48(12), pp. 85-89.

Boehm, B. W., 1984. Software Engineering Economics. *IEEE Transactions on Software Engineering,* 10(1), pp. 4-21.

Chaves, A. et al., 2022. *Autonomy and Turnover in Distributed Software Development Projects: a Systematic Literature Review*. s.l., Proceedings of the XXV Ibero-American Congress on Software Engineering.

Cooke, N. J., Kiekel, P. A. & Helm, E. E., 2010. https://www.tandfonline.com/doi/abs/10.1207/S15327566IJCE0503_10. *International Journal of Cognitive Ergonomics,* 5(3), pp. 297-315.

Cruzes, D. & Dyba, T., 2011. *Recommendedsteps for thematic synthesis in software engineering.* Banff, s.n., pp. 275-284.

Dubinsky, Y. & Hazzan, O., 2010. Ad-hoc leadership in agile software development environments. *CHASE '10: Proceedings of the 2010 ICSE Workshop on Cooperative and Human Aspects of Software Engineering*, pp. 32-38.

Edison, H., Ali, N. B. & Richard Torkar, 2013. Towards innovation measurement in the software industry. *Journal of Systems and Software,* 86(5), pp. 1390-1407.

Elizalde, R. & Bayona, S., 2018. Interpersonal Relationships, Leadership and Other Soft Skills in Software Development Projects: A Systematic Review. *Trends and Advances in Information Systems and Technologies*, Volume 746, pp. 3-15.

Estabrooks, P., 2001. Team Cohesion and Individual Productivity: The Influence of the Norm for Productivity and the Identifiability of Individual Effort. *Small Group Research*, 32(1), pp. 3-18.

Fatema, I. & Sakib, K., 2017. Factors Influencing Productivity of Agile Software Development Teamwork: A Qualitative System Dynamics Approach. *Asia-Pacific Software Engineering Conference*, pp. 737-742.

Fatema, I. & Sakib, K., 2018. Using Qualitative System Dynamics in the Development of an Agile Teamwork Productivity Model. *International Journal on Advances in Software*, 11(1), pp. 170-185.

Girardi, D., Lanubile, F., Novielli, N. & Serebrenik, A., 2022. Emotions and Perceived Productivity of Software Developers at the Workplace. *IEEE Transaction os Software Engineering*, 48(1), pp. 3326-3341.

Gracia, F. A. Z. & Russo, R. d. F. S. M., 2019. Leadership and Performance of the Software Development Team: Influence of the Type of Project Management. *RBGN*, 21(4), pp. 970-1005.

Graziotin, D., Fagerholm, F., Wang, X. & Abrahamsson, P., 2018. What happens when software developers are (un)happy. *The Journal of Systems and Software* , 140(1), pp. 32-47.

Graziotin, D., Wang, X. & Abrahamsson, P., 2015. Do feelings matter? On the correlation of affects and the self-assessed productivity in software engineering. *Journal of Software: Evolution and Process*, 27(7), pp. 467-487.

Gren, L., Torkar, R. & Feldt, R., 2017. Group development and group maturity when building agile teams: A qualitative and quantitative investigation at eight large companies. *Journal of Systems and Software*, 124(1), pp. 104-119.

Gunbayi, I., 2009. Academic staff's perceptions on stressors originating from interpersonal relations at work setting: a case study. *Procedia Social and Behavioral Sciences*, 1(1), pp. 50-60.

Gunsel, A. & Acikgoz, A., 2013. The Effects of Team Flexibility and Emotional Intelligence on Software Development Performance. *Group Decision and Negotiation,* 22(2), pp. 359-377.

Hantos, P. & Gisbert, M., 2000. Identifying software productivity improvement approaches and risks: construction industry case study. *IEEE Software*, January, pp. 48-56.

He, J., Butler, B. & King, W. R., 2014. Team Cognition: Development and Evolution in Software Project Teams. *Journal of Management Information Systems,* 24(2), pp. 261-292.

Hoda, R., Noble, J. & Marshall, S., 2013. Self-Organizing Roles on Agile Software Development Teams. *IEEE Transactions on Sofware Engineering*, 39(3), pp. 422-444.

Holtzhausen, N. & de Klerk, J., 2018. Servant leadership and the Scrum team's effectiveness. *Leadership and Organizational Development Journal,* 39(7), pp. 873-882.

IBM, 2024. *What is software development?*. [Online] Available at: https://www.ibm.com/topics/software-development [Accessed 2 April 2024].

Johannsen, R. & Zak, P. J., 2020. Autonomy Raises Productivity: An Experiment Measuring Neurophysiology. *Sec. Organizational Psychology*, 11(1).

Kakar, A. K., 2018. How do team cohesion and psychological safety impact knowledge sharing in software development projects. *The Journal of Corporate Transformation,* 25(4), pp. 1-10.

Kang, D., Jung, J. & Bae, D.-H., 2011. Constraint-based human resource allocation in software projects. *Software - Practice and Experience*, pp. 551-577.

Kazman, R. & Pasquale, L., 2020. Software Engineering in Society. *IEEE Software,* 37(1).

Kitchenham, B., 2004. *Procedures for Performing Systematic Reviews,* s.l.: Keele University.

Kitchenham, B. A. & Pfleeger, S. L., 2008. Personal Opinion Surveys. In: F. Shull, J. Singer & D. I. K. Sjøberg, eds. *Guide to Advanced Empirical Software Engineering.* London: Springer, pp. 63-92.

Kosa, M. & Yilmaz, M., 2015. *Designing Games for Improving the Software.* Ankara, Springer International Publishing, pp. 303-310.

Kosti, M. V., Feldt, R. & Angelis, L., 2014. Personality, emotional intelligence and work preferences in software engineering: An empirical study. *Information and Software Technology,* 56(8), pp. 973-990.

Kropp, M. & Meier, A., 2016. *Agile Practices, Collaboration and Experience.* s.l., International Conference on Product-Focused Software Process Improvement.

Lima, A. M., Reis, R. Q. & Reis, C. A. L., 2015. *Empirical Evidence of FActors influencing project context in distributed software projects.* Florence, ACM.

Machuca-Villegas, L., Gasca-Hurtado, G. P., Puente, S. M. & Tamayo, L. M. R., 2021. An Instrument for Measuring Perception about Social and Human Factors that Influence Software Development Productivity. *Journal of Universal Computer Science,* 27(2), pp. 111-134.

Masood, H., 2022. *Pakistan's I.T. Sector: Challenges and Opportunities amid Economic Crisis,* Lahore: Office of Research, Innovation & Commercialization Superior University.

Matturro, G., Raschetti, F. & Fontan, C., 2019. A Systematic Mapping Study on Soft Skills in. *Journal of Universal Computer Science,* 25(1), pp. 16-41.

McAvoy, J. & Butler, T., 2009. The role of project management in ineffective decision making within Agile software development projects. *European Journal of Information Systems,* 18(1), pp. 372-383.

Melo, C. d., Cruzes, D., Kon, F. & Conradi, R., 2013. Interpretative Case Studies on Agile Team Productivity and Management. *Information and Software Technology,* 55(2), pp. 412-427.

Melo, C. d. O., Cruzes, D., Kon, F. & Conradi, R., 2013. Interpretative Case Studies on Agile Team Productivity and Management. *Information and Software TEchnology,* 55(2), pp. 412-427.

Modi, S. & Strode, D., 2020. *Leadership in Agile Software Development: A Systematic Literature Review.* Wellington, Association for Information Systems.

Moe, N. B., Dingsoyr, T. & Royrvik, E., 2009. *Putting Agile Teamwork to the Test An Preliminary Instrument for Empirically Assessing and Improving Agile Software Development.* Berlin, Springer, pp. 114-123.

Moe, N. B., Dingsyr, T. & Kvangardsnes, O., 2009. *Understanding Shared Leadership in Agile Development: A Case Study.* Hawaii, Annual Hawaii International Conference on System Sciences (HICSS).

Muric, G., Abeliuk, A., Lerman, K. & Ferrera, E., 2019. Collaboration drives individual productivity. *Proceedings of the ACM on Human-Computer Interaction,* Volume 3, pp. 1-24.

Murphy-Hill, E. et al., 2021. What Predicts Software Developers' Productivity?. *IEEE TRANSACTIONSONSOFTWAREENGINEERING,* 47(3), pp. 582-594.

Noll, J., Razzak, M. A. & Beecham, S., 2017. *Motivation and Autonomy in Global Software Development: An Empirical Study.* s.l., EASE '17: Proceedings of the 21st International Conference on Evaluation and Assessment in Software Engineering.

Oliveira, C. D., 2017. *Fatores de Influência Na Produtividade Dos Desenvolvedores de Organizaciones de Software.* [Online] Available at: https://tede.ufam.edu.br/bitstream/tede/6137/5/Tese_EdsonOliveira_PPGI.pdf [Accessed 01 April 2024].

Pai, D., Subramanian, G. & Pendharkar, P., 2015. Benchmarking software development productivity of CMMI level 5 projects. *Information Technology and Management,* 16(1), pp. 235-251.

Peltokorpi, V. & Hasu, M., 2014. Moderating effects of transformational leadership between external team learning and research team performance outcomes. *R&D Management,* 45(3), pp. 304-316.

Raza, M. & Faria, J. P., 2014. A Model for Analyzing Estimation, Productivity, and Quality Performance in the Personal Software Process. *Proceedings of the 2014 International Conference on Software and System Process,* 1(1), pp. 10-19.

Rezvani, A. & Khosravi, P., 2019. *THE RELATIONSHIP BETWEEN EMOTIONAL INTELLIGENCE, STRESS AND TRUST AMONG SOFTWARE DEVELOPERS.* Stockholm, ECIS.

Riaz, M. N., Mahboob, A. & Buriro, A., 2018. Social Success Factors Affecting Implementation of Agile Software Development Methodologies in Software Industry of Pakistan: An Empirical Study. *International Journal of Advanced Computer Science and Applications,* 9(7), pp. 94-98.

Ringstad, M. A., Dingsoyr, T. & Moe, N. B., 2011. Agile Process Improvement: Diagnosis and Planning to Improve Teamwork. *ystems, Software and Service Process Improvement. EuroSPI 2011. Communications in Computer and Information Science,* Volume 172, pp. 167-178.

Sadowski, C., Storey, M.-A. & Feldt, R., 2019. A Software Development Productivity Framework. In: C. Sadowski & T. Zimmermann, eds. *Rethinking Productivity in Software Engineering.* Barkeley: Apress, pp. 39-47.

Sampaio, S. C. d. B. et al., 2010. *A Review of Productivity Factors and Strategies on Software Development.* A Review of Productivity Factors and Strategies on Software Development, CPS.

Shahzad, F., Xiu, G. & Shahbaz, M., 2017. Organizational culture and innovation performance in Pakistan's software industry. *Technology in Society,* 51(1), pp. 66-73.

Sharp, H. et al., 2009. Models of motivation in software engineering. *Information and Software Technology,* 55(1), pp. 219-233.

Srivastava, P. & Jain, S., 2017. A leadership framework for distributed self-organized scrum teams. *Team Performance Management,* 23(5), pp. 293-314.

Staistica Inc., 2024. *Software - Pakistan.* [Online] Available at: https://www.statista.com/outlook/tmo/software/pakistan [Accessed 02 April 2024].

Strode, D., 2015. *Applying Adapted Big Five Teamwork Theory to Agile Software Development.* Adelaide, Australasian Conference on Information Systems.

Trendowicz, A. & Munch, J., 2009. Factors Influencing Software Development Productivity - State-of-the-Art and Industrial Experiences. *Advances in Computers,* 77(1), pp. 185-241.

Van Kelle, E., Visser, J., Plaat, A. & der Wijst, P. v., 2015. *An Empirical Study into Social Success Factors for Agile Software Development.* s.l., ICSE Workshop on Cooperative and Human Aspects on Software Engineering, CHASE.

Wagner, S., 2019. Defining Productivity in Software Engineering. In: C. Sadowski & T. Zimmermann, eds. *Rethinking Productivity in Software Engineering.* s.l.:Apress Open, pp. 29-38.

Wagner, S. & Deissenboeck, F., 2019. Defining Productivity in Software Engineering. In: T. Zimmermann & S. Caitlin, eds. *Rethinking Productivity in Software Engineering.* Berkeley: Opress, pp. 29-38.

Wagner, S. & Murphy-Hill, E., 2019. Factors that influence Productivity: A Checklist. In: C. Sadowski & T. Zimmermann, eds. *Rethinking Productivity in Software Engineering.* Barkeley: press, pp. 69-84.

Wagner, S. & Ruhe, M., 2018. *A Systematic Review of Productivity Factors in Software Development.* Nanjing, Association for Computing Machinery.

Yang, H., Huff, S. & Strode, D., 2009. *Leadership in Software Development: Comparing Perceptions of Agile and Traditional Project Managers.* s.l., Amics.

Yilmaz, M., O'connor, R. & Clarke, P., 2015. Effective Social Productivity Measurements During Software Develoopment: An Empirical Study. *International Journal of Software Engineering and Knowledge Engineering,* 26(3), pp. 457-490.