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Mühendislik Yönetiminde Çevik Ölçeklendirmenin Önemi Ve Oecd Ülkelerinde Yüksek Teknoloji İhracatina Olan Katkisina Yönelik Bir Çalişma

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ÖZET

Değişen dünya düzeninde geleneksel mühendislik yöntemi yerine küçük ama hızlı ve toplu hareket edebilen, pazar erişim sürelerini uzatmadan müşterilere ulaşabilen; girişimci ruhlu takımlar, mühendislik yaklaşımları tercih edilmektedir. Bu tercihlere rağmen akademi ve iş dünyasında çevik mühendislik takım kavramına uymayan lider sayısı son zamanlarda giderek azalmaktadır. Çalışma, OECD ülkelerindeki milli gelirden alınan Ar-Ge harcamalarının ve çevik mühendislik model kavramının benimsendiği mühendislik yönetimi takımlarının patent sayılarının ihracat verilerinde ilişkisi açıklanarak giriş'e bağlı literatür taraması, ölçütlerin paylaşıldığı modelin tanımı ve sonuç aşamasından oluşmaktadır.

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A Study On The Importance Of Agile Scalability In Engineering Management And Its Effect On High-Tech Exports In OECD

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ABSTRACT

As a new world order is formed, entrepreneurial teams and engineering aproaches with small but quick and can mobilize collectively, reaching customers without extending market access time, are preferred instead of the traditional project method. Despite these preferences, the number of leaders in academia and business who adapt into the concept of agile engineering teams recently has been steadily decreasing. The study consists the literature review on introduction, the definition of the model which the criteria are shared in and the result stage and explains the relationship of R&D expenses from national income in OECD countries and the patent numbers of engineering management information systems, teams with the concept of agile models.

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1. INTRODUCTION *(GİRİŞ)*

In classical economy, technological progress was not calculated directly so that it is accepted as a "manna from heaven" wherein modern growth theory it is clear that well-educated labour force is indispensable source for technology creation.

Since researchers are driving force of technology they need to be managed differently rather than usual labour force. An approach based on delivering requirements iteratively & incrementally which is called as "Agile" is a preferable way to manage teams to make R&D ending with technology and innovation. Otherwise the management causes technology failure and slipped down in competitiveness with technology creators and finalizes as "creative destruction". Technological leader countries are also known as good export performer.

Firms cannot maintain their competitive power in the market with their classic project management practices and as a result, as a new approach, the project is directed to teams managed with different frameworks under the umbrella of the program and wants to update their processes in areas where it is inadequate [1]. It is stated that one of the most important factors preventing project and implementation success in traditional sectors is the lack of functional communication between stakeholders. However, in today's e-government applications, there has been a rapid transition to a period in which security is discussed, and technologies are compared, and customer satisfaction and product quality are more important than ever [2]. With this transition, digital identity, digital citizenship and Blockchain applications, the management of disruptive technologies that enable data owners to manage their data, enable transactions between the parties without trading intermediaries, eliminates the need for central authority, but only works with project applications developed with new methods and processes and produce solutions [3]. Performance measurement is one of the methods that can be used when making decisions. The most crucial stage of performance evaluation is to set appropriate criteria [4]

2.LITERATURE REVIEW *(LITERATÜR TARAMASI)*

With the share allocated from the gross national product for R&D in our country, projects are encouraged, supported and followed by ministries, universities and TÜBİTAK. However, considering the number, content, quality and limited resources of the Research and Projects produced together, there is a scarce resource management requirement in which not all projects can be supported [5]. Exiting this point, having a software measurement program with software and ensuring an objective and quantitative evaluation of software processes, continuous improvement and learning in the context of software development do not guarantee success, and in the light of the researches, more than 80% of these programs fail within the first 18 months [6]. This leads teams to present a running software to the requestor in short cycles, to move forward with more frequent approvals and feedback, and to unlike traditional methods, collecting tools to intuitively collect data. As a result of the above reasons, when the orientation is towards the Agile teams by professionals, some questions arise in which performance answers are sought. The most prominent of these questions is how companies can easily measure performance when forming a team, but how to measure and evaluate the performance of these teams if they create multiple teams? Besides, questions arise whether all business units in the organization will adopt working with this approach, whether agile work will improve the performance of the Information Technology Innovation Teams, but whether this work will have a positive impact on the overall performance of the organization. As can be seen, although it is possible to diversify the questions, the need for high competition in today's uncertainty makes the idea of having fast, agile and compatible teams attractive. However, institutions have difficulty in deciding to fulfil the criteria to make such a strategy a reality. Especially in projects requiring technology, situations that result in an unnecessary outcome are frequently encountered despite the large costs incurred for a long time [7]. When the outputs of R&D expenditures, such as patents at the firm level (micro) and country level (macro) and exports, are analysed, R&D expenditures sometimes do not result in positive output as expected. To analyse the relationship between R&D expenditures as a share of GDP, exports and patents at micro-level the biggest exporting firms with a large amount of R&D expenditure in Turkey and at macro level 36 OECD countries' and 7 emerging markets were taken into consideration. Finally, analyses were carried out for 43 countries at the macro level and 241 Turkish firms those export highest amounts. When the firms which are top exporters in Turkey are examined, it is seen that 241 of these firms spent on R&D. As a result of the analysis, it was determined that the export performance was high in line with the R&D expenditures made by 108 of these 241 firms, and 44 of the firms showed similar performance both in R&D expenditure and export performance, while the remaining 89 firms did not reach the expected export performance. When the results obtained for 43

countries are examined, it is clearly seen that; It is observed that there is no linear correlation for some countries between the R&D expenditures as a share of national income and the number of patents received in the field of H-TECH Engineering. In Figure 1, it is observed that the number of patent applications made in the field of Information and Communication Technologies and R&D expenditures are not positively correlated in some OECD countries such as Canada, Australia, Chile, Ireland, Italy, Mexico, Netherlands, Poland, Spain, Turkey, United Kingdom and USA and in non-member economies such as China, Romania, Russia, and Republic of South Africa

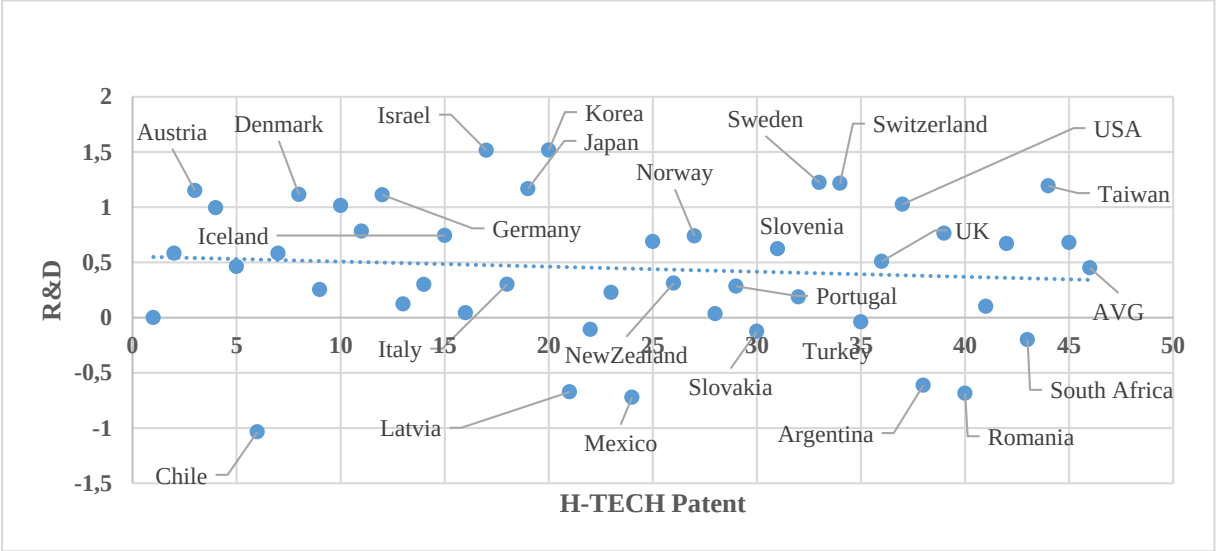

Figure 1. The relationship between R&D as a share of GDP and patent applications in the H-TECH Engineering sector in OECD countries and some Emerging Economies (2017). *(OECD ülkelerinde H-TECH Mühendislik sektöründe GSYİH payı olarak Ar-Ge ve patent başvuruları arasındaki ilişki ve bazı Gelişmekte Olan Ülkeler)*
Source: OECD (R&D expenditures as a share of national income belong to 2016 for Mexico and South Africa; ln: natural logarithm)

The research carried out in Figure 2 shows that the share of R&D expenditures as a share of their national income is not correlated with the exports of Computer, Electronics and Optics sectors in these countries. Australia, Canada, Finland, Israel, Luxembourg, New Zealand, Norway, Sweden, Turkey as well as some non-OECD developing economies countries such as, Russia and South Africa their R&D expenditures are not correlated with their exports in Computer, Electronics and Optics sectors.

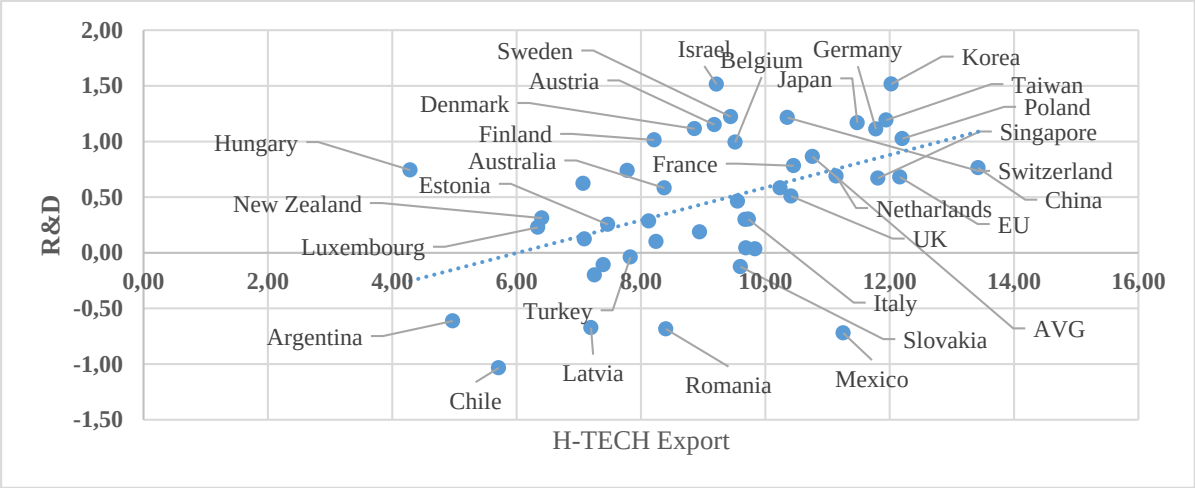

Figure 2: The relationship between OECD and the share of R&D expenditures in national income in some countries and the export in the H-TECH Engineering sector (2017) *(OECD ile bazı ülkelerde Ar-Ge harcamalarının milli gelir içindeki payı ve H-TECH Mühendislik sektöründe ihracat arasındaki ilişki)*
Source: OECD, the countries' data for 2017 but Mexico and South Africa data are for 2016.

In the figure above X axis stands for the natural logarithm value of H-TECH Engineering exports of the 43 countries' (millions USD) whereas Y axis stands for the R&D expenditures as a share of countries' GDPs. When both analyses results were evaluated, alongside the OECD countries such as Australia, Canada and Turkey, Russia and the Republic of South Africa's R&D expenditures cannot produce the expected positive outcomes as in other successful countries, and it is also seen that the expected result could not be achieved in the export of its products on Communication Technology Patent number as well as high-tech. It has been determined that projects and project teams whose analysis and outputs are not correctly described or suitable for scaling cannot provide desired outputs both on company and country basis.

Table 1 shows the R&D expenditures made by 36 OECD countries and 7 emerging market economies, the number of patents obtained in the field of Information and Communication Technology and their exports in the Computer, Electronics and Optics sectors. It can be clearly seen in the table that the R&D expenditures of some countries have resulted positively, both the number of patent applications and exports have shown positive performance in the Information, Communication and Technology sector. Although some countries make high R&D expenditures, the number of patent applications has been low and accordingly, exports in the high-tech, information and communication technology sector have not been concluded at the desired level.

Table 1. The country's R&D expenditures, the number of patent applications in the field of Information and H-TECH Engineering and their exports in the Computer, Electronics and Optics sectors *(Ülkenin Ar-Ge harcamaları, Bilgi ve H-TECH Mühendislik alanındaki patent başvurularının sayısı ve bunların Bilgisayar, Elektronik ve Optik sektörlerindeki ihracatı)*

Country	**H-TECH Patent Applications**	**R&D Expenditure as a share of GDP (%)**	**H-TECH Exports (Million $)**
China	23.368	2,15	674.210
United States	17.831	2,79	199.303
Korea	5.317	4,55	166.757
Chinese Taipei	303	3,30	153.727
Singapore	240	1,95	134.847
Germany	2.850	3,04	130.316
Japan	11.840	3,21	96.572
Mexico	44	0,49	77.168
Netherlands	562	1,99	68.894
France	1.335	2,19	34.735
United Kingdom	1.459	1,66	33.294
Switzerland	356	3,37	31.415
Czech Republic	22	1,79	27.992
Poland	81	1,03	18.686
Italy	335	1,35	16.784
Ireland	190	1,04	16.102
Hungary	74	1,35	15.919
Slovak Republic	8	0,88	14.767
Canada	979	1,59	14.112
Belgium	200	2,70	13.551
Sweden	1.588	3,40	12.627
Israel	768	4,54	10.045
Austria	175	3,16	9.706
Spain	220	1,21	7.663
Denmark	137	3,05	7.055
Romania	19	0,50	4.449
Australia	417	1,79	4.333
Russia	277	1,11	3.801
Finland	541	2,76	3.686
Portugal	39	1,33	3.376
Turkey	133	0,96	2.516
Norway	90	2,09	2.396
Estonia	9	1,29	1.750
Lithuania	5	0,90	1.627
South Africa	46	0,82	1.411
Latvia	1	0,51	1.334
Greece	20	1,13	1.200
Slovenia	6	1,86	1.177
New Zealand	35	1,37	605
Luxembourg	30	1,26	568
Chile	8	0,36	302
Argentina	3	0,54	144
Iceland	0	2,10	73

Source: OECD, the countries' data for 2017 but Mexico and South Africa data are for 2016.

Agile Software Development (ASD) methodologies have been widely accepted in the software development industry. While the iterative and incremental approach of agile methodologies are the main attraction, it also complicates the prediction and predictability of agile software projects. Such data can be used as quantitative metrics for time and effort estimation, which can help reduce risk and avoid risk. While traditional agile formulations and suggestions highlight individuals and interactions on processes and tools, this article analyses today's complex software systems and distributed teams. Emphasis on processes and tools enables agile software projects to produce project metrics that can be effectively used in predictive analytics and risk management. The system introduced here highlights a quantitative approach to agile project planning and provides a management model that generates risk criteria used to help avoid and reduce the risk [8]. A form of this can be provided through structured assessment models or frameworks. Implementing structural assessment models can enable to identify where projects stand in terms of agility and by doing so define which areas should be improved. Such an improvement approach can enable the agile principles outlined in the Agile Manifesto to be interpreted to the point and enable a more efficient adaptation of agile practices. However, it should be noted that the ultimate goal for an organization to adopt agile methods is not to be agile but to find ways to improve performance, code quality, customer and employee satisfaction through the implementation of agile methods/practices [9]. ASD is a term that covers various iterative and incremental software development methodologies. In agile software development; not only the interaction between individuals and each other is more important than the process and the tools used but the operation of the software is more important than documentation in detail. Customer contributions are also more important than contracts and agreements whereas responding to changes is more important than following a flat plan [10].

The agile manifesto focuses on twelve principles. The first principle, it is the first priority to achieve customer satisfaction by providing the earliest and continuous delivery of the software that is important to the customer. The second principle, being open to changes even if there are delays. The agile process enables the customer to compete advantageously with these changes. The third principle, to deliver the software that works in a short time two-six weeks. Principle four, business people and software developers should come together for the project on a daily basis. Principle five, it is important to implement the projects by motivating individuals and to trust them that they will meet their needs by providing them with the appropriate environment. Principle six, it is important to know that the most effective and short way of transferring information within the team is face to face interviews. Principle seven, the functioning software is the first indicator of the process. The agile process offers stable development. Principle eight, sponsors, developers and users are constantly in harmony. Principle nine, continuous attention to technical excellence and good design increases agility. Principle ten, simplicity is important. Principle eleven, the best architectures, requirements and designs come from teams that can organize themselves. Principle twelve, the team examines how his work can be more efficient and improves his behaviour accordingly [11].

The first item is about ensuring customer satisfaction. This means that customer needs are determined well, in other words, needs are analysed well. The subject highlighted in the second article is the answer to the changes. Changes in customer requirements or environmental conditions may require arrangements in the software to adapt to new conditions. This is possible through software improvement [12]. The third, fourth, fifth, eighth, eleventh and twelfth items are respectively; the completion of the software in a short time, the frequent gathering of stakeholders, the motivation of individuals, the constant harmony of sponsors, developers and users, and the need for teams to organize themselves and be productive [13]. In other words, since these items require effective use of time, communication, motivation, compliance and self-organization and efficiency, a good management activity is required for both the software process and motivation, compliance and efficiency. The sixth item is a topic that helps software developers to develop face-to-face communications during the planned phase and in accordance following the purpose. In the seventh article, he emphasizes that the operation of the software is the best criterion for evaluation. The improvement and perfecting of the software in the ninth and tenth articles and the simplification of the user depend on the realization of a radical change in a sense [14].

The development of large software systems requires project work, coordination of activities, project control and teamwork with tools to share information. Existing business sharing environments in collaborative software development often try to define and automate the development process. In addition to one-to-one communication, a shared

software development environment should be established based on the management of planning, definition, change and collaborative activities. This environment should be the basis for a high level of the dynamic development process, which can vary according to the clearly defined cooperation model, leading to various activities and business processes. The study, which we expect to contribute, is designed in the literature to cover this importance and deficiency [15].

Table 2. The Top 10 Global Companies (2019) *(En İyi 10 Küresel Şirket)*

Company Name	**Location**	**Sector**	**Rank +/-**	**Market Capitalisation ($Bn)**	**Rank**	**Market Capitalisation ($Bn)**
Microsoft	United States	Technology	2	905	3	703
Apple	United States	Technology	-1	896	1	851
Amazon.Com	United States	Consumer Services	1	875	4	701
Alphabet	United States	Technology	-2	817	2	719
Berkshire Hathaway	United States	Financials	1	494	6	492
Facebook	United States	Technology	2	476	8	464
Alibaba	Greater China	Consumer Services	0	472	7	470
Tencent	Greater China	Technology	-3	438	5	496
Johnson & Johnson	United States	Healthcare	1	372	10	344
Exxon Mobil	United States	Oil & Gas	2	342	12	316

Source: PWC

Microsoft is ranked as the most valuable company in the World in 2019 with a market value of 905 billion dollars. Apple with 896 billion dollars market value and Amazon with 875 billion dollars market value followed Microsoft. Microsoft replaced Apple as a top scorer which is ranked as the most valuable company in the World in 2018. Microsoft was ranked as the third valuable company in 2018 where Amazon was ranked as fourth in same year. It is seen that Alphabet which is another technology company was ranked as second in 2018 and fourth in 2019 (Table 2).

Table 3. The Top Ten Global Companies with Highest Absolute Increase in Market Capitalization Growth Rate
(Piyasa Değeri Artış Oranında En Yüksek Mutlak Artışa Sahip İlk 10 Küresel Şirket)

Company Name	**Location**	**Sector**	**Change In Market Capitalisation 2009-2019 ($Bn)**	**Market Capitalisation 2019 ($Bn)**	**Market Capitalisation 2009 ($Bn)**
Amazon.Com	United States	Consumer Services	843	875	31
Apple	United States	Technology	802	896	94
Microsoft	United States	Technology	742	905	163
Alphabet	United States	Technology	707	817	110
Tencent	China	Technology	425	438	13
Berkshire Hathaway	United States	Financials	360	494	134
Facebook	United States	Technology	394	479	81
Alibaba	China	Consumer Services	304	472	168
Visa	United States	Consumer Services	272	314	42
JP Morgan	United States	Financials	232	331	100

Source: PwC

In the Table 3 it is obviously seen that companies from United States also dominate the top global companies list in micro level as the country has a good performance in macro level. In the list Amazon is ranked as the most valuable company in the world with 875 billion dollars market capitalization whereas Apple with 802 billion dollars and Microsoft with 742 billion dollars market capitalization. Five technology and two e-commerce totally seven companies took place among top ten most valuable companies. When the absolute growth rates in the market capitalization of the companies are compared Amazon with an 843% growth rate between the 2009-2019 period is top ranked and is followed by Apple with 802% growth rate and Microsoft with 742% growth rate in same period. In top ten valuable companies list and top ten companies with highest growth rates in market capitalization one can easily see that the favour technology companies took place in both lists since they were managed by Agile framework.

Table 4. GDP of the Countries *(Ülkelerin GSYİH)*

Country	**2009 ($bn)**	**2018 ($bn)**
OECD - Total	42.663	52.676
United States	14.449	20.544
China	5.102	13.608
Japan	5.231	4.971
Germany	3.398	3.948
United Kingdom	2.411	2.855
France	2.690	2.778
Italy	2.191	2.084
Canada	1.371	1.713
Russia	1.223	1.658
Korea	902	1.619
Australia	928	1.434
Spain	1.486	1.419
Mexico	900	1.221
Netherlands	868	914
Turkey	645	771
Switzerland	542	705
Taiwan	392	590
Poland	440	586
Sweden	435	556
Belgium	481	543
Argentina	333	520
Country	**2009 ($bn)**	**2018 ($bn)**
Austria	400	455
Norway	386	434
Ireland	236	382
Israel	207	371
South Africa	296	368
Singapore	194	364
Denmark	321	356
Chile	172	298
Finland	252	277
Czechia	206	245
Portugal	244	241
Romania	174	240
Greece	330	218
New Zealand	121	205
Hungary	131	158
Slovak Republic	89	106
Luxembourg	51	71
Slovenia	50	54
Lithuania	37	53
Latvia	26	34
Estonia	20	31
Iceland	13	26

In Table 4 countries are listed with their GDP values in year 2009 and 2018. United States has the largest GDP with a 20,5 trillion dollar and is followed by China with 13,6 trillion dollars GDP and Japan with 5 trillion dollars GDP. One can easily see that technology companies listed Table 2 have much market value than some countries' GDP. Microsoft, Apple, Amazon and Alphabet have greater market value than 29 countries' GDP values where Facebook and Alibaba's market values are bigger than 22, Tencent's market value is bigger than 21 countries' GDP values.

3.METHODOLOGY *(METODOLOJI)*

Agile-Scrum is an application development framework. The main feature of this method is that it is based on observers, developers and repetitions. It assumes that many modern software projects are quite complex and it will be difficult to plan them all from the beginning. In order to reduce this confusion, the "Performance" six main criteria consisting "Agility", "Measurement", "Planned Iterations", "Goal", "Customer Satisfaction", "Team Wellness" is being established in terms of transparency, supervision and productivity. These six main criteria have got 84 sub-criteria so that totally there are 90 criteria in the framework (Figure 3).

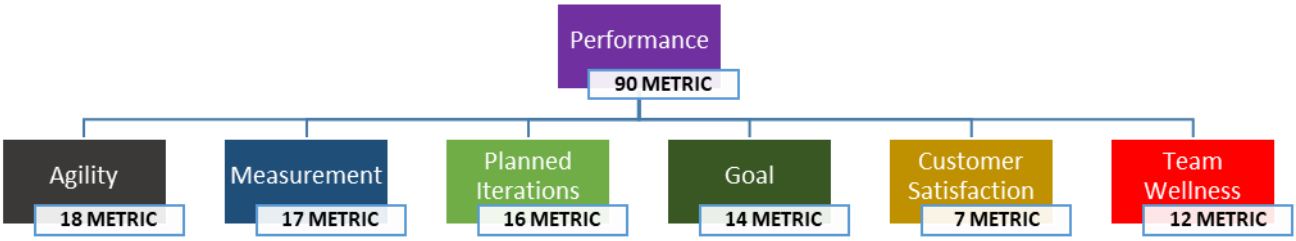

Figure 4. Level of Criteria *(Kriterlerin Ölçüt Düzeyi)*

3.1 Performance Index of Agility (*Çeviklik Performans Endeksi)*

It is the name given to a roof management for the management of agile-scrum complex projects to ensure that a product originally imagined and conformed to the design is produced at a fast, predictable cost and quality. The realization of the designed product is not carried out in the form of gradually realizing a list of requests prepared by the customer/user as detailed as possible [16]. Instead, the functions requested and defined by the customer/user are developed and revised within two or four-week periods called Sprint. This user-based requirement definition is described as a User Story and included in the job list. At the end of each Sprint, a functional piece of software is finished and can be delivered to the customer. Scrum Agile is a method that implements the principles of software development and 17 metrics have been designed for proper follow-up.

Table 5. The explanations of Agility performance criteria *(Çeviklik performans kriterlerinin açıklamaları)*

	CRITERIA	DEFINITIONS OF CRITERIAS		CRITERIA	DEFINITIONS OF CRITERIAS
C	**Agility**	**Criteria below C Level**	**C**	**Agility**	**Criteria below C Level**
C1	Artefacts	Aggregate Metrics			
C1.1	Burndown chart	The burndown chart shows representation of work left to do versus time	C2.4	Velocity for planning	Criteria determining the importance of participating in planning of team speed in iterations
C1.2	Documentation	Criterion that determines the importance of institutional memory without creating bureaucracy in iterations	C2.5	Updated product backlog	Criteria that determines the importance of keeping the worklist up to date in iterations
C1.3	Sprint backlog	Criteria determining the importance of tasks determined by the team to be completed in iterations	C2.6	Unique Roll	Criterion that determines the importance of decomposition of roles in iterations
C1.4	Product backlog	Criterion that shows the importance of new features, bug fixes, changes to achieve a certain result in iterations.	C2.7	Sprint backlog management	Criterion that determines the importance of tracking the works committed in operations
C2	Roles	Aggregate Metrics	C2.8	Impediments list	Criteria that determines the importance of listing obstacles encountered in iterations

C2.1	Product owner	Criteria that determines the importance of prioritization, identification and execution of work in iterations	C3	Timeboxed Iterations	Aggregate metrics
C2.2	Updated sprint backlog	Criteria that determine the importance of updating business frequently in iterations	C3.1	Time management	Criterion that determines the importance of time management in iterations
C2.3	Communication skills	Criterion that determines the importance of internal and external communication in the team in iterations	C3.2	Time Consistency	Criterion that determines the importance of time consistency in iterations

3.2 Performance Index of Measurement
(Performans Ölçüm Endeksi)

Performance evaluation has gained importance in a competitive environment. Decision making is one of the most important activities in the business world. Managers need accurate and reliable scientific predictions for decisions. Performance measurement is one of the methods that can be used when making decisions. The most important stage of performance evaluation is to set appropriate criteria. It is presented with 18 criteria as the most basic interpretable indicators by considering many criteria in performance measurement of teams.

Table 6. The explanations of Measurement criteria *(Ölçüm kriterlerinin açıklamaları)*

	CRITERIA	**DEFINITIONS OF CRITERIAS**		**CRITERIA**	**DEFINITIONS OF CRITERIAS**
D	Measurement	Criteria below D Level	D	Measurement	Criteria below D Level
D1	Velocity	Criterion that determines the importance of knowing the capacity dependent velocity in iterations	D10	Return Rate	Criterion for the importance of the works to be reworked in iterations
D2	Sprint burn-down	Criteria Determining the Importance of Burn-Down Shows How Much Work the Team Has Left Versus the Ideal Amount of Work Remaining in Iterations	D11	Focus Factor	The benchmark that determines the importance of the percentage of the team's effort that results in finished stories
D3	Release burn-up	Criteria determining the importance of how much a team has left to complete a release versus the ideal amount of work remaining in iterations	D12	Estimation accuracy	Objective: the ability of teams to accurately estimate their work.
D4	Sprint length	Criterion that determines the importance of sprint length in iterations.	D13	Reliability	Criterion that determines the ability of teams to meet the story points they committed to for a sprint

D5	Successful sprints	Criterion that determines the importance of successful sprints in estimation.	D14	Relative return on investment	Criterion that determines the importance of investment's added value
D6	Story completion ratio	Criteria determining the importance of completing the works in the estimated budget and time	D15	Total business value earned	Criterion that determines the importance of an accumulation of all the business value that was earned during a sprint
D7	Story lead time	Criterion that determines the importance of knowing the time it takes from which the job was added to the backlog to solving it.	D16	Process efficiency	Criterion that determines the importance of the process efficiency showing how efficient the team members spend their time working on committed stories.
D8	Productivity	The criterion that determines productivity team's capability to do business and its importance for customer satisfaction	D17	Team size	Criteria determining the importance of producing tools in cross-functional features within the limits specified for productivity
D9	Predictability	Criteria that determines the importance of presuming jobs	D18	Team &company turnover	Criterion that determines the importance of company turnover, team member turnover

3.3 Performance Index of Planned Iterations
(Planlanan Yinelemelerin Performans Endeksi)

Inspection with the scales metric in this section is intended to ensure that parts or functions of the product are delivered and evaluated regularly. 16 metrics were designed to increase the traceability by keeping the progress and problems on a daily basis and to ensure that they are localized for the solution of the problems without any complaint from the customer.

Table 7. The explanations of Planned Iterations criteria *(Planlı Yineleme kriterlerinin açıklamaları)*

	CRITERIA	**DEFINITIONS OF CRITERIAS**		**CRITERIA**	**DEFINITIONS OF CRITERIAS**
E	Planned Iterations	Criteria below E Level	E	Planned Iterations	Criteria below E Level
E1	Successful Meetings	Aggregate Metrics	E3	Successful Retrospective	Aggregate Metrics
E1.1	Participation	Criteria that Determines the Importance of Participation in Iterations	E3.1	Results İn İmprovement	Criteria that Determines the Importance of Creating an Opportunity to Develop from Outputs
E1.2	Priorities	Criteria that Determines the Importance of Consensus Establishment on the Plan	E3.2	Discussed, Addressed Categorized Risk	Criteria Determining the Importance of Addressing and Categorizing Risks and Assumptions

E1.3	Estimation	Criterion that Determines the Importance of Forecasting in Planning	E3.3	Refactoring	Criteria that Determines the Importance of the System's Response to the Current and Future Needs
E1.4	Velocity for Planning	The criterion that determines the importance of using the production speed of the team in planning	E3.4	Achievable Plan	Optimizes the Probability That the Development Team Will Meet the Sprint Goal
E2	Daily Scrum	Aggregate Metrics			
E2.1	Sprint Burndown Chart	Criteria that Determine the Importance of Tracking the Daily Flow of Jobs.	E4	Successful Sprint Review Meetings	Aggregate Metrics
E2.2	Awareness	The Criterion that Determines the Importance of Being Aware of the Work of Another Team Member	E4.1	Demo	Criterion for Determining the Importance of Getting Approval for the Working Product Before Going Live
E2.3	Problems and İmpediments	Criteria that Determines the Importance of Not Waiting for Problems to be Solved	E4.2	Feedback	Criteria Determining the Importance of Feedback
E2.4	Activity Time	Criterion that Determines the Importance of Activity Time	E5	Meeting Notes	Criterion that Determines the Importance of Note-taking in a Meeting

3.4 Performance Index of Goal *(Performans Hedef Endeksi)*

Agile Goal is defined as a specific goal to ensure the team is gathered around a higher lofty goal that exceeds the goals of all stakeholders. Due to the nature of the work, the requirements for the product are not determined from the beginning once, but there is a goal target and definition to guide the team in each iteration in order to be re-evaluated in each delivery and to make adaptations according to the situation.

Table 8. The explanations of "Goal" criteria *("Hedef" kriterlerinin açıklamaları)*

	CRITERIA	**DEFINITIONS OF CRITERIAS**		**CRITERIA**	**DEFINITIONS OF CRITERIAS**
F	Goal	Aggregate Metrics	F	Goal	Aggregate Metrics
F1	Definition of Done	Criteria that Determines the Importance of Having Data Criteria Determined	F8	Blocked Time	Criterion that Determines the Importance of being blocked in Job Loss
F2	Team Respects	Criteria that Determines the Importance of Each Team Having Its Own Data Criteria	F9	Work Item Age	Criteria that Determines the Importance of the Time Between Starting and Ending in Iterations

F3	Goal	Criteria that determine the importance of having a clear goal definition made by all team members	F10	Story Acceptance Ratio	Criteria that Determine the Importance of the Acceptance of the Output
F4	Fixed Items	Criteria that Determines the Importance of Quality in Iterations	F11	Productivity	Criterion that Determines the Importance of Productivity in Iterations
F5	Well Defined Risks	Criteria that Determine the Importance of Well-Defined Risks in Iterations	F12	User Acceptance Test	Iterations Criteria Determining the Importance of User Acceptance Test
F6	Rework	The Criterion that Determines the Importance of Avoiding Works to be Reworked in Iterations	F13	On-Time Delivery	Criterion that Determines the Importance of Timely Delivery in Iterations
F7	Failed Deployments	Criterion that Determines the Importance of Preventing Loss of Work to be Created by Failed Deployment	F14	Defects in Production	Criteria that Determines the Importance of Reputational Deterioration Problems in the Production System

3.5 Performance Index of Customer Satisfaction *(Müşteri Memnuniyeti Performans Endeksi)*

Agile approaches focus on logical customer satisfaction. After all, the customer is the reason to develop the product in the first place [**17**]. In this section, 12 metrics were designed to participate in the basic key performance indicator process by obtaining a net promotor score calculation from the questions regarding the determination of customer dissatisfaction in order to identify some customer satisfaction problems that are common in the project.

Table 9. The explanations of "Customer Satisfaction" criteria *("Müşteri Memnuniyeti" kriterlerinin açıklamaları)*

	CRITERIA	**DEFINITIONS OF CRITERIAS**		**CRITERIA**	**DEFINITIONS OF CRITERIAS**
G	Customer Satisfaction	Criteria below G Level	G	Customer Satisfaction	Criteria below G Level
G1	Well Defined Processes	Criterion that determines the importance of the process meeting the requirements	G5	Applied Stories	Criteria that determines the importance of having your requests sufficient detail and understandability
G2	Score	Criterion that determines the importance of Output's Contribution to Your Product / System	G6	Analysis	Criteria that determines the importance of the team's contribution to understanding your request

G3	Communication	Criterion that determines the importance of intra-team communication	G7	Team and Process	Criteria indicating the importance of the team determining development criteria that meet customer acceptance criteria
G4	Constructive criticism	Criterion that determines the importance of considering recommendations			

3.6 Performance Index of Team Wellness *(Takım Sağlığı Performans Endeksi)*

Exploring ways that motivate agile teams is positively correlated with output quality. Based on the work to be performed, it is necessary to employ the right resources to the teams and to control the team autonomously with a product backlog and product owner where the need is addressed correctly. It is designed to participate in the basic key performance indicator process by obtaining a net promoter score calculation in terms of giving people time and opportunity to develop their expertise.

Table 10. The explanations of "Team Wellness" criteria *(Takım sağlık durumu kriterler)*

	CRITERIA	DEFINITIONS OF CRITERIAS		CRITERIA	DEFINITIONS OF CRITERIAS
H	Team Wellness	Criteria below H Level	H	Team Wellness	Criteria below H Level
H1	Collaboration	Criterion that Determines the Importance of Intra-Team Communication and Collaboration	H7	Goal	Criteria that Determines the Importance of the Sprint Goal for Understanding the Sprint Scope and the Sprint Goal
H2	Team Enthusiasm	Criterion that Determines the Importance of Team Enthusiasm	H8	Responsibility	The Criterion that Determines the Importance of Scrum Master's Performance
H3	Lessons Learned	Criteria that Determine the Importance of Lessons Learned	H9	Sense of Mission	Criterion that Determines the Importance of the Mission That the Product Owner Will Put on the Team
H4	Communication	Criterion that Determines the Importance of Contribution of Business and Communication to Development	H10	Comprehensibleness	Criteria Determining the Importance of Ensuring Understandability of Demands
H5	Agility	Criteria Determining the Importance of Team's Acting in Accordance with Agile Framework	H11	Reproductivity	Criteria that Determines the Importance of Creativity for the Solution of Demands
H6	Blame Culture	Criterion that Determines the Importance of No Blame Culture	H12	Coaching	Criterion that Determines the Importance of Coach Support

4. RESEARCH CONSTRAINTS *(ARAŞTIRMA KISITLARI)*

The use of Scrum does not necessarily solve the problems that exist in the development of the system, but it provides a good learning method from the errors that occur in a relatively short time. The application of metrics to Scrum and the role of the Scrum team in communication plays a major role in defining errors and internal monitoring of team performance. Scrum uncovers your product and engineering management, so you can continually improve the performance of your product, team, and work environment. There is a lack of data for R&D expenditures as a share of national income. So, the data for Mexico and South Africa belong to 2016 where the data belong to 2017 for the other 41 countries. Since there is a lack of data for the countries not included in the study we could analyse only 36 OECD members and 7 emerging economies.

5. CONCLUSION *(SONUÇ)*

To catch up the developed countries' income level the developing countries should make investments in R&D to increase their goods and service exports. This will not only decrease their current account deficit but also increase their citizens' prosperity as well. The team in R&D has crucial importance for the countries to reach their goals. So, management of these teams should be considered carefully.

If a company at a micro level and a country at macro level want to increase their export volume they should increase R&D expenditures resulting with technology creation and patents. To reach this goal Agility framework is strictly offered to apply for the management of team in R&D. Expenditures for teams which are not managed effectively will be resulted inefficient teams that are far from producing output. Although inefficiency has various adverse effects at both micro and macro levels, it has effects as it can be understood from The analysis made above, even by causing time losses and efficiency decreases. Using metrics in Scrum is useful for looking at the team's product performance and evaluating the maturity of a plan. Measurements made during the sprint run allow direct identification of problems while the team is working on jobs. Although Scrum prioritizes flexibility in the process, this measurement model built by us will allow careful planning of jobs, giving full priority to customer requests, avoiding risks, considering all possibilities. Our primary focus is to explore different ways to ensure the reliability of the metrics, as this is the only factor for long-term use of metric programs, which shows strong potential in dictation. This study is aimed to be guide for the future studies about measuring the behaviour of operational process metrics and determining their impact on the development process of their company and using a ranking algorithm to include.

CONFLICT OF INTEREST *(ÇIKAR ÇATIŞMASI BİLDİRİMİ)*

No potential conflict of interest was reported by the authors.

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