1. Data analysis procedure:

To tackle Silicon´s objective to reduce failed R&D projects and enhance economic efficiency of successful ones, we carried out a data analysis that captures network density and bridging ties metrics to explore relationships between these metrics and project outcomes. The analysis was structured in a way that captures significant information and identifies factors influencing project success or failure:

1. **Explore and Understand the data:** We loaded data about teams, outcomes, and affiliations to understand projects carried out in the past year by Silicon, and the current knowledge sharing relationship among technicians and engineers working in the area of microprocessors at the company.

2. **Calculate Metrics**: Calculations on average node degree helped us measure the density of interactions per employee. Degree distribution helped us visualise how team connections are spread and identity if resources were clustered around particular nodes. Connectedness helped us evaluate which members were part of cohesive teams and which weren't, highlighting potential collaboration breaks. Clustering coefficient helped us understand if knowledge sharing was resilient among nodes or isolated. Betweenness centrality helped us pinpoint key employees who act as bridges in the network but can be potential bottlenecks for projects. Finally, Burt's constraint index measured the level of dependency of a node on a single contact.

3. **Create Data Frames:** Data Frames allow us to merge the information of employee metrics and acquire better comprehension and visualisation of the data.

4. **Aggregate Data at Team-Level and Merge with Project Outcomes:** We aggregated metrics at the team-level to get insights into overall team structures and relationships with team success or project duration. By combining this with project outcomes we were able to compare how average network properties relate to team performance.

5. **Conduct Statistical Analysis**: Using multiple linear regression, we ran statistical analyses to explore the relationship between the metrics of each team and the outcomes achieved by them. We decided to predict:
    a. Team success based on density and bridging ties metrics,
    b. Duration of project based on density and bridging ties metrics,
    c. Team success based on novelty of project and duration of project.

This revealed some statistical issues such as multicollinearity between variables like Mean_Constraint and Mean_Cluster, which lead to the elimination of these two variables from the model, and high standard error of Mean_betweeness, leading to the standardisation of variables to rerun the regression. Additionally, we removed the variable Mean_Connect because it did not contribute to the model once standardised given that it showed a constant value of Connectedness =1 for all employees.

With the new model, we were able to identify which changes in metrics influenced project success and which metrics made a bigger difference than others. With these findings we were able to reason on the economic and organisational significance of these relationships in order to successfully deliver recommendations to Silicon.

2. Results

Our analysis indicates that project success is significantly impacted by the Betweenness Centrality (referred to as Mean_Betweenness). As expected, Mean_Betweenness, which measures the number of times a member acts as a bridge within the network, reveals a negative coefficient in our findings (See Table 1). This means that increasing Mean_Betweenness by one unit will result in a decrease of 0.2286 in the probability that a project is successful. The p-value (0.000) supports the statistical significance of this relationship. As seen in figure 1, projects that succeed have lower Mean_betweenness than projects that fail. This finding suggests that in those cases where teams rely only on a few individuals for information exchange, knowledge sharing or even coordination, bottlenecks might be created, negatively affecting the overall performance of the project.

Coefficients

	Estimate	Std. Error	t value	p value
(Intercept)	0.7723	0.037	20.621	0.000
mean_avg_degree	0.0575	0.046	1.248	0.215
mean_betweeness	-0.2286	0.046	-4.974	0.000
Amount of Employees	0.0158	0.038	0.416	0.678

Quantity	Value
R squared	0.203
F-statistic	9.464

Table 1: OLS Regression explaining project success Results

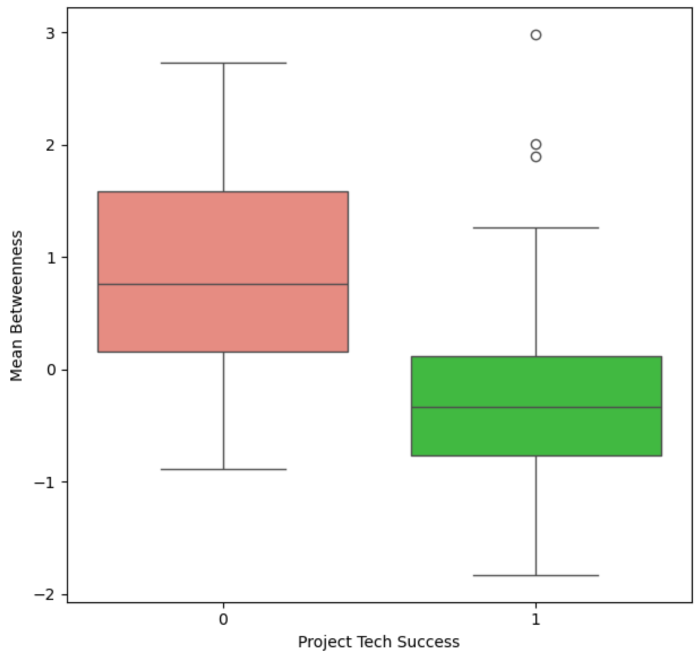

Figure 1: Impact of mean_betweenness on Project Success

Moreover, our analysis indicates that project duration is significantly impacted by both the Average Degree (referred to as Mean_Avg_Degree) and Mean_betweenness. The Mean_Avg_Degree reflects the average number of connections each team member has with others within the team. Our findings reveal a significant negative correlation with project duration, with a p-value of 0.045. Its coefficient indicates that as the Mean_Avg_Degree increases, project duration decreases by approximately 0.81 (See Table 2). This means that in those teams where members are more connected (have a higher Mean Average Degree) are likely to complete projects faster. This finding aligns with the idea that more connections may enhance processes, as teams with better connectivity can collaborate more effectively and efficiently (See Figure 2).

In regards to Mean_betweenness, it presents a positive coefficient (See Table 2). This means that increasing this variable by one unit will result in an increase of 3.1962 days in Project Duration. The p-value (0.000) supports the statistical significance of this relationship. Once again this implies that in order to reduce project duration, individuals that act as bridges within the teams need to be diversified and evenly distributed (See Figure 2) .

Coefficients

	Estimate	Std. Error	t value	p value
(Intercept)	87.2986	0.323	269.911	0.000
mean_avg_degree	-0.8080	0.398	-2.031	0.045
mean_betweeness	3.1962	0.397	8.053	0.000
Amount of Employees	0.1470	0.328	0.448	0.655

Quantity	Value
R squared	0.438
F-statistic	25.25

Table 2: OLS Regression explaining project duration Results

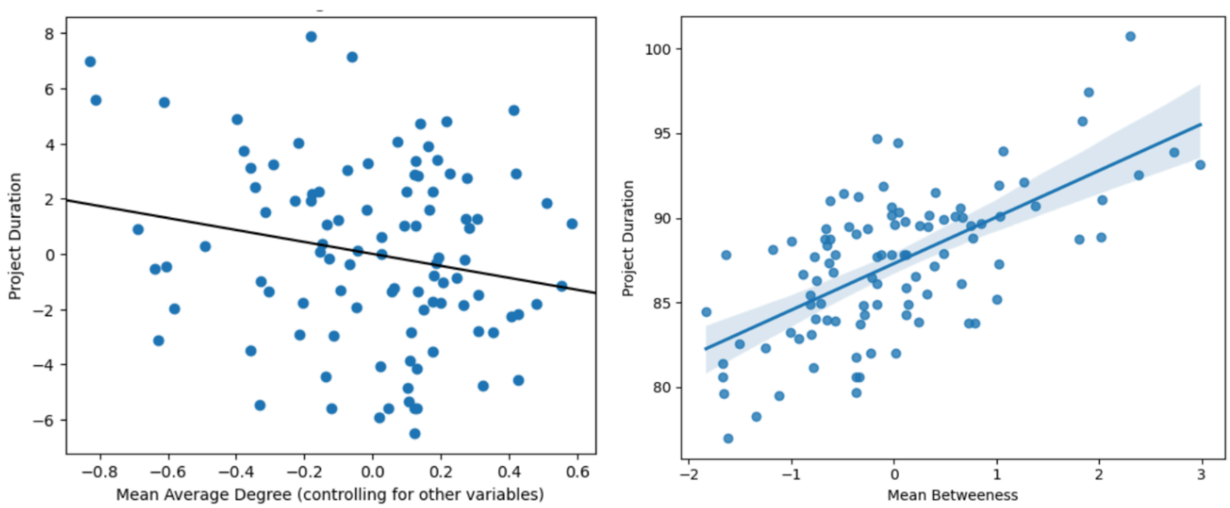

Figure 2: Multiple linear regression explaining project duration

Furthermore, the evidence shows that the variable that significantly influences a project's success is project duration. As presented in Table 3, it is important to highlight the negative correlation between project duration and technical success. If we increase project duration by 1 day then project success will be negatively affected by 0.0302. This explains that by reducing the duration of projects, there would be less technical difficulties, leading to increased probability of project success. In Figure 3, we further explore the relationship between duration and novelty, resulting in a positive one for both successful and failed projects. Suggesting that novel projects are inherently more time consuming. This backs up the idea that Silicon's projects which have resulted in success, tend to be less novel and last less than those which end up being failures.

Coefficients

	Estimate	Std. Error	t value	p value
(Intercept)	3.4474	0.830	4.155	0.000
project_novelty	-0.0121	0.065	-0.187	0.852
project_duration	-0.0302	0.010	-3.047	0.003

Quantity	Value
R squared	0.079
F-statistic	5.304

Table 3: OLS Regression explaining project success Results

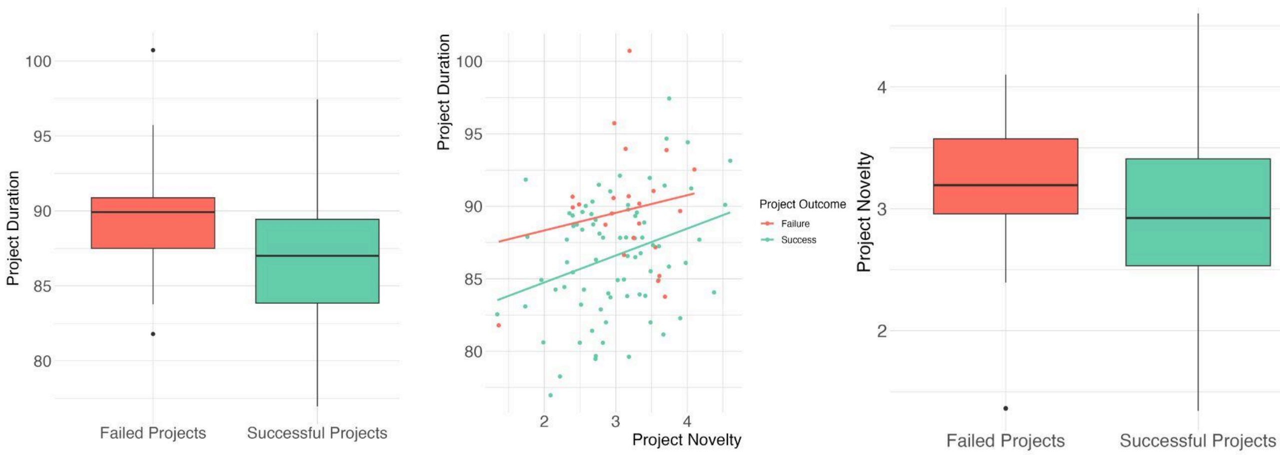

Figure 3: Impact of Project Novelty and Project Duration on Project Success

In conclusion, our analysis illustrates the crucial role that network's characteristics play in influencing project outcomes within Silicon's teams. The positive correlation between Mean_Avg_Degree and project duration reflects the importance of team members being connected in order to enhance collaboration, knowledge sharing and resilience. Meanwhile, the negative impact that Mean_betweenness has on project success and duration implies that overdependence on a few employees might create bottlenecks, preventing team effectiveness and resulting in less desirable project outcomes for Silicon. Lastly, our analysis reveals that project duration is a significant factor in project success revealing that longer projects ultimately lead to lower success rates.

3. Business Recommendations

Currently, Silicon's employees do not exhibit the desirable levels of interaction between them (low Mean_Avg_Degree). Instead, only a few employees handle most of the communication between different groups, which can make them feel overburdened (high Mean_betweeness). This delays or potentially halts decision-making (high project_duration), because of the overabundance of responsibilities and directly affects project success rates. If Silicon aims to reduce the quota of abandoned/failed R&D projects and increase the economic efficiency of the R&D projects that are technically successful, the company should instead:

Redefine the Project Management Structure

As shown in *Figure 5 and Table 3*, the total duration of a project directly affects its chances for success, with longer projects tending to be less probable to succeed than the shorter ones (coef = -0.0302, p = 0.003). In order to minimise project duration, Silicon must implement an elaborate project management structure that emphasises regular evaluations and clear communication between its employees.

To that end, ***monthly project milestones and checkpoints*** will serve as critical indicators for assessing progress, allowing teams to jointly celebrate achievements, identify potential roadblocks early on, and realign efforts as necessary. This proactive strategy will not only help keep projects on track but will also foster a culture of accountability and transparency, across all hierarchical levels of the company.

Building on this, ***defining clear inter-stage handoffs*** is vital for minimising dependencies between teams. By ensuring that each team understands its deliverables and the expectations for passing them to the next stage, Silicon can facilitate smoother workflow transitions and maximise continuity. Resulting in a significant reduction in delays caused by miscommunication or misalignment and ultimately enhancing overall project efficiency and timeliness.

Finally, ***implementing regular feedback loops*** after each project stage is paramount for our recommended project management structure. These brief reviews will allow Silicon's teams to reflect on their work and share valuable insights between them. Consequently, facilitating continuous improvement and allowing teams to adapt their strategies in real-time, according to the needs/requests of their peers, which is bound to yield more favourable project outcomes.

Establish Team Autonomy and Empowerment

Our analysis suggests that Mean_betweenness (coef = -0.2286, p = 0.000 for success, coef = 3.1962, p = 0.000 for duration) has a significant impact on project outcomes, indicating that lower centralization correlates with higher project success and shorter duration. Consequently, in parallel to the implementation of an improved project management structure, cultivating team autonomy is crucial for enhanced project efficiency.

Namely, by ***creating independent, task-specific teams***, Silicon will reduce its existing reliance on centralised decision-making, a phenomenon which can often slow down progress. Empowering teams with greater autonomy will also allow them to respond swiftly to challenges, adapt rapidly to changes and even achieve innovation without harming the overall project outcomes.

For Silicon's autonomous teams to be successful, it is necessary to institute a company-wide culture, where employees are encouraged to share information directly, without needing to employ the assistance of a handful of information brokers. Which can be practically implemented, by ***allocating bridging responsibilities across several team members***. Resulting in a corporate environment where information flows smoothly, project timelines are optimised, and success rates improve. This is particularly important in the case of specialist technicians and engineers as it will additionally facilitate the transfer of their invaluable knowledge and skills, through personal connections.

Our suggestion for a shift in the present team structure within Silicon is backed by existing research. Specifically, that a decentralised communication network, exhibiting increased autonomy among its nodes, not only prevents information bottlenecks but also reduces the workload on central connectors and improves overall team efficiency (Cross, R., & Parker, A., 2004)

To further maximise project efficiency, Silicon's empowered teams should be complemented by a ***modular, decentralised project design***, which breaks complex projects into smaller, manageable parts. Each module can be tackled independently, further minimising inter-team dependencies and allowing teams to progress with the necessary agility to pivot quickly in response to feedback or changes in project requirements, ultimately enhancing Silicon's responsiveness to market demands.

Foster Networking and Collaboration Opportunities

The aforementioned structures (iterative projects - autonomous teams) largely depend on the existence of tight interpersonal bonds between employees. Therefore, Silicon must hone in on creating a company-wide collaborative culture. Simultaneously, this suggestion intends to replicate the benefits stemming from our analysis of average degree and its correlation with shorter project durations (coef = -0.8080 , p = 0.045).

Within a company, a sense of togetherness can most effectively materialise through ***enhanced networking opportunities.*** Facilitating regular cross-departmental socialising and shared activities is instrumental in encouraging informal relationships among employees. These interactions build trust, promote collaboration, and help break down silos that can inhibit effective communication. Activities such as team-building events, workshops, or social gatherings create a sense of community, making it easier for employees to collaborate on projects and leverage each other's strengths.

In addition to these social initiatives, Silicon should ***encourage a diverse network beyond self-similar and proximity-based ties.*** By promoting networking across different roles and departments, Silicon can enhance its employers' adaptability and creativity. Initiatives like rotational mentorship programs or mixed-department lunches enable employees to gain new perspectives and share knowledge, fostering a more innovative work environment.

Finally, by fostering a culture of collaboration, Silicon can help alleviate conflicts that arise from competition over limited resources, such as salary, recognition, and promotion opportunities. ***Establishing avenues for joint efforts and reinforcing shared goals*** that go beyond what a single team could achieve, Silicon can turn potential rivalries into genuine camaraderie (M. Sheriff et al, 1954). Through this foundation of trust, solidarity and mutual support, Silicon will not only drastically increase the efficiency of its technological projects in the present, but will also secure a stronger, more united future for the company for years to come.

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