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Climate and Product Quality in Software Development Teams: Assessing the Mediating Role of Problem Solving and Learning

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Abstract

The popularity of new product development has been increasing in knowledge-intensive organizations as a means to manage aggressive competition. Given the criticality of product development to the performance of many organizations, it is important to unveil the mechanisms that support problem solving. In line with the relevant literature, this study examined the relationships among team climate, team problem solving, team learning, and software quality. As well, this study explored the mediating effect of team problem solving on the relationship between team climate and team learning, and the mediating effect of team learning on the relationship between team problem solving and software quality. By using 139 questionnaires from different projects, structural equation modeling was employed as a statistical analysis tool to investigate the given hypotheses. The findings showed that (i) team climate was positively related to team problem solving, ii) team problem solving positively influenced team learning, iii) team learning was positively associated with software quality. In addition, the results indicated that the relationships between team climate and team learning was partially mediated by team problem solving, while the relationship between team problem solving and software quality was partially mediated by team learning. The implications for both theory and practice are discussed.

***Keywords**: Team Climate, Team Problem Solving, Team Learning, Software Quality.*

Yazılım Geliştirme Takımlarında İklim ve Ürün Kalitesi: Problem Çözmenin ve Öğrenmenin Bağdaştırıcı Rollerinin Değerlenmesi

Özet

Haşin rekabetin yönetilmesi maksadıyla bilgi-yoğun örgütler her geçen gün daha fazla yeni ürün geliştirmeye yönelmektelerdir. Yeni ürün geliştirmenin birçok örgütün performansına olan kritik etkisini göze alarak, problem çözmeyi destek-

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leyen mekanizmaların açığa çıkarılması önem arz etmektedir. Mevcut literatürün dikkate alınması çizgisinde, bu çalışma takım iklimi, takım problem çözmesi, takım öğrenmesi ve yazılım ürünü kalitesi arasındaki ilişkileri incelemektedir. Yine, bu çalışmada takım problem çözmesinin takım iklimi ve takım öğrenmesi arasındaki ilişki üzerinde bağdaştırıcı rolü ile takım öğrenmesinin takım problem çözme ve yazılım ürünü kalitesi arasındaki ilişki üzerindeki bağdaştırıcı rolü araştırılmaktadır. 139 farklı yazılım geliştirmesi projesinden elde edilen veriler, yapısal eşitlik modeli tabanlı kısmi En Küçük Kareler (PLS) metodu takip edilerek, bahsedilen ilişkileri açıklamak maksadıyla kullanılmıştır. Bulgular şu sonuçları vermiştir: (i) takım iklimi takım problem çözmesi üzerinde pozitif yönlü bir etkiye sahiptir, (ii) takım problem çözmesi takım öğrenmesini pozitif yönlü etkilemektedir, (iii) takım öğrenmesi ise yazılım ürününün kalitesini pozitif yönlü artırmaktadır. İlaveten, sonuçlar takım problem çözmesinin takım iklimi ve takım öğrenmesi arasındaki ilişki üzerinde kısmi bağdaştırıcı role sahip olduğunu; takım öğrenmesinin de takım problem çözmesi ve yazılım ürünü kalitesi arasındaki ilişki üzerinde kısmi bağdaştırıcı role sahip olduğunu göstermiştir. Bu bağlamda, kuramsal ve pratik etkiler tartışılmıştır.

Anahtar Kelimeler: *Takım İklimi, Takım Problem Çözmesi, Takım Öğrenmesi, Yazılım Ürünü Kalitesi*

1. INTRODUCTION

The traditional approaches for the achievement of business objectives have dramatically changed, especially those adopted by industries that operate in knowledge-intensive environments, such as the software industry. In these days, firms have increasingly preferred to use teams for the development of new products, services, processes and/or business models to achieve their vision instead of requiring individuals to adopt mere patents following trends established by competitors[1]. Recent studies indicate that 82 percent of firms with 100 or more employees prefer to assign employees to various team tasks and activities instead of assigning them to individual projects. In fact, approximately 70-75 percent of these teams are assigned to product development projects[2]. The literature of technology innovation management (TIM) reveals that firms which launch high technology products are quite often driven by rapid technological changes[3]. In this regard, traditional models and production methods should be updated in order to facilitate firms to be competitive and meet the increased demands of ongoing changing customer preferences.

If this is the case, teams involved in product development projects must invest in a continuous learning process, as their responsibilities often span a number of

1 Drach-Zahavy, Anat, "The proficiency trap: How to balance enriched job designs and the team's need for support", Journal of Organizational Behavior, 2004, 25, p.979-996.

2 Edmondson, Amy C., and Nembhard, Ingrid, M. "Product development and learning in project teams: The challenges are the benefits", Journal of Production Innovation Management, 2009, 26, p.123-138.

3 Günsel, Ayşe, and Açıkgöz, Atif, "The effects of team flexibility and emotional intelligence on software development performance", Group Decision and Negotiation, 2013, 22, p.359-377.

unfamiliar boundaries. Attention on the subject with team learning is desirable, as it fosters both rapid growth and diversity in perspectives. In this vein, teams are increasingly considered to be the important learning units within firms. This is particularly true for product development teams that face high levels of uncertainty and a need to integrate diverse sources of expertise, both of which require learning behavior[4]. In doing so, team members should collectively acquire and apply new knowledge and understandings to address team tasks and issues for which solutions have not yet been provided[5]. In this way, teams detect technical and market-related product problems and find alternative solutions for the problems, thereby producing new products with superior quality[6]. An accumulating body of evidence also supports the concept that team level learning leads product development teams to solve product-, process-, and project-related problems efficiently[7].

Focusing on the construct of problem solving which has been broadly discussed in the extant literature[8] as a dynamic capability, it seems that problem solving capability enhances learning since those who are involved in problem-solving procedures are often dealing with a variety of new challenges. Teams that are in great need of providing effective solutions for a given problem may learn from their pitfalls (lessons from the past); as such they contribute to the integration of the organizational knowledge stock which can be easily re-used and implemented in prospective projects[9]. Based on the problem-solving school of thought[10], knowledge creation is the sole process that should be implemented when a problem needs to be solved. As such, organizations and individuals learn only when a solution is actually provided and applied to a given problem. Additionally, teams increase their ability to respond to dynamic challenges, solve problems, and produce high quality products through the process of learning[11].

In this regard, knowledge-intensive firms should excel in problem-solving processes aiming at the improvement of traditional product development methods so as to gain first-mover advantage in the industry in which they operate. However,

4 Edmondson and Nembhard, 2009, p.123-138.

5 Sole, Deborah, and Edmondson, Amy, "Situated knowledge and learning in dispersed teams", British Journal of Management, 2002, 13, p.17-34.

6 Akgün, Ali E., Lynn, Gary, and Yılmaz, Cengiz, "Learning process in new product development teams and effects on product success: A socio-cognitive perspective", Industrial Marketing Management, 2006, 35, p.210-224.

7 Katila, Riitta, and Ahuja, Gautam, "Something old, something new: A longitudinal study of search behavior and new product introduction", Academy of Management Journal, 2002, 45, p.1183-1194.

8 Thomke, Stefan H., and Fujimoto, Takahiro, "The effect of 'front-loading' problem-solving on product development performance", Journal of Product Innovation Management, 2000, 17, p.128-142.

9 Tjosvold, Dean, Yu, Zi-You, and Hui, Chun, "Team learning from mistakes: The contribution of cooperative goals and problem-solving", Journal of Management Studies, 2004, 41, p.1223-1245.

10 Nonaka, Ikujiro, & Takeuchi, Hirotaka," The knowledge-creating company". (New York: Oxford University Press, 1995).

11 Huang, Jing-Wen, and Li, Yong-Hui, "Slack resources in team learning and project performance", Journal of Business Research, 2012, 65, p.381-388.

the way that teams of such firms should develop and retain problem-solving capabilities appears to be one of the main concerns of such teams which are involved in product development projects. The characteristics of a context (such as climate or culture), at either an organizational or team level, could equally facilitate or restrain the efforts made by teams to develop problem-solving capabilities[12]. For the purposes of this study, we assumed that team climate as an organizational context in which members' perceptions, experiences, and beliefs regarding contingencies, conditions, and relations among its members might have a significant effect on the development of problem-solving capabilities within a team.

Although there are widely held assumptions that team problem solving significantly affects product development outcomes, empirical research lacks sufficient evidence to support the antecedents of this construct in terms of team capability in the context of product development projects. In other words, extant literature, to the best of our knowledge, has not yet supported, either conceptually or empirically, interrelationships among the variables of climate, problem solving and learning at a team level, and consequently their potential effect on product development projects. To address this gap we attempt to provide a holistic model which views linkages amongst the variables of team climate, team problem solving, team learning, and product quality in the context of software development projects. Specifically, we explore the mediating effect of problem solving viewed as team capability on the relationship between team climate and team learning, as well as the mediating effect of team learning on the relationship between team problem solving and software quality.

The section which follows provides a literature review to establish the theoretical background of the study whilst the research hypothesis and the methodology are presented in the third and fourth sections accordingly. The fifth section presents study results discussed in the sixth section, in which managerial and theoretical implications for future research are also proposed. The seventh and last section concludes the study.

2. LITERATURE REVIEW

2.1. Team Problem Solving

In the knowledge management literature, organizations are defined as bundles of valuable, rare, inimitable, and non-substitutable capabilities and resources. Day[13] considers capabilities to be a combination of both skills and tacit knowledge which are operationalized throughout various processes of product development. In other words, capabilities are built upon knowledge and skills which are embed-

12 Zellmer-Bruhn, Mary, and Gibson, Cristina, "Multinational Organization Context: Implications for Team Learning and Performance", Academy of Management Journal, 2006, 49, p.501-518.

13 Day, George S., "The capabilities of market-driven organizations", Journal of Marketing, 1994, 58, p.37-52.

ded in teams' behaviors, technical systems, and managerial functions[14]. Product development teams should develop several capabilities, i.e., dynamic capabilities such as problem solving capability in order to evaluate, assimilate, and absorb large amounts of precise knowledge which are derived, either externally from or internally to organizational boundaries. Problem solving has been considered as the engine of knowledge creation and its importance at a team level has been widely studied in the field of product development[15].

Both scholars and practitioners consider problem solving to be a dynamic capability enabling product development teams to develop original solutions to solve problems, thus rendering them competitive in the environment in which they interact. Product development, by its nature, consists of a set of routinized problem-solving processes and those who are involved in these processes are constantly dealing with unpredictable situations and crucial problems[16].

A problem is often defined as a deviation from a desired set of specific reactions or conditions which result in mass symptoms that should be addressed[17]. Once a problem is detected, an inquiry is launched for a suitable solution to be found and implemented accordingly. Based on Huber's[18] work, the problem-solving process entails different phases which are related to understanding the problem, planning an appropriate solution, and also proposing various alternatives, implementing the chosen solution and periodically monitoring it. In the context of product development teams, problem-solving capability consists of a set of capabilities which include searching for new knowledge related to the issue(s) which have emerged, and developing the design and implementation of an appropriate action plan for solution of the problem and the final development of new improved products[19].

At a team level, problem solving is required, amongst others, to create new knowledge and provide new approaches to a complicated and unstructured issue[20]. As product development processes require direct problem-solving techniques, individual knowledge possessed by team members should be shared with the whole team, thus transformed into team knowledge. According to Nonaka and Takeuchi[21], four modes of knowledge conversion are identified which involve

14 Atuahene-Gima, Kwaku, and Wei, Yinghong, "The vital role of problem-solving competence in new product success", Journal of Product Innovation Management, 2011, 28, p.81-98.

15 Aladwani, Adel, "An integrated performance model of information systems projects", Journal of Management Information Systems, 2002, 19, p.185-210.

16 Thomke and Fujimoto, 2000, p.128-142.

17 Nickerson, Jack, Yen, C. James, and Mahoney, Joseph T., "Exploring the problem-finding and problem- solving approach for designing organizations", Academy of Management Perspectives, 2012, 26, p.52-72.

18 Huber, George, P., "Managerial Decision Making". (Scott Foresman & Co, 1980).

19 Thomke, Stefan H., "Managing experimentation in the design of new products", Management Science, 1998, 44, p.743-762.

20 Nickerson et al., 2012, p.52-72.

21 Nonaka, Ikujiro, and Takeuchi, Hirotaka," The knowledge-creating company". (New York: Oxford University Press, 1995).

creating new knowledge at the next level: socialization (tacit to tacit knowledge), externalization (tacit to explicit knowledge), combination (explicit to explicit knowledge), and internalization (explicit to tacit knowledge). Through this process, new knowledge and understandings are available to teams for instant use, in order for their teams to provide accurate solutions on a given problem[22]. In this vein, it could be observed that team problem solving is related to the team members' ability to discuss problems collectively in order to provide solutions throughout the development of a product or make improvements on existing products. Based on this discussion, it might be supported that the team's ability to solve problems is the outcome of team learning[23].

2.2. Team Learning

Today, an increasing number of firms have to deal with vital decisions in a rapid manner. This both challenges and instills the ability to learn quickly. Individual learning is necessary but is inadequate to generate learning at the organizational level[24]. A growing body of research[25] has considered teams as the main learning units in firms as an interface between individual and organizational learning[26]. Teams embody their knowledge based upon their members' knowledge and experiences[27]; thus, both teams and firms can learn. In other words, firms develop organizational learning capability through the learning of their teams. Similarly, Edmosson (1999) stresses the importance of teams in the organizational learning processes observing that, in these days, firms increasingly make use of teams in managing complicated tasks instead of assigning employees to individual routine tasks and activities.

The extant literature provides a variety of definitions for team learning, ranging from "an ongoing process of reflection and action characterized by asking questions, seeking feedback, experimenting, reflecting on results, and discussing errors or unexpected outcomes of actions"[28] to a change in the group's repertoire of potential behavior. Team learning in behavioral terms refers to the acquisition and application of new knowledge that involves the frequent use of team communication processes[29]. In this way, team learning is conceptualized as the collective acquisition, combination, creation, and dissemination of team members' knowledge.

22 Thomke and Fujimoto, 2000, p.128-142.

23 Bstieler, Ludwig, and Hemmert, Martin, "Increasing learning and time efficiency in interorganizational new product development teams", Journal of Product Innovation Management, 2010, 27, p.485-499.

24 Chen, Stephen, "Task partitioning in new product development teams: A knowledge and learning perspective", Journal of Engineering and Technology Management, 2005, 22, p.291-314.

25 Yang, Jen-Shou., and Chen, Chin-Yi., "Systemic design for improving team learning climate and capability: A case study", Total Quality Management, 2005, 16, p.727-740.

26 Huang and Li, 2012, p.381-388

27 Yang and Chen, 2005, p.727-740

28 Edmondson, 1999, p.350-383.

29 Sole, 2002, p.17-34.

Team learning allows communities of practice to learn together and spreads new knowledge through social networks. By boosting collective learning, team members easily address mutual problems for which solutions were not previously obvious[30]. New knowledge improves existing routines; thus, teams become capable of producing original products ahead of their deadlines in order to meet managerial and market demands[31]. Furthermore, high-level team learning accelerates high-level collective thinking and communication as well as the ability to working creatively as a single entity. The discipline of high-level team learning permits the development of shared intelligence beyond that of any one individual member of a product development team.

2.3. Team Climate

Team climate reflects team members' shared experiences and beliefs in actions that are supported by the team's policies, practices, and procedures[32]. It is also related to a team's mutual perceptions about the quality of congruence between team practices and conditions of work processes. Based upon these views in existing literature, it is reasonable to stress team climate as an atmosphere that facilitates or hinders the negotiations of the team members with each other, because it is an effective tool in shaping the attitudes, behaviors, and actions of the team members[33]. Team climate can be conceptualized as the combination of norms, attitudes, and expectations that team members perceive in order to function in a particular context.

According to González-Romá et al.[34], team climate is a multidimensional construct and consists of four factors: (i) organizational support, (ii) innovation orientation, (iii) goal orientation, and (iv) informal structure. Organizational support refers to whether or not team members are supported by the whole organization. Innovation orientation refers to whether or not new ideas are implemented by the team. Goal orientation refers to whether or not team members make an effort to reach goals. Informal structure refers to whether or not team norms and procedures are designed to enable team members to excel in the undertaken tasks and improve their capabilities[35]. The above mentioned classifications reflect the plausible effects of team climate on team problem solving, thus leading teams to develop learning and improve software quality in related projects.

30 Zellmer-Bruhn and Gibson, 2006, p.501-518.

31 Bstieler and Hemmert, 2010, p.485-499.

32 Açıkgöz, Atif, Günsel, Ayşe, Bayyurt, Nizamettin, and Kuzey, Cemil, "Team climate, team cognition, team intuition, and software quality: The moderating role of project complexity", Group Decision and Negotiation, 2014, 23, p.1145-1176.

33 Açıkgöz et al., 2014, p.1145-1176.

34 González-Romá, Vicente, Fortes-Ferreira, Lina, and Peiró, José, "Team climate, climate strength and team performance: A longitudinal study", Journal of Occupational and Organizational Psychology, 2009, 82, p.511-536.

35 Açıkgöz et al., 2014, p.1145-1176.

The development of a teams' capability is often related to the organizational support received from top management, which is also the outcome of their attitudes and perceptions[36]. Organizational support facilitates individuals in reducing barriers in their daily interaction with the other members of the team whilst at the same time allowing potential disagreements to be resolved, which also eliminates miscommunications at the team level[37]. Accordingly, the team members are more likely to be involved in learning activities critical to the development of team-level capabilities[38]. Furthermore, organizational support encourages teams to undertake risks and communicate their ideas and concerns without feeling frustrated by the top management[39]. Human resource practices which provide team members with concrete psychological support become increasingly important for the performance of the teams[40] since the fear of failure is minimized and the team members appear to be keener in fully participating in various tasks throughout the development of a project (Bstieler & Hemmert, 2010).

Siguaw et al.[41] define innovation orientation as the capacity to introduce original product- and process-related ideas. It is related to the openness to new ideas, which encourages a team to devote its energy toward improving existing products or inventing novel products. In general, innovation orientation is a multidimensional knowledge structure embedded in the formal and informal systems, behaviors, and processes of the team, which, in turn, promotes creative thinking and facilitates the development of relevant team-level capabilities[42]. In particular, it is the team's set of attitudes and perceptions that incline them toward developing team-level capabilities for producing high-quality products[43].

Goals can contribute toward orienting a team in a particular direction so that they will know what they need to do and focus on[44]. Goal orientation is associated with clarity of thought, which is formally articulated through vision and mission statements[45]. Without goal orientation, it is difficult for teams to achieve their objectives[46]. Accordingly, having a clear goal allows them to perform better

36 Nambisan, Satish, "Software firm evolution and innovation-orientation", Journal of Engineering and Technology Management, 2002, 19, p.141-165.

37 Bstieler and Hemmert, 2010, p.485-499.

38 Edmondson and Nembhard, 2009, p.123-138.

39 Bstieler and Hemmert, 2010, p.485-499.

40 Siguaw, Judy A., Simpson, Penny M., and Enz, Cathy A., "Conceptualizing innovation orientation: A framework for study and integration of innovation research", Journal of Product Innovation Management, 2006, 23, p.556-574.

41 Siguaw et al., 2006, p.556-574.

42 Siguaw et al., 2006, p.556-574.

43 Nambisan, 2002, p.141-165.

44 Lynn, Gary S., Skov, Richar B., and Abel, Kate D., "Practices that support team learning and their impact on speed to market and new product success", Journal of Product Innovation Management, 1999, 16, s.439-454.

45 Siguaw et al., 2006, p.556-574.

46 Bstieler and Hemmert, 2010, p.485-499.

by providing a mutual awareness of the purpose of their efforts and as well by motivating them to develop goal-related team-level capabilities[47].

A team thinks as one collective body because of common beliefs, values, and understandings, which are collectively called the team's informal structure[48]. Each team has its own unique informal structure in order to deal with troubles or problems[49]. Informal structure is a set of team members' shared beliefs and understandings that directs all of the team's operations[50]. Teams with a nonhierarchical structure allow their members to express themselves in a more constructive way than do teams with a more hierarchical structure[51]. Hence, it is much easier for teams with a nonhierarchical structure to focus on developing key team-level capabilities.

3. HYPOTHESIS DEVELOPMENT

3.1. Team Climate and Team Problem Solving

One of the core functions of product development teams is to develop a problem-solving capability[52]. Tjosvold et al.[53] (2004) consider team climate to be critical for determining the team members' mutual capability development efforts through the improvement of their psychological atmosphere[54]. If the atmosphere is positive, team members are more likely to discuss problems freely in order to solve them and make performance improvements[55]. For example, based on a field study of 310 front-line employees (receptionists and waiters) nested in 117 units in Spanish hotels and restaurants, employee problem-solving behaviors are associated with innovative climate. Alternatively, such an atmosphere probably motivates the product developers (i) to express their thoughts and opinions without the fear of reprisal, (ii) to share their knowledge, skills, and background willingly based upon mutual trust, (iii) to collaborate among each other, and (iv) to make a great efforts in developing solutions to product development problems[56]. However, there is a gap in the knowledge management literature concerning what determines team problem solving and how this capability can be improved. To address this gap, we think that team climate might be fitting. In other words, this study claims that team climate –in terms of organizational support, innovation orientation, goal orientation, and informal structure- might be an important antecedent

47 Lynn et al., 1999, p.439-454.
48 Siguaw et al., 2006, p.556-574.
49 Bstieler and Hemmert, 2010, p.485-499.
50 Siguaw et al., 2006, p.556-574.
51 Bstieler and Hemmert, 2010, p.485-499.
52 Atuahene-Gima and Wei, 2011, p.81-98.
53 Tjosvold et al., 2004, p.1223-1245
54 Siguaw et al., 2006, p.556-574.
55 Huang and Li, 2012, p.381-388.
56 Açıkgöz et al., 2014, p.1145-1176.

for developing and utilizing team problem solving in software development projects. Based on the above reasoning, it was hypothesized that:

Hypothesis 1: Team climate is positively related to team problem solving in terms of 1a) organizational support, 1b) innovation orientation, 1c) goal orientation, and 1d) informal structure.

3.2. Team Problem Solving and Team Learning

Another basic question for this study is related to how product development teams learn or to what capabilities promote team learning[57]. This study has adapted the approach that learning from mistakes and experiences through operationalizing the problem-solving capability is an answer. In the organizational learning literature, the effect of team problem solving on team learning is not clarified in the context of product development projects. By revealing this effect, it becomes apparent that while product development teams become capable of creating new solutions to unexpected problems, they learn more, resulting in lessening the probability of problem occurrence. Similarly, if product development teams boost their problem-solving capability, they will probably be able to create new knowledge through the consecutive processes of team learning[58]. Accordingly, it was hypothesized that:

Hypothesis 2: Team problem solving is positively related to team learning in software development projects.

3.3. Team Learning and Software Quality

It is highly likely that team learning plays a significant role on project success[59]. Product quality is a crucial indicator of project success in software development projects, as it demonstrates how effectively a product does what it was designed and manufactured to do[60]. In other words, the quality of the product is related to how well it satisfies user requirements, because higher customer satisfaction results in higher profits[61]. According to Edmondson and Nembhard[62], team learning contributes to the quality of product development projects. Likewise, team learning enables a firm to gain favorable performance outcomes. Therefore, by enhancing learning, product development teams -and also firms- become capable of taking the benefit of emergent ideas that may distinguish the product

57 Lynn et al., 1999, p.439-454

58 Tjosvold et al., 2004, p.1223-1245.

59 Huang and Li, 2012, p.381-388.

60 Atuahene-Gima and Wei, 2011, p.81-98.

61 Li, Yuzhu, Yang, Ming-Hsien, Klein, Gary, and Chen, Houn-Gee, "The role of team problem solving competency in information system development projects", International Journal of Project Management, 2011, 29, p.911-922.

62 Edmondson and Nembhard, 2009, p.123-138.

or solutions from competitors' offerings and may challenge existing products[63], thereby possibly resulting in producing high-quality products. Instead, the finding of creative alternatives through team learning provides opportunities for teams in order to produce quick evaluations and feedback on product quality. Creative alternatives not only guarantee the operational efficiency, flexibility, and responsiveness that customers require in a new product but also they differentiate it from rival products[64]. In this direction, it was hypothesized that:

Hypothesis 3: Team learning is positively related to software quality in new product development projects.

3.4. The Mediating Role of Team Problem Solving

In this research, we also explore the impact of team climate on team learning through team problem solving and the impact of team problem solving on software quality through team learning.

A team-based working environment is a common phenomenon in today's firms. Although diversified backgrounds of the team members are favorable for creating new ideas, problems also prevail in teams. If the problems can be managed appropriately, the outcome of problem solving activities can stimulate the team members to explore new ideas, as well as encouraging new horizons for thinking[65]. However, it should be noted that team problem solving rarely operates in an isolated manner. For example, as team climate facilitates product development efforts, it can positively influence the outcome, such as team learning. Hence, in the organizational learning literature the relationship between team climate and team learning becomes more complicated. In this direction, we propose that team problem solving mediates the relationship between team climate and team learning. The reason is that team climate supports team members to solve product development problems, and foster their mutual knowledge base. Here, team members convey these new knowledge sources in all team activities through this climate. Team climate is then used as a mirror for reflection, which may increase awareness of the extent of team learning, such that a positive climate acts as a basis for continuous knowledge exchange, nurturing the development of consciousness of generating new product ideas. In addition, team climate can be considered to be a tool that allows team members to respond to particular problems in the light of their own and their firms' concerns. In a sense, team climate acts as a filtering tool for team learning. Further, team climate increases team members' attention and alertness for team learning. For instance, when team members perceived team climate as negative (i.e., insufficient support from organization), they became more careful about problems. This type of negative atmosphere also forces project leaders to create new routines, norms, and procedures for prod-

63 Katila and Ahuja, 2002, p.1183-1194.

64 Atuahene-Gima and Wei, 2011, p.81-98.

65 Tjosvold et al., 2004, p.1223-1245.

uct development activities. As well, a supportive climate will increase networking activities and knowledge sharing within the team, increasing team learning through the creation of new knowledge for problem solving. A positive climate may support team members to vivify their problem-solving capabilities in order to share their experience and delve into how they can correct the error and reduce the probability of its recurrence[66]. In other words, team climate may facilitate the timely vivification of problem-solving capability that enhances team learning through affecting the team members' attitudes and behaviors. In this direction, it was hypothesized that:

Hypothesis 4: Team problem solving will mediate the relationship between team climate and team learning.

3.5. The Mediating Role of Team Learning

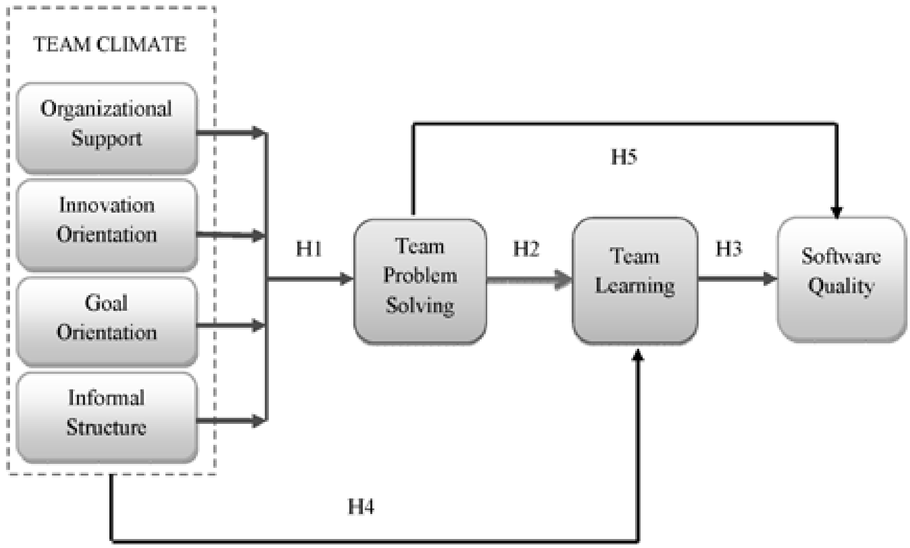
As mentioned previously, team learning may have positive effects on software quality. However, considering the relationships between team problem solving and software quality, it may be asserted that the role of team learning is ambiguous in product development projects. More empirical evidence is needed to understand the effects of problem-solving capability on software quality by way of clarifying the role of team learning. In the organizational learning literature, it is generally acknowledged that problem solving is able to produce positive learning results. During product development projects, identifying errors and problems implies the incorporation of new knowledge into existing routines. It also closely related to the reinterpretation of existing knowledge in relation to new knowledge, thus enhancing team learning. Accordingly, team problem solving may vivify team learning when team members encounter problems to solve, thus maintaining performance. For example, Thomke and Fujimoto[67] argue that the benefits of problem-solving capabilities can provide a leverage capacity for improving product development performance, such as software quality. In this context, we propose that team learning mediates the relationship between team problem solving and software quality. The logic is that team problem solving enables team members to learn from errors and problems, and to reflect this new knowledge in project outcomes, i.e., software quality. In this direction, it was hypothesized that:

Hypothesis 5: Team learning will mediate the relationship between team problem solving and software quality.

66 Tjosvold et al., 2004, p.1223-1245.

67 Thomke and Fujimoto, 2000, p.128-142.

Figure 1: *Proposed Relationships among the Study Variables*



4. RESEARCH DESIGN

In order to establish the groundwork for this study as well as to design the research, a large-scale cross-sectional survey was conducted. Prior to the development of the final version of the questionnaire, the survey instruments passed through several revisions. Based upon the results of the literature review, a study was conducted with a panel of academic experts in the TIM fields. A list of the constructs was submitted, with corresponding measurements, to these experts. A list of survey questions was then drafted so that that the questions were highly consistent with the constructs according to the feedback from the panel of experts. In the second step, the survey instruments were back-translated in order to identify the desired questions; the questions were first translated into Turkish by an expert translator and then translated back into English by another expert translator. The translators then jointly reconciled the differences to ensure that the questions were rendered from English to Turkish correctly. In the third step, the Turkish version of the survey questionnaire was submitted to five managers (who were each part of at least one software development project) in order to determine its suitability, i.e., face validity. Finally, using the 'personally administered questionnaire method', the finalized survey questionnaire was distributed and collected by the authors of this study.

In order to more vigorously test the proposed model (see Fig. 1), structural equation modeling (SEM) was employed. SEM is a very useful and powerful statistical analysis tool which enables the detection of complex relationships between multiple endogenous and exogenous variables; in addition, it combines mathematical modeling with factor analysis in order to test hypotheses consisting of interacting variables and path-ways. SEM is a second-generation multivariate analysis tool that eliminates the limitations of first-generation statistical analysis tools, such as multiple regressions and discriminant analysis[68]. SEM is preferred by researchers for various valid reasons; for example: i) it assesses both the reliability and validity of the measures of theoretical constructs simultaneously and estimates the relationships between them; and ii) it identifies path loadings across the entire model in a single run instead of the multiple runs usually required to apply regression techniques[69]. There are two distinct approaches in order to estimate the parameters of an SEM: covariance-based SEM and component-based (or variance-based) SEM, which is also known as partial least squares (PLS). The objective of a covariance based approach is to minimize the difference between the sample covariances and those predicted by the theoretical model, while the objective of variance based approach is to maximize the variance of the dependent variables explained by the independent. PLS path modeling is an iterative algorithm. In the beginning, it solves the blocks of the measurement model separately, while in the next step, it estimates the path coefficients in the structural model. The advantage of the PLS approach is that it explains the residual variance of the latent variables as well as those of the manifest variables in any regression run in the model at best. In this research, the partial least squares structural equation modeling (PLS-SEM) was used.

4.1. Measures

The latent constructs were assessed using multi-item measures on a five-point Likert scale ranging from 'strongly disagree' (1) to 'strongly agree' (5) from prior studies. Therefore, the research model included no single-item constructs. This study has adopted a first order reflective model as opposed to formative. It is not always clear whether a reflective or a formative model should be used. However, in reflective models, the direction of causality is from construct to measure; measures are expected to be correlated; dropping an indicator from the model does not affect the construct; and measurement error is taken into account at the item level rather than at the construct level. As a result of these criteria, since all the indicators are expected to be highly correlated with the latent variable score in this research model, as well as construct cause measures, it was appropriate to employ reflective measures in the research model.

A short explanation of each measure follows (questionnaire items are provided in Table 1). In order to measure the team climate of software development

68 Chin, Wynne W., "The partial least squares approach for structural equation modeling." In Marcoulides, George A., (Eds.) Modern business research methods. (Mahwah, NJ: Lawrence Erlbaum Associates, 1998).

69 Gefen, David, Straub, Detmar, and Boudreau, Marie-Claude, "Structural equation modeling techniques and regression: Guidelines for research practice", Communications of the Association for Information Systems, 2000, 7, p.1-78.

teams, this study used four dimensions derived from González-Romá et al.[70]; that is: organizational support, innovation orientation, goal orientation, and informal structure. For each dimension, four questions were asked. To measure team problem solving, this study employed five questions derived from Aladwani[71]. To measure team learning, three questions were derived from Lynn, Reilly, and Akgün's[72] study. This scale involves items like "Overall, the team did an outstanding job correcting product problem areas with which customers were dissatisfied." Finally, ten questions (covering operational efficiency, flexibility, and responsiveness of the software product) were used derived from Nidumolu[73] to assess software quality.

4.2. Sample

The empirical analyses for the study are based on data from 42 firms. According to the Istanbul Chamber of Commerce, the firms either directly operated in the software development industry or had a software development department. The objective of the study was explained to the respective managers via telephone. Furthermore, it was particularly emphasized that the respondents must be software engineers or developers with expertise in software development projects. Moreover, only one team member from each team was asked to participate in the survey, and each participant was asked to evaluate one unique project.

Initially 99 firms were contacted; 71 agreed to participate in the study, but participants from only 42 firms actually completed the questionnaire, resulting in a response rate of 59 percent. Prior to the cleaning of the data, the sample included 143 software projects (several firms participated in the project with more than one respondent). During the cleaning of the sample, 4 samples were eliminated due to a high level of missing data. Therefore, the final sample was comprised of 139 participants from 139 different teams involved in new software development projects. According to the descriptive statistics from the organizations, the proportion of projects returned are as follows: information and communication technology (63%), business services (24%), and financial services (13%). All of the software development projects' data were returned through the IT departments of the 42 participant firms: 5 projects from 9 departments, 4 projects from 9 departments, 3 projects from 11 departments, 2 projects from 12 departments, and 1 project from 1 department.

70 González-Romá et al., 2009, p.511-536.

71 Aladwani, 2002, p.185-210

72 Lynn, Gary S., Reilly, Richard R., and Akgün, Ali E.," Knowledge management in new product teams: Practices and outcomes", IEEE Transactions on Engineering Management, 2000, 47, p.221-231.

73 Nidumolu, Sarma, "The effect of coordination and uncertainty on software project performance: residual performance risk as an intervening variable", Information Systems Research, 1995, 6, p.191-219.

While collecting data from participants, an effort was made to ensure that their comfort level was high and their resistance level was low when filling out the questionnaire by taking the following steps: i) the respondents were informed that there were no predetermined right or wrong answers in order to encourage them to respond the questions as honestly and directly as possible; ii) since software engineers/developers perceive questions more accurately than non-engineers/developers due to their experience, involvement, and responsibilities, and since these participants tend to provide more valid information or data on issues directly related to their work roles, each of these respondents was assured that his or her response would remain anonymous in order to increase the respondents' motivation to cooperate by removing any fear of retaliation. It was believed that these assurances would reduce any resistance on the part of the participants and thus would make them less likely to edit their answers in an effort to make them socially desirable, permissive, or consistent with their perception of the researchers' wishes. Only one project at a time was assessed by one team member from each team who had agreed to participate in the survey.

According to the demographic statistics, 85 percent of the participants were male. Participants under 26 years of age accounted for 24 percent of the sample, while 33 percent were between 26 and 28 years old, 21 percent were between 29 and 31, 14 percent were between 32 and 34, and 8 percent were over 35 years old. In addition, 58 percent of the participants had 0-5 years of work experience, 27 percent had 6-10 years, and 15 percent had more than 10 years of experience. Furthermore, 39 percent of the participants had 3-5 developers on their team, 28 percent had 6-9 developers, 20 percent had 10-15 developers, 6 percent had 16-19 developers, and 7 percent had more than 20 developers.

4.3. Measures' Validity and Reliability

Following collection of the sample data, the data were subjected to a purification process in order to evaluate their reliability, discriminant validity, convergent validity, and unidimensionality[74].

According to Nunnally[75], an exploratory factor analysis (EFA) should be initially conducted on the data to allow researchers to refine the measurements by carefully analyzing the results of factor loadings, item-to-total correlation and Cronbach's alpha. Following this suggestion, EFA was employed on 35 measured items; the constructs comprised seven variables. A principal component with a varimax rotation was employed, and an eigenvalue of 1 was selected as the cut-off point. Due to the low levels of factor loadings, two items were dropped from the analysis—one from organizational support and one from software quality. An examination of these items revealed that dropping them would not compromise

74 Fornell, Claes, and Larcker, David F., "Evaluating structural equation models with unobservable variables and measurement error", Journal of Marketing Research, 1981, 48, p.39-50.

75 Nunnally, Jum C., "Psychometric theory". (New York: McGraw-Hill, 1978).

the content validity of their respective constructs. The other items loaded substantially on their respective factors. As shown in Table 1, the factor loadings of the constructs range from.48 to.83. A single factor was extracted for each multiple-item scale in this analysis. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was .895, which was higher than the proposed threshold value of .7; also, the Bartlett test of sphericity was significant at $p < .0001$ (χ^2 (496) = 2901.514), indicating the appropriateness of this data for factor analysis. These results indicate the appropriateness of the data for the EFA procedure. Additionally, the extent of common method bias with Harman's one-factor test was measured. The test includes entering all constructs into an unrotated principal components factor analysis and examining the resultant variance[76]. The threat of common method bias is high if a single factor accounts for more than 50 percent of the variance[77]. The results demonstrated that none of the factors significantly dominated the variance (see the last column of Table 1); hence, it is concluded that common method bias was unlikely. The items (including the dropped items) and their factor loadings after EFA, eigenvalue, percentage of variance explained and unrotated variance appears in Table 1.

Table 1: *The Result of Exploratory Factor Analysis*

LV	Manifest Variables	SL	E	VE (%)	UV (%)
	In my work team . . .				
	Team members feel supported by the organization.	.78			
	You can tell that the company is interested in the members of the team.	.79			
OS	The human resources management is carried out keeping the team members in mind.	.69	2.44	7.62	4.97
	*The team manager contributes to creating a friendly and cordial work climate.	---			
	In my work team . . .				
	New ideas and methods are often tried out.	.78			
	New ideas are put into practice to improve the work and its results.	.81			
IO	The development of new methods, products or services is often proposed.	.83	3.00	9.37	5.57
	Team members take advantage of their knowledge and skills to develop new ways of working, new services or new products.	.50			
	In my work team . . .				
	Team members try hard to reach the team goals.	.48			
GO	Team members aspire to achieving greater performance.	.83	2.13	6.64	4.27
	High, difficult goals are viewed as a challenge.	.70			
	Everyone contributes enthusiastically to reaching the goals.	.53			

76 Harman, Harry, H., "Modern Factor Analysis". (Chicago: University of Chicago Press, 1960).

77 Podsakoff, Philip M., and Organ, Dennis W., "Self-reports in organizational research: Problems and prospects", Journal of Management, 1986, 12, p.531-544.

LV	Manifest Variables	SL	E	VE (%)	UV (%)
IS	The norms and procedures in my work team . . .		3.26	10.18	6.38
	Help our team to function better.	.74			
	Help us to find the best way to do things.	.71			
	Facilitate relationships between team members.	.71			
	Help us to understand the relationship between each person's work and that of his/her co-workers.	.81			
TPS	The project team was effective in identifying problems	.81	4.52	14.12	7.55
	The project team was effective in defining problems	.79			
	The project team was effective at generating alternative solutions	.74			
	The project team was effective in reviewing alternatives.	.80			
	The project team was effective in evaluating options	.75			
TL	Post-launch, this product had far fewer technical problems than our nearest competitor's product or our own previous products.	.75	2.05	6.41	3.51
	Overall, the team did outstanding job uncovering product problem areas with which customers were dissatisfied.	.70			
	Overall, the team did an outstanding job correcting product problem areas with which customers were dissatisfied.	.51			
SQ	The software is reliable.	.68	5.08	15.87	37.97
	There is a quick response time by the product.	.70			
	The client is satisfied with the overall operational efficiency of the software.	.70			
	The software adapts to changes in business with cost efficiency.	.70			
	The software adapts to changes in business requirements.	.73			
	The final product achieves overall long-term flexibility of the software.	.58			
	The software is easy to use.	.59			
	The software customizes outputs to various client needs.	.60			
	The software is responsive overall to client needs.	.69			
	*The cost of software operations is efficient.	---			

Note1: The sign of * denotes the dropped item.

Note2: LV = Latent Variable, SL = Standardized Loading, E = Eigenvalue, VE = Variance Explained, , UV = Unrotated Variance OS = Organizational Support, IO = Innovation Orientation, GO = Goal Orientation, IS = Informal Structure, TPS = Team Problem Solving, TL = Team Learning, SQ = Software Quality

Since EFA alone does not provide an explicit test of unidimensionality, a confirmatory factor analysis (CFA) was also performed. In order to assess the discriminant validity of our model, two-factor models (as recommended by Bagozzi and Phillips[78]) were estimated, in which individual factor correlations, one at a time, were restricted to unity. The fit of the restricted models was compared to that of the original model. In total, 90 models were evaluated using AMOS. As shown in Table 2, the chi-square change ($\Delta\chi^2$) in each model, both constrained

78 Bagozzi, Richard P., Yi, Youjae, and Phillips, Lynn W., "Assessing construct validity in organizational research", Administrative Science Quarterly, 1991, 36, p.421-58.

and unconstrained, was significant ($\Delta\chi^2 > 3.84$), which suggests that the constructs demonstrated discriminant validity[79].

Table 2: *Discriminant Analysis of the Construct Measures*

Constructs			Unconstrained (χ2/d.f.)	Constrained (χ2/d.f.)	Δχ2
OS	↔	IO	22.2/13	48.6/14	26.4
OS	↔	GO	31.4/13	61.5/14	30.1
OS	↔	IS	19/13	39.6/14	20.6
OS	↔	TPS	121.4/53	153.7/54	32.3
OS	↔	TL	5.1/8	52.3/9	47.2
OS	↔	SQ	121.4/53	153.7/54	32.3
IO	↔	GO	46.1/19	91.7/20	45.6
IO	↔	IS	21.3/13	66.2/14	44.9
IO	↔	TPS	48/19	84.3/20	36.3
IO	↔	TL	10.6/13	64.7/14	54.1
IO	↔	SQ	152.1/64	197.9/65	45.8
GO	↔	IS	54.1/19	94.7/20	40.6
GO	↔	TPS	71.3/26	106/27	34.7
GO	↔	TL	28.9/13	95.9/14	67
GO	↔	SQ	161.3/64	215.7/65	54.4
IS	↔	TPS	69.5/26	104.7/27	35.2
IS	↔	TL	20.2/13	62.9/14	42.7
IS	↔	SQ	138.3/64	187.6/65	49.3
TPS	↔	TL	54.8/19	102.2/20	47.4
TPS	↔	SQ	192.8/76	244.9/77	52.1
TL	↔	SQ	115.4/53	176.6/54	61.2

Note. OS = Organizational Support, IO = Innovation Orientation, GO = Goal Orientation, IS = Informal Structure, TPS = Team Problem Solving, TL = Team Learning, SQ = Software Quality

The measures were also subjected to one model CFA. As shown in Table 3, the resulting measurement model was found to fit the data reasonably well: 2 (440) = 658.053, comparative fit index (CFI) = .92, incremental fit index (IFI) = .92, Tucker-Lewis Index (TLI) = .91, χ^2/d.f. = 1.50, and root mean square error of approximation (RMSEA) = .06. In addition, all items loaded significantly on their respective constructs (with the lowest t-value being 2.50), providing support for convergent validity.

79 Anderson, James C., and Gerbing, David W., "Structural equation modeling in practice: A review and recommended two-step approach", Psycgological Bulletin, 1988, 103, p.411-423.

Table 3: *Measurement Models and Confirmatory Factor Analysis*

Construct	Parametera	Standardized Coefficient	t-Valueb
OS	λOS1	.81	Scaling
	λOS2	.96	11.58
	λOS3	.62	7.66
IO	λIO1	.81	Scaling
	λIO2	.86	11.15
	λIO3	.82	10.56
	λIO4	.61	7.33
GO	λGO1	.75	Scaling
	λGO2	.64	6.92
	λGO3	.52	5.60
	λGO4	.82	8.48
IS	λIS1	.87	Scaling
	λIS2	.77	10.73
	λIS3	.83	12.03
	λIS4	.80	11.36
TPS	λPSC1	.79	Scaling
	λPSC2	.75	13.75
	λPSC3	.88	11.79
	λPSC4	.92	12.54
	λPSC5	.77	9.83
TL	λTL1	.63	Scaling
	λTL2	.70	6.30
	λTL3	.76	6.61
SQ	λSQ1	.73	Scaling
	λSQ2	.81	9.21
	λSQ3	.81	9.25
	λSQ4	.63	7.19
	λSQ5	.70	7.91
	λSQ6	.68	7.70
	λSQ7	.63	7.13
	λSQ8	.58	6.50
	λSQ9	.69	7.90

a λ parameters indicate paths from measurement items to first-order constructs
b Scaling denotes λ value of indicator set to 1 to enable latent factor identification.
Note1. $\chi2$ (440) = 658.053, CFI = .92, IFI = .92, TLI = .91, RMSEA = .06
Note2. OS = Organizational Support, IO = Innovation Orientation, GO = Goal Orientation, IS = Informal Structure, TPS = Team Problem Solving, TL = Team Learning, SQ = Software Quality

Table 4 shows the correlations among all seven variables. The relatively low-to-moderate correlations provide further evidence of discriminant validity. Also, all reliability estimates—including the coefficient alphas, the average variance extracted (AVE) for each construct, and the AMOS-based composite reliability values—are well beyond the threshold levels suggested by Nunnally[80]. Further, following the suggestion of Fornell and Larcker[81], the squared root of AVE for each construct was greater than the latent factor correlations between the pairs of constructs, suggesting discriminant validity. All in all, the obtained results concluded that the measures were unidimensional, with adequate reliability and discriminant validity.

Table 4: *Discriminant Validity and Reliability Indicators*

No	Mean	Standard Deviation	Variables	1	2	3	4	5	6	7
1	3.50	1.02	OS	.86						
2	4.01	.74	IO	.43**	.77					
3	3.63	.81	GO	.52**	.48**	.87				
4	3.90	.79	IS	.45**	.40**	.48**	.84			
5	3.88	.78	TPS	.40**	.55**	.54**	.44**	.87		
6	3.69	.71	TL	.29**	.30**	.51**	.36**	.55**	.81	
7	4.07	.64	SQ	.52**	.49**	.51**	.56**	.52**	.53**	.74
			CR	.89	.86	.92	.90	.94	.85	.92
			AVE	.74	.60	.75	.70	.76	.65	.55
			α	.83	.78	.89	.85	.92	.74	.90

Note1. Diagonals show the square root of AVEs
Note2. OS = Organizational Support, IO = Innovation Orientation, GO = Goal Orientation, IS = Informal Structure, TPS = Team Problem Solving, TL = Team Learning, SQ = Software Quality, CR = Composite Reliability, AVE = Average Variance Extracted, α = Cronbach's Alpha
* $p < .05$, ** $p < .01$.

4.4. Hypothesis Testing

The partial least squares and bootstrapping re-sampling methods[82] were used to estimate both the main and the interaction effects in the proposed model. This procedure entailed generating 500 sub-samples of cases randomly selected, with replacement, from the original data. Path coefficients were then generated for each randomly selected sub-sample. T-statistics were calculated for all coefficients based on their stability across the sub-samples in order to determine which links were statistically significant. The path coefficients and their associated t-values demonstrated the direction and impact of each hypothesized relationship.

Table 5 shows the hypotheses, including paths, of the values of betas and significance levels. With regard to antecedents, the findings illustrated that two

80 Nunnally, 1978.

81 Fornell and Larcker, 1981, p.39-50.

82 Ringle, C. M., Wende, S., ve Will, A., "SmartPLS - Version 2.0". (Universität Hamburg, Hamburg, 2005).

sub-dimensions of team climate —innovation orientation (β = .35, p < .05) and goal orientation (β = .28, p < .01)— were positively associated with the problem-solving capability of the software development teams. However, this study was unable to find any statistically significant association between organizational support and the problem-solving capability and between informal structure and the problem-solving capability of software development teams, so H1 was partially supported. Concerning the product development process, the results showed that the problem-solving capability of the software development teams was positively associated with team learning (β = .56, p < .01); therefore, H2 was supported. Concerning the outcomes of the study, the results indicated that team learning was positively associated with software quality (β = .36, p < .01), so H3 was supported.

Table 5: *The Main Results*

Paths			Betas	Sub-hypotheses	Sub-results	Hypotheses	Results
OS	→	TPS	.06	H1a	Not Supported		
IO	→	TPS	.35*	H1b	Supported	H1	Partially Supported
GO	→	TPS	.28**	H1c	Supported		
IS	→	TPS	.14	H1d	Not Supported		
TPS	→	TL	.56**	-	-	H2	Supported
TL	→	SQ	.36**	-	-	H3	Supported

Note. OS = Organizational Support, IO = Innovation Orientation, GO = Goal Orientation, IS = Informal Structure, TPS = Team Problem Solving, TL = Team Learning, SQ = Software Quality
*p< .05, **p< .01

4.5. The Mediating Role of Team Problem Solving

The mediating effect of team problem solving on the relationship between team climate and team learning as well as the mediating effect of team learning on the relationship between team problem solving and software quality were both tested. Mediation is a hypothesized causal chain in which a variable affects the second one while in turn, the second affects a third variable. Baron and Kenny[83] proposed four-step methodology testing for mediation. To illustrate the procedure, X and Y are represented as independent, dependent variables respectively, while the intervening variable M, which mediated the relationship between X and Y is represented as the mediator. The direct effects between the variables are represented as a, b, c, and c′. The procedure is summarized as follows:

- Step 1) X and Y has a significant relationship (c: X → Y)
- Step 2) X and M has a significant relationship (a: X → M)

83 Baron, Reuben M., and Kenny, David A., "The moderator mediator variable distinction in social psychological research – conceptual, strategic, and statistical considerations", Journal of Personality and Social Psychology, 1986, 51, p.1173-1182.

- Step 3) M and Y has a significant relationship after X is controlled for (b: M → Y)
- Step 4) there is a zero (none) relationship between X and Y after M is controlled for (c′: X → M → Y).

Violation of steps 1-3 would result in no mediation effect at all. In other words, if one or more of these relationships are non-significant, it is concluded that mediation is not possible or likely. When there are significant relationships from steps 1 through 3, step 4 is checked. Full mediation exists if X is no longer significant when M is controlled. Partial mediation exists if X is still significant (both X and M significantly predict Y). In addition to the proposed procedure, the inclusion of M should decrease the magnitude of the effect of the independent variable on the dependent variable compared to the exclusion of M. Finally, the explained variance (the value of R^2) is increased upon inclusion of M. Following these steps, three PLS based SEM models are illustrated in Table 6 in order to examine the mediating effect of team problem solving between team climate and team learning.

Model 1 represents the relationship between team climate (X) and team learning (Y). According to the results, only one of the dimensions of team climate, informal structure, was positively related to team learning ($\beta = .45$, $p < .01$) and R^2_{TL} was .28.

Model 2 shows the relationship between team climate (X) and team problem solving (M). The results clearly demonstrate that two sub-dimensions of team climate, being goal orientation ($\beta = .35$, $p < .01$) and informal structure ($\beta = .28$, $p < .01$) had a significant and positive impact on team problem solving respectively. In addition, the total variance explained in the endogenous variable team problem solving, R^2_{TPS} was .44.

Model 3 includes the relationship between team problem solving (M) and team learning (Y) while controlling for team climate (X). The results in model 3 suggested that team problem solving had a significant and positive effect on team learning ($\beta = .41$, $p < .01$). In addition, the sub-dimension of team climate: informal structure, was still statistically significant. The explained total variance on the endogenous variables, team learning and team problem solving, were .38 and .43 respectively ($R^2_{TL} = .38$; $R^2_{TPS} = .43$).

The results suggested that the inclusion of team problem solving as the mediator reduced the effect of team climate on team learning, while addition of it into the model increased the R^2 value of team learning significantly to .38. Therefore, team problem solving partially mediated the relationship between team climate and team learning, and H4 was partially supported (see Table 6).

Table 6: *Results of Mediating Role of Team Problem Solving (TC → TPS → TL)*

Relationships			Model 1	Model 2	Model 3
GO	→	TL	.04		-.09
IO	→	TL	.13		.07
IS	→	TL	.45***		.32**
OS	→	TL	-.02		-.04
GO	→	TPS		.35**	.35**
IO	→	TPS		.14	.14
IS	→	TPS		.28***	.29***
OS	→	TPS		.06	.05
TPS	→	TL			.41***
		R^2_{TL}	.28		.38
		R^2_{TPS}		.44	.43

Note: OS = Organizational Support, IO = Innovation Orientation, GO = Goal Orientation, IS = Informal Structure, TPS = Team Problem Solving, TL = Team Learning
** p < .05; *** p < .01

4.6. The Mediating Role of Team Learning

Baron and Kenny's[84] mediating analysis procedures were also employed to determine the mediating effect of team learning on the relationship between team problem solving and software quality. The results are shown in Table 7.

Model 1 determined the relationship between team problem solving (X) and software quality (Y) which indicated that team problem solving had a significant positive impact on software quality ($\beta = .54, p < .01$). In addition, the total variance explained by the endogenous variable was .29 ($R^2_{SQ} = .29$).

Model 2 demonstrated the relationship between team problem solving (X) and team learning (M). It was found that that team problem solving is significantly and positively related to team learning ($\beta = .56, p < .01$), while $R^2_{TL} = .31$.

Model 3 represented the relationship between team learning (M) and software quality (Y) while controlling for team problem solving (X). It was clear that team learning had a significant positive impact on software quality ($\beta = .36, p < .01$), while $R^2_{SQ} = .37$ and $R^2_{TL} = .31$. In addition, the results showed that team problem solving is still significant on software quality.

Based on the obtained results, team learning decreased the effect of team problem solving on the software quality, moreover inclusion of it into the model lead to

84 Baron and Kenny, 1986, p.1173-1182.

an increase of R^2 value of software quality significantly (R^2_{SQ} = .37). Consequently, team learning partially mediated the relationship between team problem solving and software quality, and H5 was partially supported (see Table 7).

Table 7: *Results of Mediating Role of Team Learning (TPS → TL → SQ)*

Relationships			Model 1	Model 2	Model 3
TPS	→	SQ	.54***		.33***
TPS	→	TL		.56***	.56***
TL	→	SQ			.36***
		R^2_{SQ}	.29		.37
		R^2_{TL}		.31	.31

Note: TPS = Team Problem Solving, TL = Team Learning, SQ = Software Quality
**p<.05; ***p<.01

4.7. Structural model

The PLS structural model was validated by the R^2 of the endogenous latent variable and the Goodness-of-Fit (GoF) index[85]. The R^2 values of the endogenous constructs were used to assess the model fit. To assess the model fit in terms of how well data points fit on a line or curve, the R^2 values of the endogenous variables provided useful information. Chin[86] proposed a classification of R^2 values as small ($.02 \leq R^2 < .13$), as medium ($.13 \leq R^2 < .26$), and as large ($.26 \leq R^2$). Though there is no overall fit index in PLS path modeling, a global criterion of goodness of fit as GoF index was proposed by Tenenhaus et al.[87]. The aim of the index is to take into account both structural and measurement model performance; therefore it provides a single measure for the overall prediction performance of the model. The GoF index is obtained as the geometric mean of the average communality index and the average R^2 value. It is an index for validating a PLS model globally, so therefore it was employed to account for the PLS model performance for both the measurement and the structural model with a focus on overall prediction performance of the model, besides establishing consistency with the geometric mean of the average communality as well as the average R^2 values of dependent variables. A higher value of GoF, which ranges between 0 and 1, shows better structural model estimation while a lower value represents the poor establishment of a path

85 Tenenhaus, Michel., Vinzi, Vincenzo Esposito, Chatelin, Yves-Marie, and Lauro, Carlo, "PLS path modeling", Computational Statistics and Data Analysis, 48, 2005, s.159-205.

86 Chin, Wynne W., "The partial least squares approach for structural equation modeling." In Marcoulides, George A., (Eds.) Modern business research methods. (Mahwah, NJ: Lawrence Erlbaum Associates, 1998).

87 Tenenhaus, Michel., Vinzi, Vincenzo Esposito, Chatelin, Yves-Marie, and Lauro, Carlo, "PLS path modeling", Computational Statistics and Data Analysis, 48, 2005, s.159-205.

model. GoF is also classified, in line with the effect sizes for R^2, as small ($.1 \leq$ GoF $< .25$), medium ($.25 \leq$ GoF $< .36$), and large ($.36 \leq$ GoF) effect sizes.

Table 8 shows the results of the structural model. In accordance with the categorization of the R^2 effect sizes, the effect sizes of constructs were large for the values of the problem-solving capability ($R^2 = .44$), team learning ($R^2 = .31$), and software quality ($R^2 = .37$). When this study employed GoF using .5 as a cut-off value for communality, the result was .50, indicating a good fit.

Table 8: *Structural Model*

Fit Measures	Endogenous Constructs	Main Effect Model
	Team Problem Solving	.44
	Team Learning	.31
R^2	Software Quality	.37
GoF		.50

Note. GoF = √ Average Communality x Average R^2

5. DISCUSSION

Today, the value of teams in product development is unquestionable. Both the interdisciplinary nature of the work and industry trends call for professionals from different functions and backgrounds to work together on development projects to create new high-quality products in the shortest time. Understanding the key success factors of teamwork has been a topic of research for the last two decades. This study attempted to offer a contribution to the organizational learning and knowledge management literatures by presenting a model which would help researchers and project managers to understand potential interrelationships among team climate, team problem solving, team learning, and product quality in software development projects. This study makes five specific contributions to the relevant literature.

Firstly, the findings showed that the innovation orientation and goal orientation dimensions of team climate are directly and positively related to the problem-solving capability of software development teams. This means that when team members are willing to benefit from new ideas in addition to their collective efforts to reach goals efficiently, the team becomes more successful in dealing with unexpected situations and able to provide innovative answers for solving complicated problems, detecting and resolving crises and preventing errors in the project. In particular, goal orientation, which demonstrates the team's collective efforts to reach goals during the project, and innovation orientation as an extent to which new ideas about work are implemented within teamwork, seem critical for software development teams to develop and maintain their problem-solving capability. There is an important implication in this simple result: the capability of a software development team: in order to understand the problems; to plan appropriate solutions with various alternatives; and further to implement as well as to monitor the chosen solution; is inseparable from team climate characterized by goal and innovation orientation. When team problem solving is supported with a fitting climate, a team's knowledge interaction mechanisms get stronger, and team members have the opportunity to discuss problems collectively in order to solve them and make necessary improvements.

Surprisingly, this study could not find a direct statistical association between the other dimensions of team climate (i.e., organizational support and informal structure) and the problem-solving capability of software development teams. However, this does not mean that no such relationship exists; rather, these dimensions may influence team problem solving via other significant dimensions of team climate, as suggested by the significant correlation between each of the team climate sub-dimensions and team problem solving (see Table 4). Specifically, the sub-dimensions have potentially partial effects on team problem solving after all other team climate dimensions have been controlled. In a sense, the influence of one team climate dimension is not independent from the team climate context created by the other dimensions, which implies that one team climate dimension triggers another.

Secondly, this study investigated the influence of the problem-solving capability of software development teams on team learning in order to understand their learning from challenging situations. The findings indicated that the problem-solving capability of software development teams is associated with higher levels of team learning. It seems that when the software development teams detect technical and market-related product problems quickly, they are more likely to find alternative solutions such as initiating new product processes; therefore, they become better at acquiring, processing, and sharing unique information or knowledge. In this sense, the problem-solving capability of software development teams provides greater opportunities for learning through experience. This type of learning yields a change in the range of team behaviors and activities that allows the team to adapt to rapid changes in technology and market.

Third, this study examines the contingency of team learning on the quality of software products in software development projects. Indeed, product development teams primarily learn based on their extension of existing knowledge and skills through refinement, choice, production, efficiency, implementation, and execution. However, only a limited number of new ideas may be created by using existing knowledge. Product development teams thus rely on their ability to add new elements to their knowledge repertoire because it facilitates and promotes the generation of new knowledge. Thus, Katila and Ahuja[88] suggest that project teams benefit from new insights to enhance performance in terms of product development processes.

88 Katila and Ahuja, 2002, p.1183-1194.

In line with the extant literature, the findings indicated that the process of knowledge creation through the incorporation of new knowledge and insights, in addition to the extension of the existing ones into team operations, will eventually contribute to the team's ability to deal with unexpected situations, to create innovative answers for problems, to detect and resolve crises, and to prevent the project from encountering errors. As a result, teams will show superior performance in producing new software products that i) provide functions in order to meet stated and implied needs (i.e., operational efficiency), ii) can easily be adapted to changing business needs (i.e., flexibility), and iii) are user-friendly in providing customized information to meet user's needs (i.e., responsiveness).

Moreover, this study contributes new insights to the significant role of team climate within product development projects. Even if this study empirically demonstrates that while team learning increases with the intensity of problem-solving capability; there are a variety of variables that either directly or indirectly promote or hinder learning. Team climate has the potential to affect team learning as well as the problem-solving capability of product development teams. Indeed, the TIM literature abounds with evidence concerning the effects of team climate on team learning. For example, Edmondson[89] states that team learning behaviors are associated with features of climate. The findings demonstrated that the relationships between team climate and team learning were partially mediated through their problem-solving capability. This result highlights the fact that team learning —as a series of behaviors through which a team discovers, develops, and applies knowledge to address team tasks and resolve problems that arise during the course of development— is promoted or hindered by the team climate as a main context. The problem-solving capability here plays a role as a mechanism, enabling the teams to create new knowledge and insights through exploring new information and skills in addition to exploiting the existing ones.

Finally, regarding the interrelationships amongst problem-solving capability, team learning and software quality, the findings of this study revealed that team learning partially mediates the relationships between team problem solving, team learning, and software quality. Team problem solving, which refers to the ability to create original solutions for the problems with which product development teams are confronted, contributes to software quality through internalizing the new insights and competencies that are created during the problem-solving period. Thus the problem-solving capability of teams emerges as a key competitive weapon within software development because of its key role in the generation of new knowledge and the exploration of pure insight. Software development teams become capable of producing software products with superior quality through new knowledge and insight, which addresses deviations within a desired set of specific conditions, as well as finding the solutions for these deviations, particularly in the early phases of software development.

89 Edmondson, 1999, p.350-383.

5.1. Managerial Implications

This study demonstrates that team climate significantly contributes to the development and utilization of the problem-solving capability of new software development teams, which ultimately has a significant impact on team learning. Teams with more proficient learning have a higher impact on the quality of new software products. What we can learn from these results is that by considering team climate as a basis for team problem solving, higher levels of learning as well as software products with superior quality can be achieved. In order to produce high-quality software products, management should be made aware of the fact that quality in general, in knowledge intensive industries in particular, is increasingly becoming dependent upon the learning capacity of their work groups. Thus, the project leaders and managers should promote learning activities in order to react faster to the immense changes in the technology and software market. In this sense, project leaders and managers should take the necessary steps to encourage team members to search for and develop new information and competencies beyond the existing ones. The project management, as well as the management organization as a collaborative body, needs to establish an environment in which learning is ongoing as well as an explicit objective; in other words, learning should be pursued deliberately and consciously. In order to do so, project leaders and managers should develop supportive and trusting relationships between team members in order to increase social interaction and knowledge exchange during the software development process. Shared credibility amongst the team may increase the motivation of team members to engage in learning activities.

Additionally, assigning team members to perform a series of specialized tasks may be another useful strategy to benefit from learning new applications. The coordination of project tasks could strengthen an ongoing dialogue among team members to facilitate team level learning. Project leaders and managers should actively create a stimulating atmosphere (i.e., team climate) to augment learning activities in their projects. Team members can then generate greater experimentation and innovation to develop new products and to further achieve producing high quality software products.

This research revealed the essential role of problem-solving capability on team learning, as well the quality of new software products. During product development projects, various major problems occur; finding quick solutions for those problems is critical. Thus, the project management should primarily focus on enhancing the team members' collective efforts in order to attain their predetermined goals. In addition, management should pay special attention to their new ideas and apply them in the projects.

The results reveal particular recommendations to project leaders and managers to enhance team problem solving in order to produce positive outcomes in software quality. Project leaders and managers should promote team problem solving by developing and encouraging a supportive team climate. Managers should generate a shared vision among the team members so as to clearly define, share, and attain detailed objectives. They should also direct team members' collective efforts to reach goals through high-quality products. In addition, it is important to establish a social context that encourages team members to use their experiences and proficiencies as well as to interact and collaborate freely with each other. Moreover, managers should provide practical support for innovation to encourage team members to introduce new and better ways of fulfilling tasks. As well, management should design norms and procedures to enable teams to master their tasks as well as improve their capabilities. Consequently, the results support the significant impact of project management's positive attitudes towards their team members' ability to solve problems throughout the project.

5.2. Theoretical Implications

In this study, we hypothesized that (i) the problem-solving capability of software development teams is enhanced by team climate, (ii) the problem-solving capability promotes team learning, and (iii) team learning has an impact on software quality. Moreover, we examined the mediating role of team problem solving between team climate and team learning, as well as the mediating role of team learning between team problem solving and software quality. The results offered insightful implications for organizational learning and knowledge management literature. The current organizational learning literature posits that team learning is an interface between individual and organizational learning and that there is an intense interaction between individuals, teams, and organizations through the acquisition, processing, dissemination, and implementation of new knowledge. Moreover, the extant literature stresses that teams learn by searching for new opportunities through experimenting with new alternatives. In this sense, the results of this study enrich organizational learning by indicating the role of a team-level capability in terms of problem solving.

The capability of a software development team to understand problems, to plan appropriate solutions with various alternatives, and further to implement and to monitor the chosen solution (i.e., team problem solving) makes it necessary for the software development team to ask questions, seek feedback, experiment, reflect on results, and discuss errors or the unexpected outcomes of actions (i.e., team learning) Thus the problem-solving capability provides an ongoing knowledge processing mechanism that enables the team to achieve higher level learning.

Moreover, the findings address the influence of team climate on team learning during software development projects. An appropriate climate provides a positive atmosphere for the software development team in which their members can develop supportive and trusting relationships, which in turn increase social interaction and knowledge exchange. These increased social interaction and knowledge exchanges are highly associated with team problem solving and, correspondingly, that capability leads to achieving higher levels of learning. Accordingly, the findings of this study indicated that team learning is created by a specific team climate that provides a psychologically safe atmosphere for members, and that affects their behaviors, attitudes, and actions towards creating new knowledge.

Further, this research also provides strong support for the claim contained in the organizational learning literature that team learning leads to successful project outcomes. The findings revealed that team learning solutions are highly associated with the production of high quality software products. As a result, team learning appears to be a vital determinant for the success of software development projects.

This study also makes a significant contribution to knowledge management literature, which claims that product development projects strongly require the creation and implementation of new knowledge. The findings suggested that team learning, as a comprehensive search activity for new knowledge and insights on product features and market would be accomplished more easily as long as the teams have established a method of thinking and a behavior pattern in order to reach the desired outcomes. The problem-solving capability is comprised of searching for new information, selecting and implementing an action plan, and finally launching and developing new products. Accordingly, this study enhances the knowledge management literature by addressing a specific capability (i.e., team problem solving) that fosters learning behaviors in software development teams. In a larger sense, this result indicates a direct link between knowledge management applications and the learning behaviors of new software development teams. Particularly, product development projects are marked by high levels of product and process innovation, high knowledge intensity, dynamism, shrinking product and technology life circles, turbulence, and change. In the context of product development, the challenge basically is to create successful products. Organizations should take advantage of proficiency in problem solving to foster team learning which will ultimately produce new software products.

5.3. Limitations and future research

While this study is limited in terms of methodological aspects, it provides important implications for understanding the impact of team climate on team problem solving, as well as the impact of team problem solving on team learning. The main limitation was the sample size, which was relatively small (n = 139); the research relied on data obtained from a single informant for a given project. Since Turkey is a developing country with a developing software industry, it was truly a challenge to access these software development teams. Thus, caution should be exercised in generalizing the results, since a larger sample size may provide a better representation of the population of software development teams.

The use of multiple participants from the same project could have triangulated the results and increased the reliability and validity of informant reports. However, as noted above, reaching the software development teams was challenging. In other words, another limitation is that conducting a field study of an emerging software industry in Turkey with a small number of teams presented a real challenge in terms of the collection of data from multiple participants.

Furthermore, it was problematic to contact both the software developers and the product users simultaneously. Specifically, this research is inclined to a common method bias, in that the same individuals responded to both the dependent variable and the independent variable in a cross-sectional manner. To compensate for this limitation, we measured the extent of common method bias using Harman's one-factor test (see Table 1).

Utilizing a cross-sectional design through questionnaires was another limitation of this study. Although surveying is a large and growing area of research in the social context, the questionnaire method may not provide objective results regarding software product quality, which is a naturally dynamic phenomenon. However, it should also be noted that this research provided some evidence of associations as a cross-sectional field study. In this context, Podsakoff and Organ[90] stated that "because correlational field studies often provide useful information about relationships among important variables in actual organizational settings, few would advocate that they be totally discarded" (p: 539). In order to overcome this limitation, future research can employ longitudinal studies in which the quality perceptions of the developers are followed over time.

Finally, the generalizability of the sample is another limitation of this study. We conducted this study in a specific national context (Turkey); therefore, readers should be cautious in generalizing the results to different cultural contexts. In this regard, a sample of Turkish software development projects, like any culturally bound research study, imposes constraints on the interpretation and application of the results.

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90 Podsakoff and Organ, 1986, p.531-544.

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