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Assessing Soft Skills for Software Requirements Engineering Processes

Yousef A. Yousef[1], Abdelrafe Elzamly[1], Mohamed Doheir[2] and Noorayisahbe Mohd Yaacob[3]

[1]Al-Aqsa University, Gaza, Palestine
[2]University Malaysia of Computer Science and Engineering (UNIMY), Cyberjaya, Selangor, Malaysia
[3]Taylor's University, Subang Jaya, Selangor, Malaysia

Software requirement engineering (SRE) is the process of establishing, documenting, and maintaining software requirements. The goal of this research is to investigate the importance of soft skills in SRE. The data collection was performed through an online questionnaire. Descriptive statistics, principal components analysis (PCA), and stepwise regression techniques were used to analyze the data. A comprehensive review determined the 31 soft skills associated with SRE. There were 122 software development experts in Gaza who participated in the survey. The PCA analysis extracted six factors, named problem-solving, learning willingness, commitment, pressure resilience, critical thinking, and interpersonal skills. The analysis discovered that the level of SRE practice in Gaza is 73.71%. Furthermore, it was determined that 89.2% of respondents have critical thinking skills, and 85% have problem-solving and commitment skills. The result shows that all soft skills factors have strong links to SRE. However, only four soft skills (problem-solving, willingness to learn, pressure tolerance, and critical thinking) were found to have an impact on SRE. Considering these findings, we recommend focusing on the development of soft skills, especially problem-solving and willingness to learn skills, for the team analyzing software system requirements.

ACM CCS (2012) Classification: Software and its engineering → Software creation and management → Software development process management

Keywords: software requirement engineering, soft skills, software project

1. Introduction

In recent decades, the information and communication technology (ICT) became a crucial factor in the success of many organizations. This has contributed to the growth of the development of modern information systems that are able to meet the objectives of these organizations. Worldwide IT invested more than $503 billion in software development in 2020 and is expected to cross $556 billion in 2021 [1]. However, state-of-the-art refers to software projects' incredibly high failure rate. The Standish Group reported a partial or complete failure of 64% of software projects due to several factors [21]. The most significant factors of unsuccessful software projects are incomplete and changing requirements, poor planning, failure to communicate and act as a team, and inappropriate skills [2, 3].

Many software projects have challenges in fully and precisely specifying the requirements at the start of the project [4]. This presents a variety of project risks and obstacles including exceeding the project costs and schedules intended and failure to achieve project goals. It is therefore crucial for the team to be able to manage the processes of system requirements with the necessary hard and soft skills. Hard skills are examples of practical experience and technical skills. Soft skills provide employers with the chance to improve working relationships and performance. Communication skills among team members, for example, contribute

to a healthy work environment and help the team achieve productivity and organizational goals.

Several studies, including [5–10], address the concept of soft skills in software engineering. The current research, after these studies, focuses on the soft skills that affected the SRE in Gaza Strip. Therefore, the study's main aim is to:

1. Identify and rate the importance of soft skills in software requirements processes.
2. Investigate the relationships between soft skills and the software requirements process.
3. Investigate the impact of soft skills on the software requirements processes.

2. Research Questions

In order to achieve the objectives, this research addresses the following questions:

- What are the important soft skills of software requirements processes?
- What is the relationship between soft skills and the processes of software requirements?
- What is the effect of soft skills on the processes of software requirements?

According to the research questions, the developed hypotheses are:

- H1: There is an important connection between the dimension of soft skills (problem-solving, willingness to learn, commitment, withstanding pressure, critical thinking, and interpersonal skills) and the SRE.
- H2: There is a significant impact of soft skills dimensions (problem-solving, willingness to learn, commitment, withstanding pressure, critical thinking, and interpersonal skills) on SRE.

3. Soft Skills

All professions require special skills in addition to knowledge to be successful. A skill is a person's ability to do what is expected of them well. According to [11], skills help people to evaluate new and challenging problems, discover innovative solutions, and make suitable choices. In literature, skills are classified into hard and soft skills. Hard skills are technical knowledge derived from any experience in life and involve formal and informal learning [6]. These skills can be developed through practice, repetition, and education. Soft skills apply to non-technical skills that are essential for any team's success. These talents in the literature are referred to as nontechnical skills. This includes communications skills, generic work of a team, passion, dedication, leadership, multi-culturalism, interpersonal ability, customer orientation, and emotion [5, 7, 9].

Soft skills refer to a collection of interpersonal skills that enable people to enhance their relationships and performance at work [12]. These skills are necessary for any career and are crucial for joining and facing the labor market [13]. Soft skills in software development processes (SDP) are generally considered complementary to hard skills [14]. Unfortunately, previous researchers discovered that it is difficult to identify soft skills and measure their influence on SDP success chances [8, 12]. In this context, several researchers investigated the numerous soft skills related to software engineering. Ahmed *et al.* [6], for example, defined skills that are appropriate to various software development life cycle roles. They concluded that communication, interpersonal, analytical, and problem-solving skills, organizational skills, ability to work independently, and openness and adaptability to changes are more vital soft skills in SDP. Mtsweni *et al.* [8] identified soft skills that contribute to the success of SDPs. These skills are team player, personal integrity, group work, time management, effective questioning, open communication, critical thinking, problem-solving, generating feedback, and planning and control. Ahmed *et al.* [6] conducted interviews with 35 software engineering professionals working for software firms. They came to the conclusion that the most important values for team leaders are leadership, communication, customer

orientation, interpersonal skills, and teamwork. In 2017, Patacsil and Tablatin [15] determined the most important soft skills in IT industry. They found that teamwork and communication skills are very important soft skills.

Mtsweni *et al.* [8] identified and classified soft skills that enable the effective delivery of SDPs. They concluded that diverse soft skills are essential to promoting effective SDPs. The following table shows the soft skills studies and their proposed dimensions.

Table 1. A Review of Soft Skills in Software Engineering.

No.	Soft Skills Dimension	References
1.	Communication skills	[5, 6, 8, 12, 14-17]
2.	Critical thinking	[8, 14, 16]
3.	Teamwork	[5, 6, 8, 10, 12, 13, 15–18]
4.	Emotional intelligence	[10, 13]
5.	Flexibility	[6, 10, 14, 16, 17, 19]
6.	Goal orientation	[5, 13, 17]
7.	Interpersonal skills	[5, 6, 14–16, 18, 19]
8.	Leadership skills	[13, 15–17]
9.	Management skills	[5, 6, 15–17]
10.	Motivational skills	[5, 14, 15]
11.	Personal integrity	[8, 16]
12.	Planning and control	[5, 8, 17, 18]
13.	Pressure tolerance	[8, 10, 13, 15, 17]
14.	Problem solving	[5, 6, 8, 10, 16–18]
15.	Responsibility	[5, 17]
16.	Time management	[8, 10, 17]
17.	Willingness to learn	[5, 10, 14, 17]
18.	Work ethics	[5, 16]

According to the previous table, the ability to work in a team is the most frequently reported skill, as indicated in ten studies, followed by the ability to communicate, as stated in eight studies, and the ability to engage with people, as stated in seven studies. These studies used several techniques for identifying soft skills. Examples of these approaches include surveys, interviews, literature reviews, and quantitative content analysis.

4. Software Requirements Engineering

A software requirement is a statement on a proposed system to manage the flow of data to and from the organization. This statement explains the roles and behavior of the proposed system agreed upon by all parties in relation to the organization [3, 20]. Software requirements engineering (SRE) is considered one of the most crucial stages in SDP before designing, coding, testing, or maintenance takes place. It is a set of processes developed to recognize a software requirement, define user requirements correctly and help developers to understand exactly what the customer needs. However, some software project failures due to poor specification of requirements have been reported [3, 21].

According to Sommerville [22], SRE processes are mostly determined by the application domain, stakeholders, and organization structure. The SRE processes are as follows:

- Requirements discovery: The discovery of requirements-related activities (*e.g.*, stakeholder discussion, document analysis, and prototyping).
- Requirements classification and organization: To ensure a more accurate understanding of each requirement and to represent the various sets of requirements.
- Requirements prioritization and negotiation: This process includes prioritizing requirements, identifying, and resolving requirements' conflicts through negotiation.
- Requirements specification: Representing and storing the collected requirements knowledge in an organized manner.

- Requirements validation: Ensuring that the requirements information will allow for the development of a solution that satisfies stakeholder needs.

Different software development approaches address requirements in various ways. While some methodologies rely on a whole stage devoted to requirements engineering (plan-driven), others see it as a waste of time, especially given the frequent changes in initial requirements (agile method). In this study, we look at the impact of critical skills on the success of these processes without taking into account the various requirements management methodologies.

5. Research Methodology

This study is based on a literature review that relates to soft skills and software requirement processes. The initial questionnaire consisted of 17 items measuring the software requirement engineering processes and 43 items measuring nine dimensions of soft skills. The responses were recorded using a five-point scale (from 1: very disagree to 5: very agree). The questionnaire was developed in Google Docs and the data were processed using Microsoft Excel 2010 and SPSS 20. The reliability and construct validity of the initial questionnaire was examined by statistical reliability analysis and exploratory factor analysis (PCA). To test the research hypothesis, stepwise regression techniques were utilized. Modeling regression is one of the most used methods to estimate the effect of an independent variable on the dependent variables.

5.1. Sampling

Table 2 shows the demographic characteristics of the experts who participated in the study. A total of 122 experts participated in the survey. Males made up 71.2% of the sample, while females made up 28.8%. Undergraduate degrees made up 66.7% of responses, while postgraduates made up 33.3%. It also shows that more than half of the respondents have more than six years of experience, accounting for 51.5% of the total. This indicates that the survey respondents are qualified and have enough expertise to share their opinions on soft skills and how they affect SRE.

Table 2. Demographics of the research sample.

Characteristics		Sample Number	%
Gender	Male	87	71.2
	Female	35	28.8
Qualification	Undergraduate	81	66.7
	Postgraduate	41	33.3
Job	Developer	70	57.6
	Manager	30	24.2
	Analyst	13	10.6
	Maintenance	9	7.6
Experiences	1–5	59	48.5
	6–10	24	19.7
	> 10	39	31.8

5.2. Reliability and Validity Analysis

Cronbach's alpha is a measure of internal consistency and a measure of scale reliability [23]. We used Cronbach's alpha as a measure of internal consistency. The study's Cronbach's alpha value is 0.961, which indicates the instrument items' high levels of consistency.

5.3. Principal Components Analysis

PCA is used in this study to reduce the dimensions of soft skills related to SRE. The method of factor analysis depends on the Eigenvalues and the cross-loading to determine the number of dimensions in the instrument. Eigenvalues are important factors in which components with Eigenvalues greater than 1 are more significant and factors less than 1 with Eigenvalues are negligible. Cross-loading refers to the two or more-dimensional distribution of items. The component analysis and varimax rotation were run on 43 soft skills from a survey of 122 respondents. The results show only six dimensions that have eigenvalues greater than 1.0. A total of 12 soft skills were eliminated due to cross-loading. Hence, the final questionnaire is composed of six dimensions and 31 soft skills as seen in Table 3.

Table 3. Results of Factor Analysis.

Factors	Items					
	1	2	3	4	5	6
Factor 1: Problem-solving						
Ability to think in times of crisis.	.729					
Consider the ideas and opinions of others.	.751					
Strong drive to achieve my goals.	.756					
Willing to accept new responsibilities.	.590					
Know how people will react to a new idea or suggestion in advance.	.738					
Understand the organization's social fabric.	.678					
Attention to the detailed aspects of work.	.758					
Hold regular meetings to discuss the plan, achievements, and alternative plans for implementation.	.676					
Consider all alternatives to solve the problem.	.508					
Strive to look at problems from different perspectives and find multiple solutions.	.708					
Immediately look for ways to improve the idea and avoid future problems.	.625					
Factor 2: Willingness to learn						
Enjoy working in a fast-paced environment and changing demands.		.655				
Develop an execution plan with the sequence of events needed to complete it.		.596				
Decisions are made based on past knowledge of how to carry out the plan.		.677				
Stay up to date with recent developments in my field.		.856				
Factor 3: Commitment						
Constantly work on changing the current working conditions.			.478			
Set priorities and stick to them when I plan my daily work.			.752			
Strictly adhere to the working hours.			.586			
Factor 4: Withstand pressure						
Focus on the person who is talking to me.				.466		
Ability to control my emotions when facing any dangers.				.785		
Keeping feelings and work apart.				.746		
Work done on time.				.694		
Enjoy working in a fast-paced environment and changing demands.				.742		
A certain amount of pressure helps me perform at my best.				.796		
Desire for work with some degree of uncertainty.				.456		
Factor 5: Critical Thinking						
A strong drive to achieve goals.					.619	
Break down big tasks into subtasks and timelines.					.788	
Factor 6: Interpersonal skills						
Consider the possibility of others receiving ideas.						.452
To prevent forgetting, write down the facts and concepts that come to mind.						0.69
Ask questions and find a solution through consultations with colleagues.						.481
Take the time to evaluate the effectiveness of working as a group.						.767

Six factors (soft skill dimensions) were identified, as shown by the data in Table 3: problem-solving, willingness to learn, commitment, withstanding pressure, critical thinking, and interpersonal skills. These factors together revealed that the soft skills component accounted for 69.92% of the overall variance. Firstly, problem-solving demonstrates the most variance (33.8%), which contains 11 items. The second factor is called willingness to learn, which contains four items. The third factor is called commitment, which contains three items. The fourth component is known as withstand pressure, which only has two items. The interpersonal skills factor contains four items.

6. Results and Discussion

6.1. Software Requirements Engineering Practice Level

In this study, the opinions of a group of software employees were polled, with an emphasis on those involved in gathering and analyzing software requirements. Software requirements engineering practice level is 73.7%, according to Table 4. The most common requirement processes are documenting the requirements (83.53%), documenting the software requirements (84.7%), and using standards documentation

Table 4. Software requirements engineering processes.

No.	Requirement Processes	Mean	%	Rank
1.	Requirements are documented using a set of standards.	3.24	64.71	15
2.	For such requirements, a prototype is being developed.	3.71	74.12	10
3.	Other systems with requirements that are similar to the new system are used.	3.35	67.06	13
4.	Before system development begins, all requirements are gathered and standardized.	3.29	65.88	14
5.	Overlaps between requirements are found using interaction matrices (relationships between requirements).	3.76	75.29	8
6.	To examine requirements, specific criteria are employed.	3.65	72.94	11
7.	A strategy is devised to resolve conflicts between several requirements.	4.00	80.00	5
8.	The requirements are listed in order of importance.	3.59	71.76	12
9.	Requirements are grouped according to their role in the system, with rules in place to deal with inaccuracies and inconsistencies.	3.24	64.71	16
10.	A collection of standards is used to document requirements.	4.12	82.35	3
11.	There are policies in place to manage requirements.	3.76	75.29	9
12.	During the development of a system, requirements are constantly monitored.	3.82	76.47	6
13.	Rejected requests are kept track of.	2.82	56.47	17
14.	Requirements are described via templates/documents.	4.18	83.53	2
15.	All software requirements are put into a list.	4.24	84.71	1
16.	A glossary of specialist terminology is available.	4.06	81.18	4
17.	Diagrams are used to properly describe requirements (UML).	3.82	76.47	7
		3.69	73.71	

(82.35%). Grouping requirements (64.71%) and keeping track of rejected requirements (56.47%) are the less common requirement methods.

6.2. Levels of Soft Skills

In this research, respondents were asked to rate their level of soft skills related to SRE. According to Table 5, 89.2% of those polled have critical thinking abilities. 85% are ready to make a commitment and have problem-solving skills, and 81.2% willingness to learn. However, 79.4% can work under pressure.

Table 5. Soft Skills in SRE.

No.	E-Skill Dimension	Mean	%
1.	Problem-solving	4.25	85
2.	Willingness to learn	4.06	81.2
3.	Commitment	4.25	85
4.	Withstand pressure	3.97	79.4
5.	Critical Thinking	4.46	89.2
6.	Interpersonal skills	3.42	68.4

Table 6 summarizes the top ten soft skills as rated by respondents, from the most important to the least important ones.

Table 6. The top 10 Soft Skills.

Soft Skills	Mean	Rank
A certain amount of pressure helps perform best.	4.5	1
Strong drive to achieve my goals.	4.4848	2
Take the time to evaluate the effectiveness of working as a group.	4.4848	3
Committed to achieving my objectives.	4.4545	4
Break down big tasks into subtasks and timelines.	4.4394	5
Understand the organization's social fabric.	4.3939	6
Focus on the person who is talking.	4.3788	7
Attention to the detailed aspects of work.	4.3485	8
Consider the possibility of others receiving ideas.	4.3333	9
Consider all alternatives to solve the problem.	4.3182	10

According to Table 6, 90% of respondents prefer working with a reasonable amount of unpredictability, and 89.7% have a strong drive to achieve goals.

6.3. Correlation Analysis

The Pearson correlation coefficient was used to investigate the relationship between the identified soft skills and SRE. The results are shown in Table 7.

Table 7. Correlation Coefficient.

Soft Skills	Person Correlations	Significance
Problem-solving	0.321**	0.009
Willingness to learn	0.058***	0.643
Commitment	0.575**	0.000
Withstand pressure	0.445**	0.000
Critical Thinking	0.541**	0.000
Interpersonal skills	0.617**	0.000
* Correlation is significant at the 0.01 level (2-tailed).		
** Not significant		

As shown in Table 7, the strongest association is between interpersonal skills (p = 0.617, Sig = 0.009), followed by commitment (p = 0.575, Sig = 0.000), critical thinking (p = 0.541, Sig = 0.000), withstanding pressure (p = 0.445, Sig = 0.000), and problem-solving (p = 0.321, Sig = 0.009). This implies that SRE and soft skill dimensions (problem-solving, commitment, pressure tolerance, critical thinking, and interpersonal skills) have a strong association. It also demonstrates that SRE is not related to willingness to learn. As a result, the first hypothesis can only be accepted partially because 5 of the 6 identified skills are related to SRE.

6.4. Regression Analysis

Regression analysis was used in this study to examine how independent variables (soft skills) affect the dependent variable (SRE). Table 8 shows the impact of soft skills characteristics on SRE.

Table 8. The impact of soft skills on SRE.

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
	(Constant)	2.355	.499		4.715	.000
1	Problem-solving_	.316	.117	.321	2.709	.009
2	Willingness to learn	.295	.101	.251	2.911	.004
3	Withstand pressure	.291	.117	.296	2.482	.016
4	Critical Thinking	.346	.123	.332	2.813	.007
Where, R = .558, R^2 = .312, Adjusted R^2 = .229, F-value = 3.756, Sig. F = 0.002.						

According to the regression analysis, the value of R is 0.558, with a p-value of 0.002, indicating that soft skills and SRE are positively correlated. Soft skills (problem-solving, willingness to learn, pressure tolerance, and critical thinking) account for 31.2% of the total variation in the dependent variable (SRE), according to the R^2 = 0.312. The remaining soft skills (commitment and interpersonal skills), on the other hand, are discarded because they are unconnected to SRE. Based on these findings, the multi-regression equation (E1) was developed:

$$\begin{aligned} SRE = {} & 2.355 + 0.316\ \text{Problem-solving} + \\ & 0.295\ \text{Willingness to learn} + \\ & 0.291\ \text{Withstand pressure} + \\ & 0.346\ \text{Critical Thinking} + e \end{aligned} \quad (1)$$

Equation 1 reveals the positive effect of the improvement of soft skills on the SRE. Figure 1 shows the interaction model between independent factors (soft skills) and the dependent variable in this investigation (SRE).

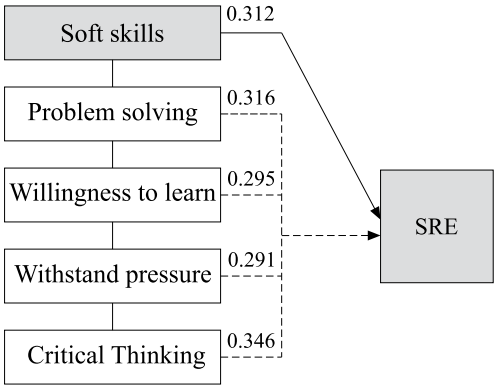

Figure 1. Research Model.

7. Conclusion

This research aimed to determine the soft skills essential to successful systems requirements engineering processes. In order to achieve the objective, a questionnaire was devised to gather the views of a group of developers and system analysts in the Gaza Strip. The analysis revealed that 84.7% of respondents use a specific list to recognize the requirements (list the requirements in the order of importance), 83.53% describe requirements in specific forms, and 82.35% use standards in documenting requirements. However, only 56.475% of respondents track the rejected requirements. The analysis also showed that the level of SRE is 73.71%, which is a good percentage but requires continuous improvement. In terms of soft skills, critical thinking ranked first with 89%, followed by problem-solving and commitment skills with 85%, and a desire to learn with 81%. Soft skills (problem-solving, commitment, pressure resistance, critical thinking, and interpersonal skills) were found to have the strongest associations with SRE. Finally, the analysis revealed that soft skills (problem-solving, willingness to learn, pressure tolerance, and critical thinking) had a positive effect on SRE (31.1%). This indicates that if soft skills are improved, the chance of SRE success will increase. The findings of this research will contribute to the existing literature on identifying soft skills that can improve software requirement processes and provide successful outcomes.

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Contact addresses:
Yousef A. Yousef
Al-Aqsa University
Gaza
Palestine
e-mail: Ya.yousef@alaqsa.edu.ps

Abdelrafe Elzamly
Al-Aqsa University
Gaza
Palestine
e-mail: Abdelrafe.Elzamly@alaqsa.edu.ps

Mohamed Doheir
University Malaysia of Computer Science and Engineering
Cyberjaya
Selangor
Malaysia
e-mail: mohamed.doheir@unimy.edu.my

Noorayisahbe Mohd Yaacob
Taylor's University
Subang Jaya
Selangor
Malaysia
e-mail: syayaacob88@gmail.com

Yousef A. Yousef received a BSc degree in computer science from the Al-Aqsa University, Gaza, and an MSc degree in computer information systems (CIS) from the Arab Academy of Banking and Financial Sciences, Amman, Jordan. He subsequently received a PhD in management information systems (MIS) from Al-Jinan University, Lebanon, in 2017. He is an assistant professor for MIS at the Department of Computer and Information Sciences, Al-Aqsa University, Gaza, Palestine. Dr. Yousef's primary research interest is in MIS, big data analysis, and software risk management. Dr. Youssef held numerous administrative positions at Al-Aqsa University, including the assistant vice president for information technology affairs.

Abdelrafe Elzamly received his BSc degree in Computer from Al-Aqsa University, Gaza in 1999, his MSc degree in computer information systems from the University of Banking and Financial Sciences in 2006, and his PhD in information and communication technology from the Technical University Malaysia Melaka (UTeM) in 2016. He is currently working as a full-time assistant professor at Al-Aqsa University, Gaza. He worked as a part-time lecturer at the Islamic University in Gaza from 1999 to 2007. Between 2010 and 2012, he worked as a manager at the Mustafa Center for Studies and Scientific Research in Gaza. His research interests are in risk management, quality software, software engineering, cloud computing security, and data mining.

Mohamed Doheir received his BSc degree in educational computer science from Al Aqsa University, Gaza, Palestine in 2006, his MSc degree in Internet working technology from the University Technical Malaysia Malaka (UTeM) in 2020, and a PhD in health care management from the University Technical Malaysia Malaka (UTeM). His research interests are in health care, cloud computing, and network simulations.

Noorayisahbe Mohd Yaacob received a PhD in health care management from the University Technical Malaysia Malaka (UTeM). She is currently working as a full-time assistant professor at the Malaysia-Japan International Institute of Technology, Jabatan Kejuruteraan Elektronik Sistem (Staf Akademik).