Bridging the Gap between Users and Developers in Software Intensive Projects of Turkish Defense Industry

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Abstract

In this study, socio-technical factors creating a multi-dimensional gap between users and developers in software intensive projects of Turkish Defense Industry are examined. Although there are numerous studies on the challenges and problems of the IT sector in the literature, defense industries have their own parameters. Therefore, they need to be examined separately. Findings have shown a significant gap between users and developers of software intensive projects. In addition to this, sociotechnical factors have important role on the success or failure of projects in Turkish defense industry.

Although there are numerous studies on the challenges and problems of the IT sector in the literature, Defense industries have their own parameters. Therefore, they need to be examined separately.

Keywords

Information Systems, Design/Development, SocioTechnical Issues, Defense Industry

1. Introduction

In this study, socio-technical factors creating a multi-dimensional gap between users and developers in software intensive projects of Turkish Defense Industry are examined. Although there are numerous studies on the challenges and problems of the IT sector in the literature, Defense industries have their own parameters. Therefore, they need to be examined separately.

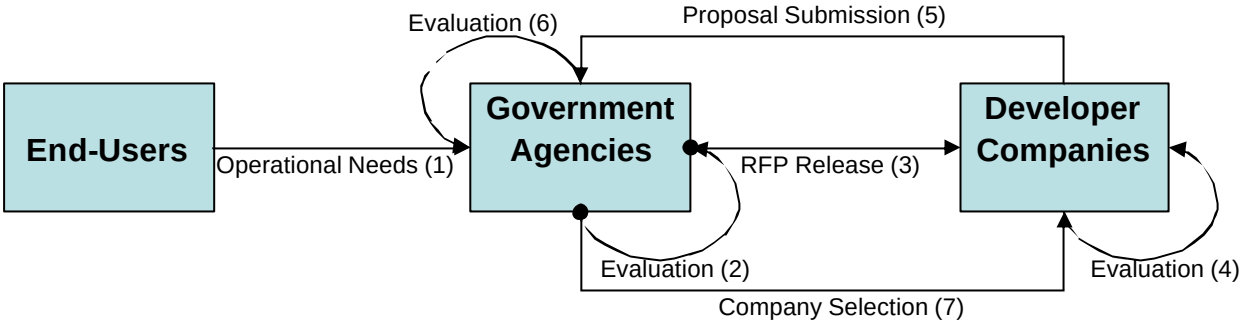

Figure 1. Typical Process for Competitively Bid Contract Award

Despite the fact that there are some inner layers and processes, Figure 1 roughly depicts the typical process for a competitively bid contract award in Turkish Defense Industry. End-users send their operational needs to a government agency. The government agency evaluates the request of the end-users. If the government agency agrees with the end-users, the government personnel prepare Request For Proposal (RFP) together with the end-users and release RFPs to the selected developer companies. The developer companies evaluate the RFP document and they decide whether or not they prepare a proposal. Some companies prepare their proposals and submit them to the government agency. The government agency evaluates the proposals submitted and selects one of them. During the development, the government agency staff and the end-users track and audit the project via review meetings and other unscheduled events. Grudin classified the software projects in three different development paradigms: contract development, product development and in-house development [9]. The military projects in Turkey are mostly the contract development. Although Figure 1 depicts the process for the contract development projects, the study covers the other two types of projects as well.

User participation is important for meeting the actual operational needs. Grudin pointed out that user involvement in design is not specified in procedures for the system acceptance and installation. Project plans do not cover the user involvement and organizational structures tend to exclude the user participation [9]. Development methodologies changing from the waterfall model to the spiral model encourage the user participation in each phase of the development. Alexander and Stevens listed the possible sources of requirements in a project and they pointed out that the developers need to make sure that the users have a feeling of an ownership over the requirements defined by themselves [18].

Goransson et al emphasized on the need for a person who specifies the usability goals, conducts user analysis and task analysis then leads the design team. They also stressed the importance to have direct communication and cooperation between users and developers.[1] Mann studied on the IT-User gap by giving its detailed characteristics. He made an overview of the various gap types existing in the literature [16]. The developers and the users generally speak in different languages. This may cause a difficulty in understanding the user needs and transferring them into the technical requirements [3]. Besides, the developers sometimes think their efforts, their overtimes, are not appreciated by the upper management if the project is completed on time within the budget [17]. This thought develops along with the unwillingness of precisely meeting the changing user requirements.

Throughout this paper, the term “user” is used for the end-users, project officers, and personnel in the government agencies. Project officers can be the end-users or the personnel in the government agencies.

2. Research Questions

The gap between users and developers in software-intensive projects of Turkish Defense Industry is studied to identify the sociotechnical factors making this gap came out and expanded and to discover possible methods for removing those factors. In this study, the gap between users and developers is classified. Major research questions are listed below:

- Whether the gaps reported in the literature exist in the Turkish Defense Industry or not?
- What are the socio-technical factors that underlie creating the gaps?
- Are there different types of gaps encountered which are not in the literature?
- What kind of solutions can be proposed for bridging the encountered gaps between users and developers?

3. Research Method

A case study approach was chosen in order to capture in-depth and contextual data. 30 users (the end-users, project officers and personnel working for the government agencies) and 30 developers in seven different Defense companies in Turkey participated in this case study. All the participants were selected as volunteers. Some of the users are working in the government agency which is controlling the procurement process. Some of them were selected from the personnel who are the potential end-users of the systems procured. The developers were selected from the 5+ years experienced personnel. They are from the upper management of the companies to the system/software engineers.

An interview guided by the questionnaire listed in Appendix-A was administered. The questionnaire was pilot tested with 6 participants (4 developers and 2 users). Questionnaire was redesigned by using the feedback gathered from this test. Questionnaire was administered in the participants’ language (Turkish). Responses of the participants to the questionnaire were written by the researchers. Interviews were administered in the participants’ working offices. At the start, the topic and the coverage of the study were explained to the participants.

Exploratory and descriptive analysis was used for data analysis. The descriptive analysis and data exploration provides the first estimates, level of the variability and uncertainty in the data, unexpected patterns and their indications. Microsoft Excel was used to assist in grouping the problems raised in the interviews and survey.

4. Result

Results are shown in two groups individually.

4.1 Developers

Table-1 Characteristics of Developer Participants in the Survey

Experience (year)	Number of Managers	Number of Systems Engineers	Number of Software Engineers
5-10	1	11	6
10-15	2	5	1
15-20	1	-	2
20+	1	-	-

60% of the developers participating in the survey stated that they could generally define real user needs instead of assumed needs. However, 35% of them stated that they could rarely define the real user needs.

50% of the developers participating in the survey stated that they always feel time pressure in preparing technical requirements. The other half of them stated that they generally feel time pressure.

95% of the developers participating in the survey stated that requirements are inadequately defined.

50% of the developers participating in the survey stated that requirements in the contract are not sufficient and 40% of them think that the users have a tendency to change requirements regardless of the contracts.

In contrast to the findings from the interviews listed in Table-2, 63% of the developers participating in the survey stated that they generally make prototypes for the users to visualize the designed system.

50% of the developers participating in the survey stated that the users generally do not attach importance of the technology used in the projects.

Only 30% of the developers participating in the survey stated that user participation in each phase of the development is very important.

Table-2 Problems raised in the developer interviews
Ill-defined requirements
Lack of prototyping
Low profile users
Frequently changing personnel
Unlimited requirement changes
Lack of user participation
Fat products with low usability
Need for proof of concept
Lack of trust
Lack of standardization
Repeated works
Lack of knowledge on procurement process
Vague statements in contracts
Growing requirements with limited resources
Lack of institutionalized knowledge
Difference between practices and directives/guidelines
Poor interaction between technology and operational concepts
Lack of product-line culture
Inadequate decompositions of operational needs
Adverse effects of unique customer
Lack of common language
Tissue conflict with domain experts
Lack of interaction between upper management and developers
Adverse effects of competitively bid contracts
Technological constraints in meeting requirements
Detailed specifications on contracts
Balance between responsibility and authority
Time Pressure

4.2 Users

Table-3 Characteristics of User Participants in the Survey

Experience (year)	Number of End-users	Number of Project Officers	Number of Gov. Personnel
5-10	1	1	11
10-15	3	1	8
15-20	2	-	3
20+	-	-	-

60% of the users participating in the survey stated that the developers always attached importance define real user needs instead of assumed needs and 25% of them stated that the developers do that generally.

60% of the users participating in the survey stated that they generally feel time pressure in reviewing technical requirements and evaluating design. 30% of them stated that they always feel time pressure.

46% of the users participating in the survey stated that requirements in the contract are not sufficient and 40% of them stated that they have always a connection with the developers to define the real user needs.

40% of the users participating in the survey stated that the developers rarely make prototypes for the users to visualize the designed system and 20% of them stated that the developers never make prototypes.

63% of the users participating in the survey stated that user participation in each phase of the development is very important.

Table-4 Problems raised in the user interviews
Communication problems
Lack of user participation
Lack of common language
Low profile developers
Lack of institutionalized knowledge
Balance between responsibility and authority
Technological constraints in meeting requirements
Frequently changing personnel
Low profile users
Purchasing from foreign resources
Resistance against new user needs and requirements
Profit-based attitudes
Tendency to use legacy systems
Long periods of awarding and contracting
Inflexible product development process
Limited infrastructure for growing requirements
Unrealistic project schedules
Technology-based approaches instead of operational needs
Poor project tracking mechanism
Undeveloped national industry

5. Discussions and Conclusions

5.1 Gaps Encountered

In the software intensive projects of the Turkish Defense Industry, five types of gaps existing in the literature were encountered throughout the study. A gap about the communication between the users and the developers [3], a gap due to the different ownerships that the users and the developers feel over the operational needs and the technological infrastructure respectively [13], and a gap due to the unrealistic expectations for the developers' capabilities [15] are supported both by the interviews and the survey administered. Gap due to the difference in working behaviours, values and characteristics [3] is supported by the interviews. At last but not least, a gap caused by the poor interaction between the users and the developers [3] is strongly supported by the survey. As expected before administering the interviews and the survey, the survey gave shallow information about the gaps and only the distinct patterns raised in the survey answers were considered. The interviews provided the researchers with good social environment in which both sides could express their sufferings although the end-users had a tendency to say "Everything is O.K" in formal interviews. Because of this fact, the researchers preferred not to use any video or voice recording device during the interviews for the sake of establishing an informal and sincere communication. Unlike the survey, the interviews gave the in-depth information about the gaps.

5.2 Socio-technical Factors

A uni-directional lack of trust towards the developers among the users was encountered in the interviews with the developers. Establishing a common language between the users and the developers seems to be important to bridge the gap caused by the communication problems.

According to the survey and the interviews, both sides are suffering from the lack of balance between the responsibility and the authority. On the developers side, responsibility generally gives them a feeling of usefulness which increases their performance and supports their positive attitudes towards the users. On the contrary, responsibility without authority affects the developers negatively and it is a common situation especially for the systems and the software engineers. On the users side, the lack of balance is not strong as on the developers side but there clearly exists according to the findings of the interviews with the users.

Strong and sometimes unrealistic expectations that the users have result in a stress and a feeling of dissatisfaction over the developers because they tend to challenge about the technology and the infrastructure over which they feel an ownership. Shah et al. proposed that the realistic expectations could occur if the developers and the users understand the other side's culture, thought process and environment [3]. Frequent changes in personnel assignments of both sides reduce the quality of the mutual understandings. Changes in personnel sometimes can be made by both sides on purpose. Changing the faces resisting against the other side's wishes can break down the determination of the other side.

Upper management on the developer side is often not aware of what kind of problems the developers suffer from or what the current situation is. They generally focus on the financial problems. The developers are seen as computers that can be run for 24 hours a day if needed. Interaction between upper management and the developers becomes poorer after contract awarding. The developers are obliged to

solve their problems with the users by themselves because upper management does not want to be “bad guy” against the users.

Having a unique customer (the government agencies) increases the stress over the upper management of the developer companies. Managers tend to accept the users’ requests regardless of whether they are realistic and feasible for the sake of maintaining the good relations with the users. Otherwise, they have no way of making bussiness.

According to interviews, unreasonable deadlines and emergencies are not the exceptions but the conditions throughout the project life cycle. They increase the pressure and stress over the developers. 95% of the developers participated in the survey feel a time pressure in doing their jobs and meeting the deadlines.

5.3 Relationships Between Problems Raised

Only the 25% of the found problems raised in both sides. Unawareness of the other side’s problems shows a strong evidence for a lack of communication.

Before starting the development phase, companies usually allocate the project resources in accordance with the requirements in the contracts. Vague statements in contracts cause poor resource allocation. This increases the possibility of growing requirements with limited resources. Additionally, lack of prototyping and user participation causes unlimited requirement changes especially at the very end of the project life cycle.

Knowing the fact that the government agencies are the only customers of the defense companies, the users tend to procure products with excessive functionality because companies could not reject their requirements other than operational needs. This tendency results in fat products with low usability. Frequently changing personnel brings about communication problems and frequent requirement changes.

Generally, companies have problems in institutionalizing knowledge gathered from the past projects. Therefore, technologically overlapping projects include repeated works. Repeated works imply the reusability problems which increase the project costs. Frequently changing personnel make the situation more dramatically worsened.

There is a bureaucracy for change procedures of military directives and guidelines. Users that could not break this psychological barrier for proposing corrective actions find their own solutions conflicting with the current directives and guidelines. Because of that, those documents currently are not living documents unlike they are supposed to be. Consequently, experiences and knowledge gathered from the past projects can not be institutionalized. The government agencies prepare RFPs and contracts with the guidance of the military directives/guidelines. Any difference between practices and military directives/guidelines causes serious conflicts between the operational needs and the contractual requirements.

Both sides assign a lesser time for requirement analysis and system design than required. For that reason, relatively more changes are required in the next phases at the expense of many man-hours and extra time.

5.4 Solutions Proposed

- On the developer side, people having engineering background, having experience with the end-users, knowing their working environment very well, speaking their domain-specific languages should be hired instead of domain experts.
- On the user side, project officers should be selected from the end-users having a technical background.
- Prototyping should be a process scheduled in the project plans just like design, coding or testing.
- Contracts should not cover overdetailed specifications.
- On the developer side, responsibility and authority should be balanced by establishing distributed decision mechanisms eliminating top-down centralized control.

5.5 Limitations

- Various inner layers on both sides (Different mental models on one side)
- Survey questions prepared according to literature
- Difficulty in getting real data from the end-users (Tendency to say "Everything is o.k")
- One of the researchers has been working for a defense company for seven years and he was more or less biased about the issue. This might have caused subjective evaluation of the data gathered from the survey and the interviews.

5.6 Suggestions for Further Research

- Enhancing validy of the findings by narrowing the focus of the study (focusing on the main user and developer groups)
- Preparing survey questions after short interviews
- Investigating the inner gaps on the developers side and on the users side individually

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APPENDIX-A QUESTIONNAIRE

	USERS	**DEVELOPERS**
1	The programs you are getting involved in generally are a) Competitively bid Contract Development b) Contract Development c) Off-the-Shelf Development d) Custom Development	The programs you are getting involved in generally are a) Competitively bid Contract Development b) Contract Development c) Off-the-Shelf Development d) Custom Development
2	At which position are you working in the projects? a) End-user b) Project Official c) Government Agency Staff d) It changes	At which position are you working in the projects? a) Manager b) Systems Engineer c) Software Engineer d) It changes
3	For how many years have you been working in Defense industry? a) 5+ b) 10+ c) 15+ d) 20+	For how many years have you been working in Defense industry? a) 5+ b) 10+ c) 15+ d) 20+
4	Which phase of the project are you currently in?	Which phase of the project are you currently in?

	a) Requirement Analysis b) System Design c) Implementation and Testing d) I have many projects	a) Requirement Analysis b) System Design c) Implementation and Testing d) I have many projects
5	How often do you think you could define your needs very well? a) Always b) Generally c) Rarely d) Never	How often do you think the system you are supposed to design is based on real user needs instead of assumed needs? a) Always b) Generally c) Rarely d) Never
6	How often do you think developers attach importance to understanding your operational needs? a) Always b) Generally c) Rarely d) Never	How often do you think you could form all technical requirements by using user's operational needs? a) Always b) Generally c) Rarely d) Never
7	In which phase do you think your relation with the developers weakens most? a) Requirement Analysis b) System Design c) Coding and Testing d) Maintenance	In which phase do you think your relation with the users weakens most? a) Requirement Analysis b) System Design c) Coding and Testing d) Maintenance
8	Do you have to express your needs in a technological language? a) No, developers could understand my domain-specific language b) No, we have technical staff to communicate with developers c) Yes, I feel we sometimes speak different languages d) Yes, There are always misunderstandings and misinterpretations between us and developers	Do you have any difficulty in speaking to users in domain-specific language? a) No, I could speak in domain-specific language b) No, we have a domain-expert. He/she communicates with users for us c) Yes, I feel we sometimes speak different languages d) Yes, There are always misunderstandings and misinterpretations between us and users
9	How often do you have assigned personnel to participation in project meetings with developers? a) Always b) Generally c) Rarely d) Never	How often do you have assigned personnel to participation in project meetings with users? a) Always b) Generally c) Rarely d) Never
10	Do developers come to the field to observe the user's working environment? a) No, they never come b) No but we describe the environment in project documents c) Yes but their observations don't reflect to their system design d) Yes, their observations reflect to their system design	Do you go to the field to observe the user's working environment? a) No, I don't think we have to b) No but I want to c) Yes but it is not helpful to understand the user needs. d) Yes, it is very helpful for us to understand the user needs.
11	What mechanism over the others is of great importance to encourage communication	What mechanism over the others is of great importance to encourage communication

	between you and developers? a) Review Relationship b) User Involvement in each phase c) User Involvement Up to Design d) Prototyping	between you and users? a) Review Relationship b) User Involvement in each phase c) User Involvement Up to Design d) Prototyping
12	Are you aware of the capabilities of new technologies? a) Yes, I am b) Yes but I think each new technology having an interface with us comes with a usability problem c) No but I think new technology is good to have d) No, I don't think I have to	Before defining technical requirements, do you make detailed analysis of existing technologies and approaches to system solution? a) Yes, we always make these kind of analyses b) Yes but technology we will use is sometimes defined by users or contracts c) No but we try to design products compatible with legacy systems d) No, technology we will use is mostly defined by users or contracts.
13	What do you think is the reason for continuously changing requirements throughout the project life cycle? a) Long project schedules and changing technologies b) Unable to completely define the user needs before contracting c) Frequently changing personnel d) All of the above	What do you think is the reason for continuously changing requirements throughout the project life cycle? a) Long project schedules and changing technologies b) Unable to completely define the user needs before contracting c) Positive attitudes towards new changes for maintaining good relations d) All of the above
14	How often are developers prototyping for visualising the designed system? a) Always b) Generally c) Rarely d) Never	How often are you prototyping for visualising the designed system? a) Always b) Generally c) Rarely d) Never
15	What kind of problem do you mostly have in understanding technical documents submitted to you before requirements/design reviews? a) No problem b) Document Language (English/Turkish) c) Too technical to understand d) Not well-prepared documents	What kind of problem do you mostly have in preparing technical documents before requirements/design reviews? a) No problem b) Document Language (English/Turkish) c) Traceability between documents d) Time-consuming QA procedures
16	How often do you feel time pressure in reviewing technical requirements and evaluating design because of the tight schedules and deadlines? a) Always b) Generally c) Rarely d) Never	How often do you feel time pressure in preparing technical requirements and designing the system because of the tight schedules and deadlines? a) Always b) Generally c) Rarely d) Never
17	How often do you think the interface that the developers design support the way in which users work? a) Always	How often do you think the interface that you design support the way in which users work? a) Always b) Generally

	b) Generally c) Rarely d) Never	c) Rarely d) Never
18	Do you think that contracts including detailed technical specifications make requirement analysis harder? a) No, requirements written on contracts generally define the user needs very well. b) No, we have always connection with the developers for defining real user needs. c) Yes, requirements written on the contracts generally are not enough. d) Yes but there is no way to define the requirements.	Do you think that contracts including detailed technical specifications make requirement analysis harder? a) No, requirements written on contracts generally define the user needs very well. b) No, we have always connection with the users for defining real user needs. c) Yes, requirements written on the contracts generally are not enough. d) Yes, the users have a tendency to change requirements regardless of the contracts.
19	What do you think about the social activities with the users? a) There is no social activity between the users and the developers b) They facilitate us to explain ourselves. c) They facilitate us to understand them. d) I don't think it is a good idea to socialize with the developers.	What do you think about the social activities with the users? a) There is no social activity between the users and the developers b) They facilitate us to explain ourselves. c) They facilitate us to understand them. d) I don't think it is a good idea to socialize with the users.
20	Which one do you mostly attach importance to? a) Completing projects on time b) Performing projects with national resources c) Being cost-effective d) Easy-to-maintain products	Which one do you mostly attach importance to? a) Completing projects on time b) Performing projects with national resources c) Being cost-effective d) Easy-to-maintain products
21	Do you think that the developers have a resistance against the new user needs? a) Always b) Generally c) Rarely d) Never	Do you think that the users have difficulty to accept the products based on new technologies? a) Always b) Generally c) Rarely d) Never
22	Do the developers develop the products not exactly meeting the user needs? a) Always b) Generally c) Rarely d) Never	Do the users define unrealistic requirements? a) Always b) Generally c) Rarely d) Never
23	Do you think that your opinions about the developers are affected by their past performances? a) Always b) Generally c) Rarely d) Never	Do you think that the user's opinions about the developers are affected by the past performances? a) Always b) Generally c) Rarely d) Never
24	Do you think that the users attach more importance to the technological infrastructure they use in the projects than the user needs? a) Always	Do you think that the users do not attach enough importance to the technological infrastructure you use in the projects? a) Always

	b) Generally c) Rarely d) Never	b) Generally c) Rarely d) Never
25	Do you think that you have some prejudice to the developers owing to the lack of communication? a) Always b) Generally c) Rarely d) Never	Do you think that the users have some prejudice to the developers owing to the lack of communication? a) Always b) Generally c) Rarely d) Never

APPENDIX-B

QUESTIONS IN INTERVIEWS WITH USERS

1. What are the problems with the developers you are experiencing in the projects you get involved?
2. What kind of improvements in project life cycle do you think are necessary to develop the products meeting all user requirements and being regularly used?

APPENDIX-C

QUESTIONS IN INTERVIEWS WITH DEVELOPERS

3. What are the problems with the users you are experiencing in the projects you get involved?
4. What kind of improvements in project life cycle do you think are necessary to develop the products meeting all user requirements and being regularly used?