



**RELINK**  
TOWARDS LINK RECOVERY

**Group**  
T2310

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# Outline

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- Background Information and Problem Definition
- Types of Innovation
- Survey with Software Practitioners
- Final Architecture
- Link Recovery
- Final Project Status
- Case Study with Arçelik

# Background Information and Problem Definition

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- Version Control Systems offer built-in features for **manually** linking issues with pull requests.
- **Missing** links between Pull Requests and Issues
- **Reducing** efficiency in bug localization, bug prediction, and feature improvements.
- **Untraceability** in software projects



- **5** Conference Articles
- **3** Competitors (ZenHub – Boring Cyborg – Quantify)



- **Detect** missing links
- **Recommend** possible links between issues and pull requests
- **Analyze** link history
- **Visualize** historical link data

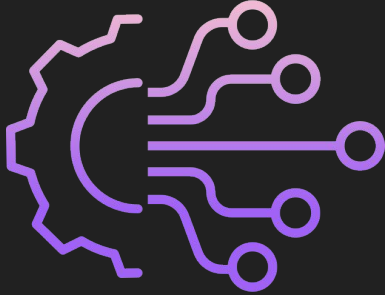
## Background Information and Problem Definition (cont'd)

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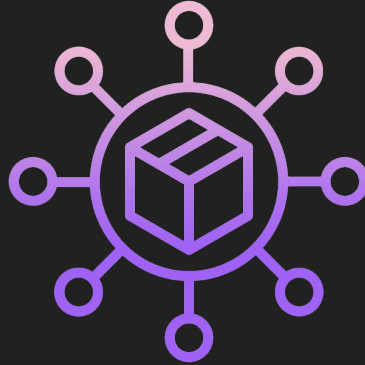
- Missing links yield untraceability.
- Untraceability prevents software analytics tools from working efficiently.
- Especially for the projects which have been developed for over 4-5 years, the number of missing links increase due to the lack of standards and conventions.
- Even though the developers apply the convention and standards now, the PRs and issues that are ~10 years old are impossible to link manually.
- Companies need a semi-automatic tool like ReLink that lists the top-5 possible issue links for each unlinked PR.

# Types of Innovation

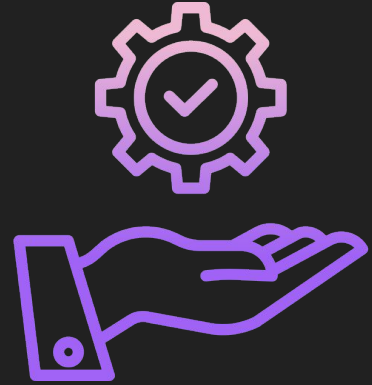
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**Network**



**Product System**



**Service**

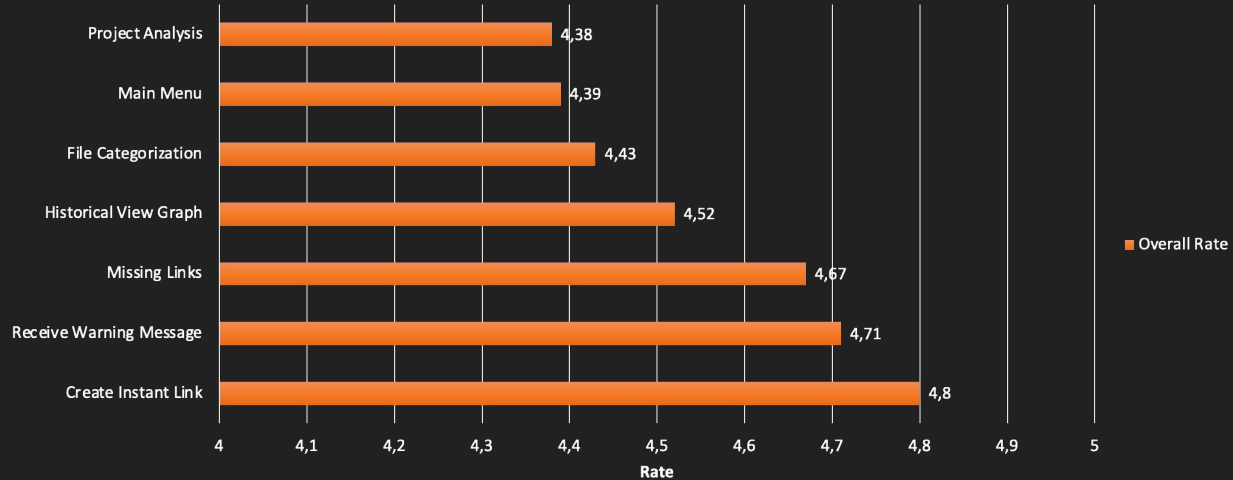
# Survey with Software Practitioners



22  
Developers

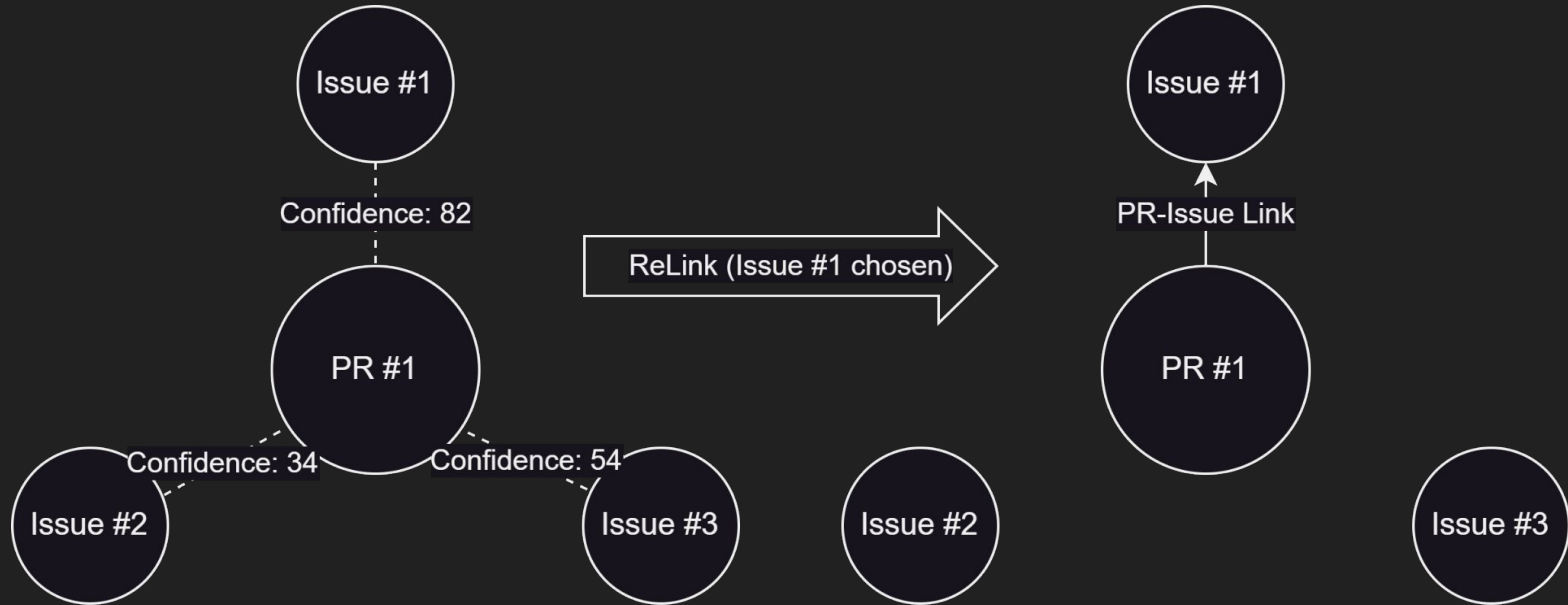


9  
Companies



1: Useless 5: Useful

# Survey with Software Practitioners



# ReLink Process

Pull Request  
of interest

Possible Links of PR 13931

Title: chunk error  
Source Branch: refs/heads/2.15.2-chunkerror  
Target Branch: refs/heads/2.15.2  
Status: completed  
Opened Date: May 4, 2023 at 10:52  
Created by: 26067460@arcelik.com  
Closed Date: May 4, 2023 at 10:57  
Closed by: 26051072@arcelik.com  
Description: chunk error

Top-5 possible  
issues provided  
by ReLink's ML  
model

Issue ID	Title	Opened Date	Resolved Date	Confidence Score
<input type="checkbox"/> <a href="#">CONG-12190</a>	Romanya şirketinde Fuel Masraf tipinde Tutar değeri (otomatik olarak) gelmemektedir.	May 4, 2023 at 11:48	May 4, 2023 at 13:56	30
<input type="checkbox"/> <a href="#">CONG-12178</a>	Xpense Sprint 53 Yazılan Test Otomasyon Execution	May 3, 2023 at 16:20	May 4, 2023 at 12:33	15
<input type="checkbox"/> <a href="#">CONG-12177</a>	Xpense Sprint 53 Otomasyon Regresyon Test Execution	May 3, 2023 at 16:18	May 5, 2023 at 13:17	10
<input type="checkbox"/> <a href="#">CONG-12172</a>	PO detay sayfasındaki POID alanın aşağısına processid eklenecek ama kullanıcı tarafından görülmeyecek	May 2, 2023 at 16:11	May 4, 2023 at 10:47	10
<input type="checkbox"/> <a href="#">CONG-12206</a>	şirket kodu parametresi ile cü kullanıcıları alma işlemi	May 4, 2023 at 16:17	May 8, 2023 at 08:48	6

Confidence  
Scores (0-100)

RELINK IGNORE ADD ANOTHER ISSUE

Add another  
issue.

ÖD

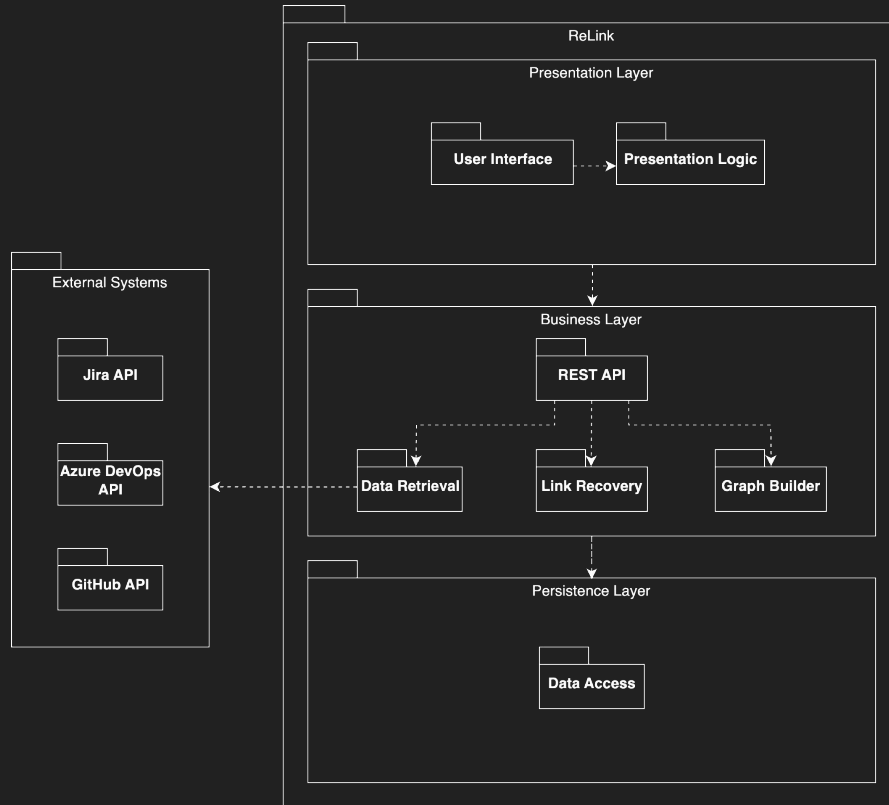
KÖ

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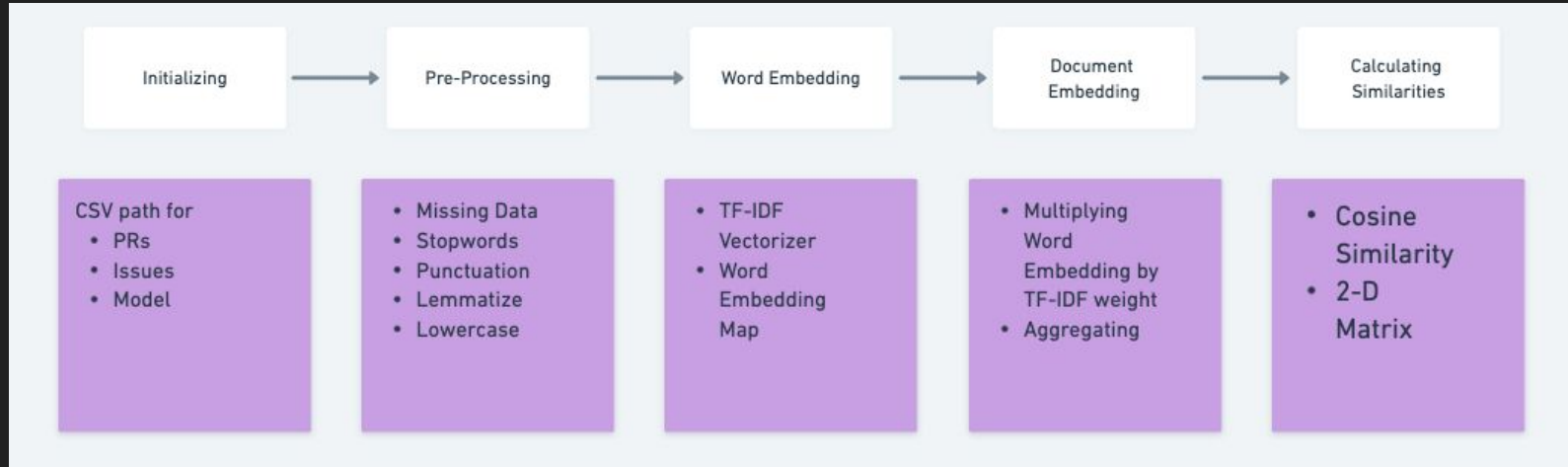


# Final Architecture



# Link Recovery: Similarity Calculation

- ReLink's link recovery consists of two parts: similarity calculation and heuristics. Text similarity is calculated with the following pipeline:



# Link Recovery: Heuristic Checks

- Pre-defined heuristic and mathematical rules with fine-tuned weights.
- Jaccard index, PR key string matching (A = PR date interval, B = issue date interval)
- Substantially increases prediction performance.



$$J(A, B) = \frac{|A \cap B|}{|A \cup B|} = \frac{|A \cap B|}{|A| + |B| - |A \cap B|}$$

- 1 Get top 500 similarity scores
- 2 Calculate and add heuristic score
- 3 Return possible links and confidences

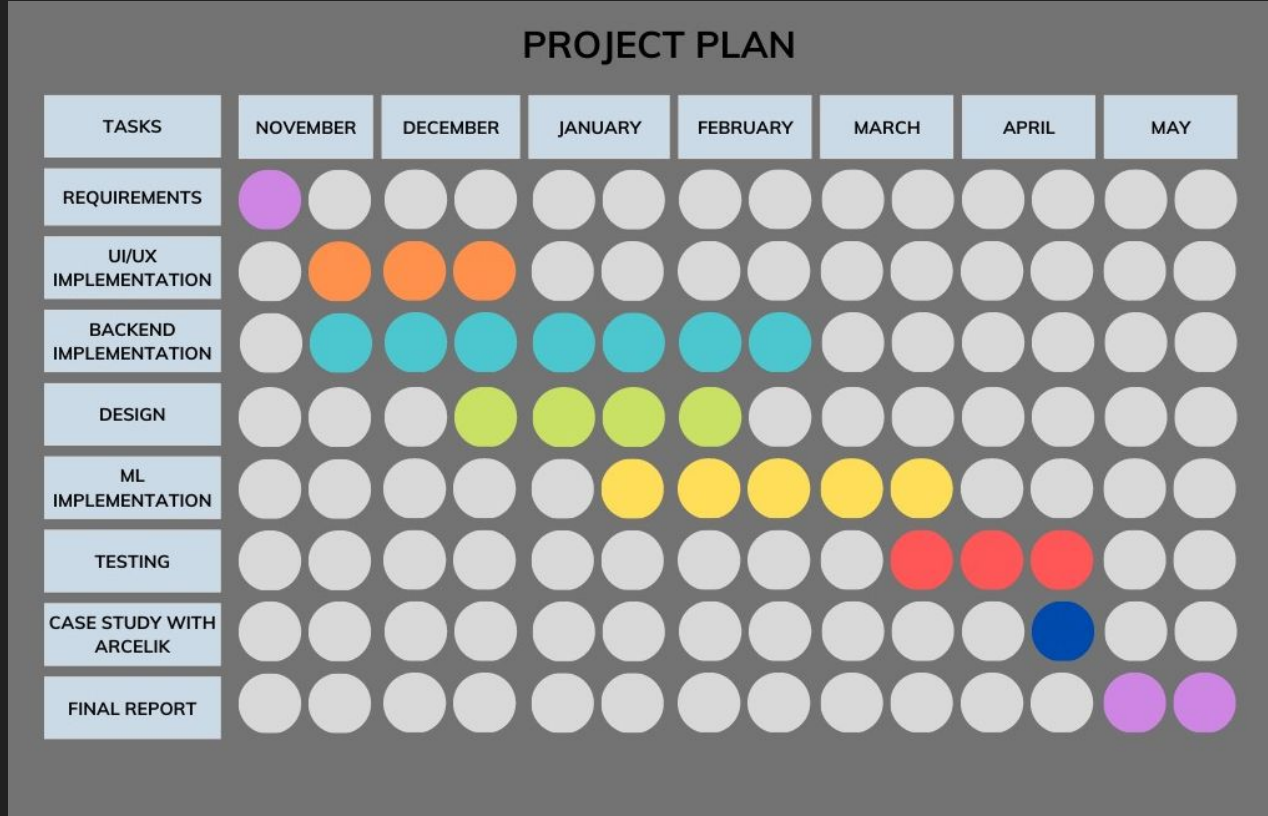
# Link Recovery: WildFly Experiment Metrics

Pred. Count	Precision	Recall	F1 Score
1	0.77	0.74	0.75
2	0.40	0.76	0.52
3	0.27	0.77	0.40
4	0.20	0.78	0.32
5	0.16	0.78	0.27

Top-1 Accuracy	0.77
Top-3 Accuracy	0.79
Top-5 Accuracy	0.80
MRR	0.78

# of PRs: 16,722, # of issues: 18,074

# Final Project Status




# Final Project Status

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Completion Percentages of Project Parts



# Case Study with Arçelik



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TOWARDS LINK RECOVERY

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[Possible Links](#)  
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## Possible Links

Repository: Azure Rows Per Page: 10

Search by: Author ID Title Choose status

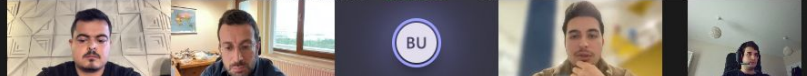
SEARCH

PR ID	Title	Opened Date	Closed Date	Created By	Status
<a href="#">13931</a>	chunk error	May 4, 2023 at 10:52	May 4, 2023 at 10:57	26067460@arcelik.com	Completed
<a href="#">13877</a>	Expense Currency hot fix	April 28, 2023 at 15:06	April 28, 2023 at 15:37	C9005239@arcelik.com	Completed
<a href="#">13555</a>	prod hotfix- okta token problemi	April 3, 2023 at 18:42	April 4, 2023 at 10:26	26075977@arcelik.com	Completed
<a href="#">13539</a>	prod hotfix caching	April 3, 2023 at 13:42	April 3, 2023 at 16:45	26075977@arcelik.com	Completed
<a href="#">13293</a>	#invoice-from-customer-hotfix#	March 15, 2023 at 16:07	March 15, 2023 at 16:31	C9014646@arcelik.com	Completed
<a href="#">12926</a>	impersonation da 2 sicil sorunu giderildi	February 28, 2023 at 10:28	April 6, 2023 at 16:01	C9012248@arcelik.com	Abandoned
<a href="#">12814</a>	prod-hotfix-overtime	February 21, 2023 at 09:52	February 21, 2023 at 09:54	26075977@arcelik.com	Completed
<a href="#">11654</a>	Canli qecis icin	December 22, 2022	December 22, 2022	C9011366@arcelik.com	Completed

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# Case Study with Arçelik



RELINK  
TOWARDS LINK RECOVERY

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Overview

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## Historical Graph of Current Links

Current links on repository.

Repository: Azure

PR ID	PR TITLE	ISSUE ID	ISSUE TITLE	INSPECT
<a href="#">14247</a>	#CONG-12566#	<a href="#">CONG-12566</a>	Readonly alanlarda data görülmektedir.	▼
<a href="#">14233</a>	#CONG-12447#	<a href="#">CONG-12447</a>	International Travel (Advance) componentlerinin oluşturulması	▼
<a href="#">14217</a>	#CONG-12564#	<a href="#">CONG-12564</a>	Philippines_ Kayıtlı Para Birimi Alanının Kaybolması	▼
<a href="#">14175</a>	kart içerisinde havuzdan al rapora eklendi	<a href="#">CONG-12162</a>	Özlük Ekibi Onayında Bekleyen Taleplerin Raporlanması - Yıllık İzin	▼
<a href="#">14151</a>	#CONG-12168#	<a href="#">CONG-12168</a>	UK&Ireland için Internal Order alanının optional gelmesi	▼
<a href="#">14148</a>	#CONG-12162# Tamamlandı	<a href="#">CONG-12162</a>	Özlük Ekibi Onayında Bekleyen Taleplerin Raporlanması - Yıllık İzin	▼

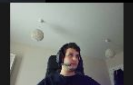
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# Case Study with Arçelik

Pull request 4273: CON 4097 x ReLink x [CONG-8908] Kullanıcı girişi y... x Pull request 11482: Eksik saat x Meeting | Microsoft Teams x

Not Secure | 10.248.3.10:3000/possibleLinks

Back to Project List Search by: author ID Title Choose status

### Possible Links of PR 11463

Title: Delete edilen rule a ait kayıtlar disabled  
Source Branch: refs/heads/CONG-4501-baris  
Target Branch: refs/heads/master  
Status: completed

Opened Date: December 12, 2022 at 16:24  
Created by: 26075977@arcelik.com  
Closed Date: December 12, 2022 at 16:25

Description: Delete edilen rule a ait kayıtlar disabled

#### Possible Links of PR

Enter Issue Key  
Q CONG-8908

No issues found.

SEARCH ADD CLOSE

Issue ID	Resolved Date	Confidence Score
<input type="checkbox"/> <a href="#">CONG-4501</a> Faz 3 - Bir TR çalışanı olarak	December 29, 2022 at 09:03	100
<input type="checkbox"/> <a href="#">CONG-9654</a> Polonya kullanıcısı Polish dili	December 12, 2022 at 15:05	30
<input type="checkbox"/> <a href="#">CONG-9652</a> Romanya kullanıcısı ile masr.	December 12, 2022 at 09:54	15
<input type="checkbox"/> <a href="#">CONG-9638</a> Taslak statüsünde gözükme bug i test ortamında masraflar görünür bilana kadar refresh page döngüsüyle çözülecektir.	December 12, 2022 at 14:10	10
<input type="checkbox"/> <a href="#">CONG-8823</a> Dbde güncellenme tarihlerine göre öncelik ile top N faturanın her jobda güncellenmesinin sağlanması	December 9, 2022 at 13:57	7

RELINK IGNORE ADD ANOTHER ISSUE

< 1 2 3 4 5 ... 241 >

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**DEMO**