

PREDICTING PRODUCTIVITY OF THE DEVELOPERS BASED ON TEAMWORK

Submitted By Group 10D

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1. INTRODUCTION

In this project, we collected productivity and teamwork related data from the software professionals of Bangladesh and analyzed the relation between the productivity and teamwork related factors. We conducted this study following the GQM framework. We prepared a questionnaire and collected data through a survey. The following sections contain our workflow, questionnaire, details about metric implementation, and result analysis.

2. GQM PARADIGM: DETERMINING WHAT TO MEASURE

We defined our goal based on the purpose, perspective, and environment, identified the questions and derived the questions that must be answered to determine whether the goal has been met, and decided what must be measured in order to be able to answer the questions adequately. To define our goal, at first, we identified our purpose, perspective, and environment.

Purpose: Analyzing the productivity of software developers

Perspective: Examine the nature of productivity from the developers' viewpoint.

Environment: Developers have good bonding between them.

Goal: Predicting productivity of the developers based on teamwork.

Questions:

Q1. What does productivity mean?

Q2. Can they handle delivery in time?

Q3. What are the sources of team chemistry related factors of developers? / How is team chemistry?

Metrics for Q1: What does productivity mean?

- Office time
- Work satisfaction
- Decision contribution
- Intrinsic reward
- Extrinsic reward/career growth

Metrics for Q2: Can they handle delivery in time?

- Number of projects last year
- Deadline crossing frequency

- Overtime frequency

Metrics for Q3: What are the sources of team chemistry related factors of developers? / How is team chemistry?

- Teammate interaction
- Effectiveness of scrum meeting
- Hangout frequency
- Team age
- Teammate's age
- Team leader & teammate interaction
- Gender diversity

3. Questionnaire Preparation and Data Collection

After defining the Goal, Questions and Metrics, we prepared a survey questionnaire to collect data from the software professionals of Bangladesh. To analyze the relationship between the productivity related factors of the software professionals, we collected data about productivity factors namely office time, work satisfaction, decision contribution, intrinsic rewards, extrinsic rewards as in career growth, number of projects last year, deadline crossing frequency and overtime frequency so that we can determine the derived productivity from all these factors.

We also collected data about the teamwork factors. We focused on teammate interaction, effectiveness of scrum meetings, hangout frequency, team age, teammate's age, teammate interaction with team leader and gender diversity. The productivity and teamwork related data was collected in the form of likert scale data.

A sample question is given here:

How often do you cross deadlines?

Options:

- Never
- Rarely
- Sometimes
- Often
- Always

4. DATA VISUALIZATION

In this section, the summary of data collected is presented in pie charts.

1. What is your Office Duration (in hours)?

35 responses

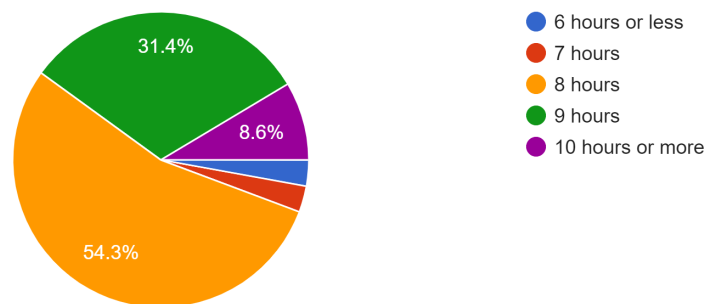


Figure: 4.1 (Office Duration)

From the pie chart, it is evident that most people work 8 hours a day and the least number of people work 7 hours or less than that.

2. How long have you been working as a developer?

35 responses

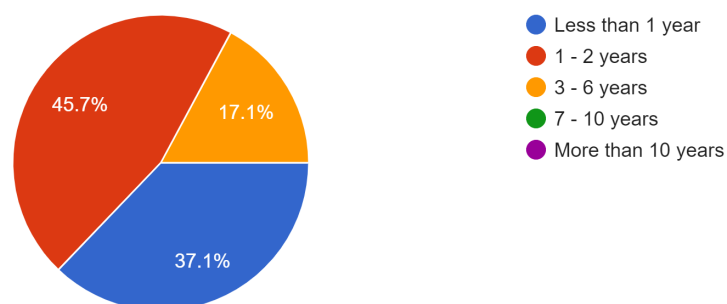


Figure: 4.2 (Working as Developer)

From the pie chart, it is evident that most people have been working for 1-2 years and the least number of people have been working for 3-6 years as developers.

3. How often do you participate in decision making?

35 responses

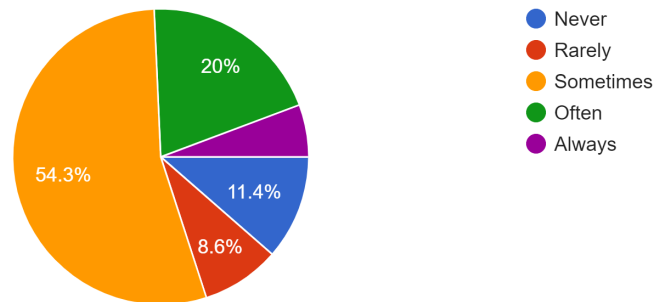


Figure: 4.3 (Decision Making)

From the pie chart, it is evident that most people participate in decision making sometimes and least number of people participates always.

4. Do your teammates motivate you in your work?

35 responses

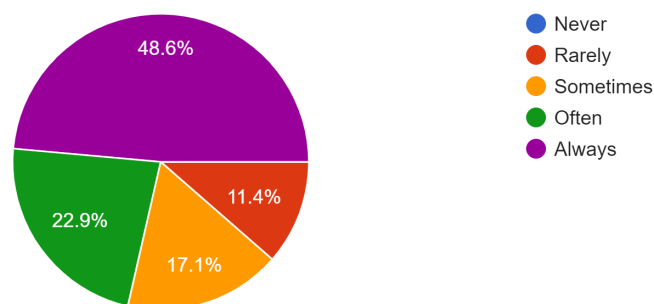


Figure: 4.4 (Teammate Motivation)

From the pie chart, it is evident that most teammates always motivate whereas a few teammates rarely motivate.

5. Are you satisfied with your career growth?

35 responses

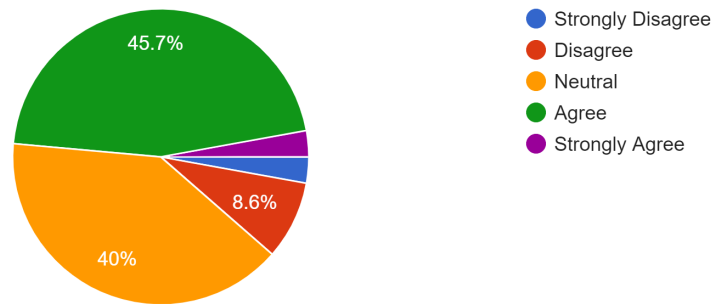


Figure: 4.5 (Career Growth)

From the pie chart, it is evident that most people are satisfied with their career growth whereas a few people are either very satisfied or very dissatisfied.

6. Number of Projects last year (approximately)?

35 responses

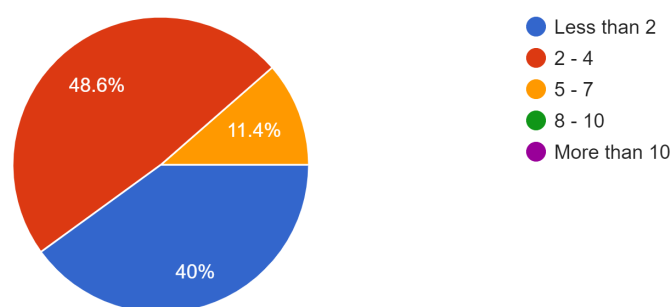


Figure: 4.6 (Number of Projects)

From the pie chart, it is evident that most people completed around 3 projects in the last year whereas a few people completed around 6 projects.

7. How is your relationship with your teammates?

35 responses

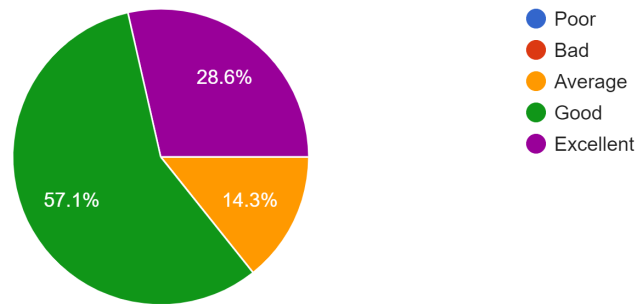


Figure: 4.7 (Relationship with Teammates)

From the pie chart, it is evident that most people have a good relationship with their teammates whereas a few people have average relationships.

8. Do you think scrum meetings increase your team's productivity?

35 responses

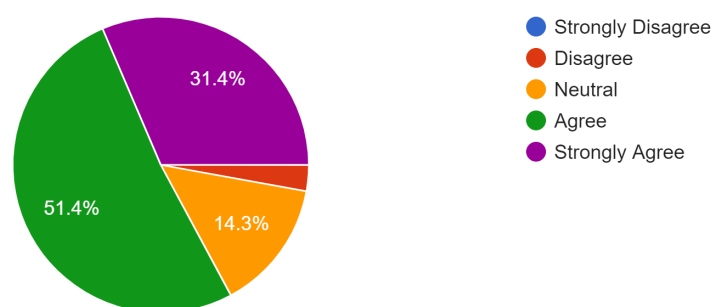


Figure: 4.8 (Scrum Meetings)

From the pie chart, it is evident that most people agree that scrum meetings increase team's productivity whereas a few people disagree.

9. How often do you cross deadline?

35 responses

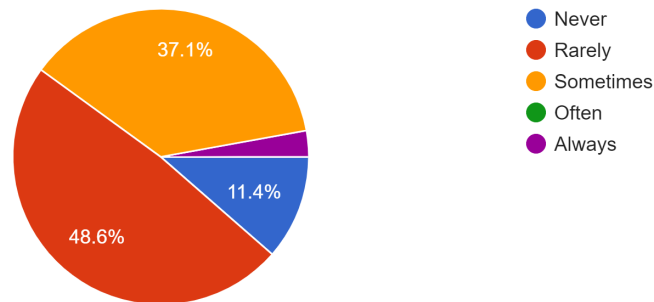


Figure: 4.9 (Cross Deadline)

From the pie chart, it is evident that most people rarely cross their deadline whereas a few people never cross their deadline.

10. How often do you work overtime?

35 responses

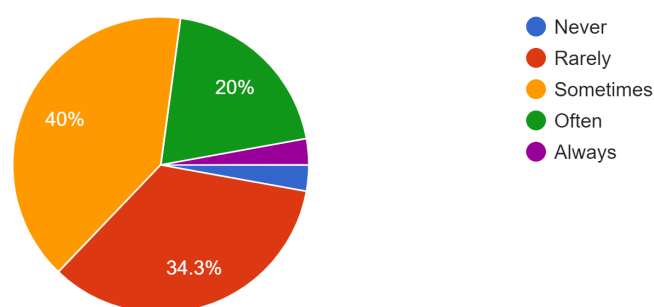


Figure: 4.10 (Work Overtime)

From the pie chart, it is evident that most people sometimes work overtime whereas very few people never or always work overtime.

11. How often do you hangout as a team?

35 responses

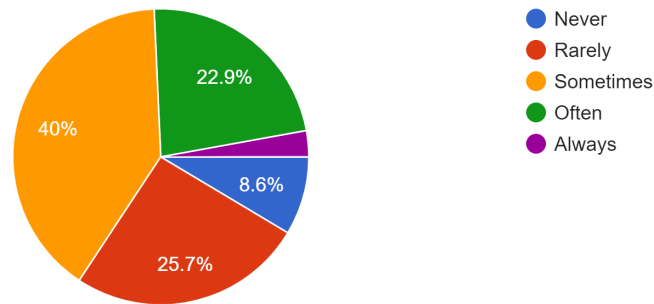


Figure: 4.11 (Team Hangout)

From the pie chart, it is evident that most people sometimes hangout as a team whereas a few people never hangout as a team.

12. With how many teams are you involved with currently?

35 responses

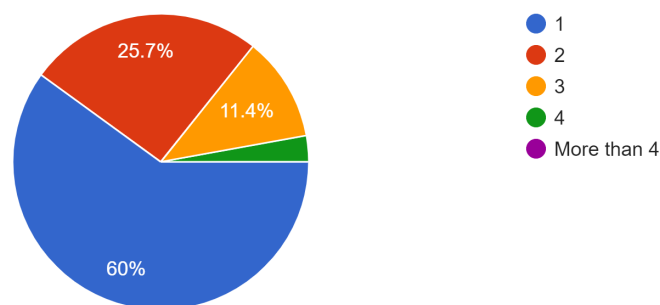
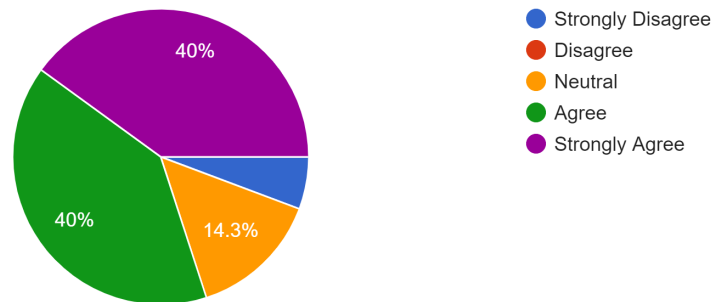


Figure: 4.12 (Current Team Involvement)

From the pie chart, it is evident that most people agree that scrum meetings increase team's productivity whereas a few people disagree.

13. Are your team leaders friendly?

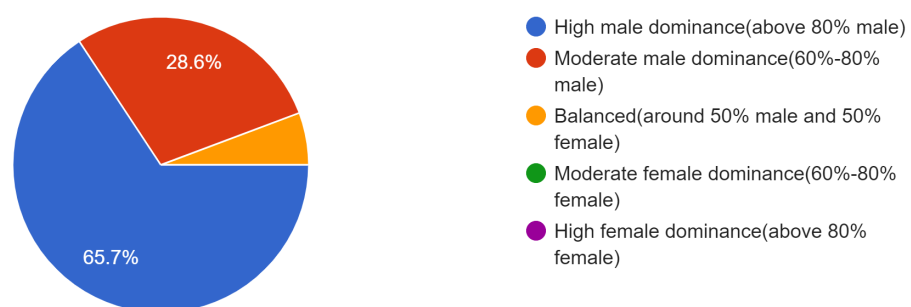
35 responses

*Figure: 4.13 (Team Leaders Friendliness)*

From the pie chart, it is evident that most people either agree or strongly agree that team leaders are friendly whereas a small number of people disagree.

14. Gender Diversity

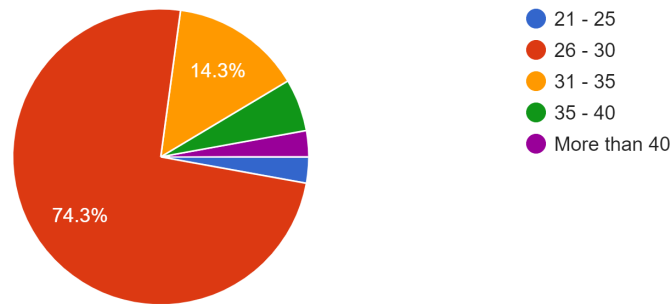
35 responses

*Figure: 4.14 (Gender Diversity)*

From the pie chart, it is evident that there is high male dominance whereas balance is maintained in a few places.

15. Average age of the teammates

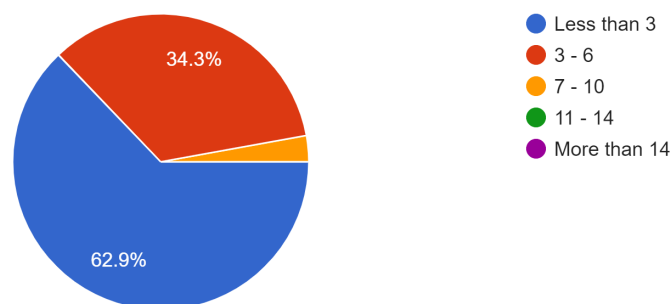
35 responses

*Figure: 4.15 (Average Age of Teammates)*

From the pie chart, it is evident that average age tends to be within 26 to 30 in most cases whereas a few people age more than 40.

16. With how many teams have you been with until now?

35 responses

*Figure: 4.16 (Involvement with Teams)*

From the pie chart, it is evident that most people have been involved with less than 3 teams but some people have been involved with around 10 teams.

Table 4.1: FACTORS TO BE ANALYZED

Productivity Factors	Teamwork Factors
<ul style="list-style-type: none">• Office time• Work satisfaction• Decision contribution• Intrinsic reward• Extrinsic reward/career growth• Number of projects last year• Deadline crossing frequency• Overtime frequency	<ul style="list-style-type: none">• Teammate interaction• Effectiveness of scrum meeting• Hangout frequency• Team age• Teammate's age• Team leader & teammate interaction• Gender diversity

5. METRIC IMPLEMENTATION

5.1 Data Preprocessing

We pre-processed and cleaned the data and changed the column names for handling easily. We collected data from 35 respondents. We discarded the timestamp and email from the data.

5.2 Encoding

The productivity and teamwork related data was in the form of likert scale. We encoded the likert scale data in a scale of 1 to 5. A sample encoding is given here: {‘Never’: 1, ‘Rarely’: 2, ‘Sometimes’:3, ‘Often’:4, ‘Always’:5}, {‘Strongly Disagree’: 1, ‘Disagree’: 2, ‘Neutral’: 3, ‘Agree’: 4, ‘Strongly Agree’: 5}, {‘Never’: 1, ‘Rarely’: 2, ‘Sometimes’: 3, ‘Often’: 4, ‘Always’: 5}, {‘Strongly Disagree’: 1, ‘Disagree’: 2, ‘Neutral’: 3, ‘Agree’: 4, ‘Strongly Agree’: 5}.

5.3 Correlation Analysis

We examined the correlation between productivity and teamwork related factors. We used spearman correlation, because the spearman rank correlation test does not assume any assumptions about the distribution of the data and is the appropriate correlation analysis when the variables are measured on a scale that is at least ordinal. We prepared correlation heatmap for better interpretation and identified the productivity factor - teamwork factor pairs with a statistically significant correlation.

5.4 Bar Charts

For the productivity factor - recreation factor pairs with a statistically significant correlation, we prepared bar charts showing the relationship between them. From the bar charts, we analyzed the nature of their relationship.

5.5 Used Tools and Libraries

We used pandas, matplotlib and seaborn for dataframe manipulation, data analysis and data visualization.

6. Result Analysis and Interpretation

The result analysis from the correlation heatmap and bar charts are given in the following sections.

6.1 Correlation Heatmap

To determine if the correlation between a productivity factor - teamwork factor pair is statistically significant, we referred to the Spearman rank correlation table of critical values, which shows the critical values associated with various sample sizes (n) and significance levels (α). In our example, our sample size was $n = 35$. Using a **significance level of 0.05**, for a **two tailed test** we found that the **critical value is 0.335**. If the absolute value of the correlation coefficient between two factors are greater than the critical value in the table, then we can say that the correlation is statistically significant.

Code for heatmap generation can be found here:

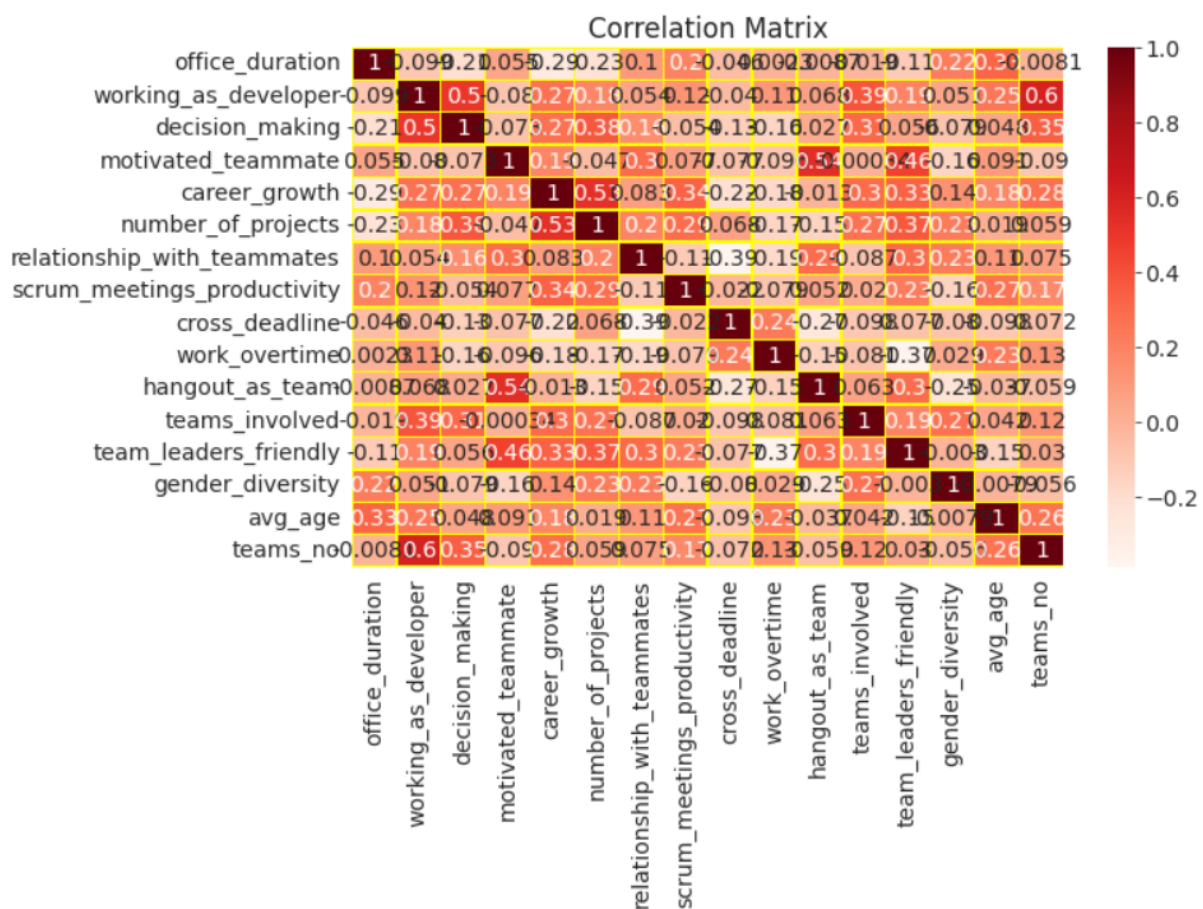


Fig: 6.1 (Correlation Matrix)

6.2 Findings from Correlation Heatmap

From around 110 correlations we found out that 10 correlations are statistically significant having a coefficient greater than the critical value. The correlations are mentioned below:

1. Decision Making and Working as a developer has a statistically significant positive correlation (coefficient = 0.502 > critical value = 0.335).
2. Decision Making and Number of projects has a statistically significant positive correlation (coefficient = 0.375 > critical value = 0.335).
3. Career Growth + Number of projects has a statistically significant positive correlation (coefficient = 0.529 > critical value = 0.335).
4. Career Growth + Scrum meeting has a statistically significant positive correlation (coefficient = 0.3359 > critical value = 0.335).
5. Hangout as a team + Motivated teammate has a statistically significant positive correlation (coefficient = 0.539 > critical value = 0.335).
6. Teams involved + Working as a developer has a statistically significant positive correlation (coefficient = 0.386 > critical value = 0.335).
7. Team leader friendly + Motivated Teammate has a statistically significant positive correlation (coefficient = 0.462 > critical value = 0.335).
8. Team leader friendly + Number of projects has a statistically significant positive correlation (coefficient = 0.369 > critical value = 0.335).
9. No of teams + Working as a developer has a statistically significant positive correlation (coefficient = 0.602 > critical value = 0.335).
10. No of teams + Decision making has a statistically significant positive correlation (coefficient = 0.347 > critical value = 0.335).

6.3 Findings from Histograms

For the productivity factor - teamwork factor pairs with a statistically significant correlation, we prepared histograms showing the relationship between them. From the bar charts, we analyzed the nature of their relationship.

Code for bar chart generation can be found here:

<https://colab.research.google.com/drive/1LjLDsUI0K3BvyDiTmntRI-FljW-92Srn?usp=sharing>

6.3.1 DECISION MAKING & WORKING TIME AS A DEVELOPER

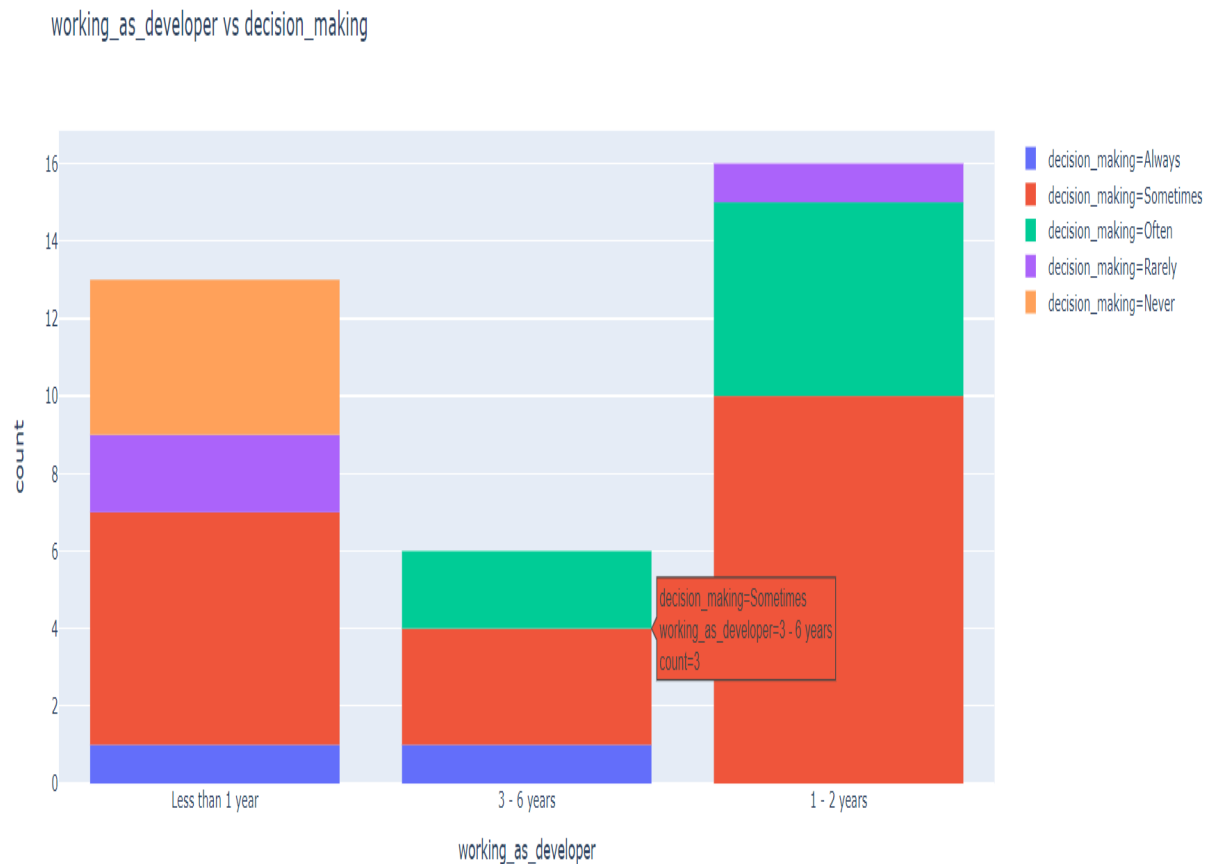


Fig: 6.3.1 (Working as Developer vs Decision Making)

From figure: 6.3.1 we can see that decision making increases relatively with the working time as a developer. A developer with lower working time has a tendency to not participate in decision making.

6.3.2 DECISION MAKING & NUMBER OF PROJECTS

number_of_projects vs decision_making

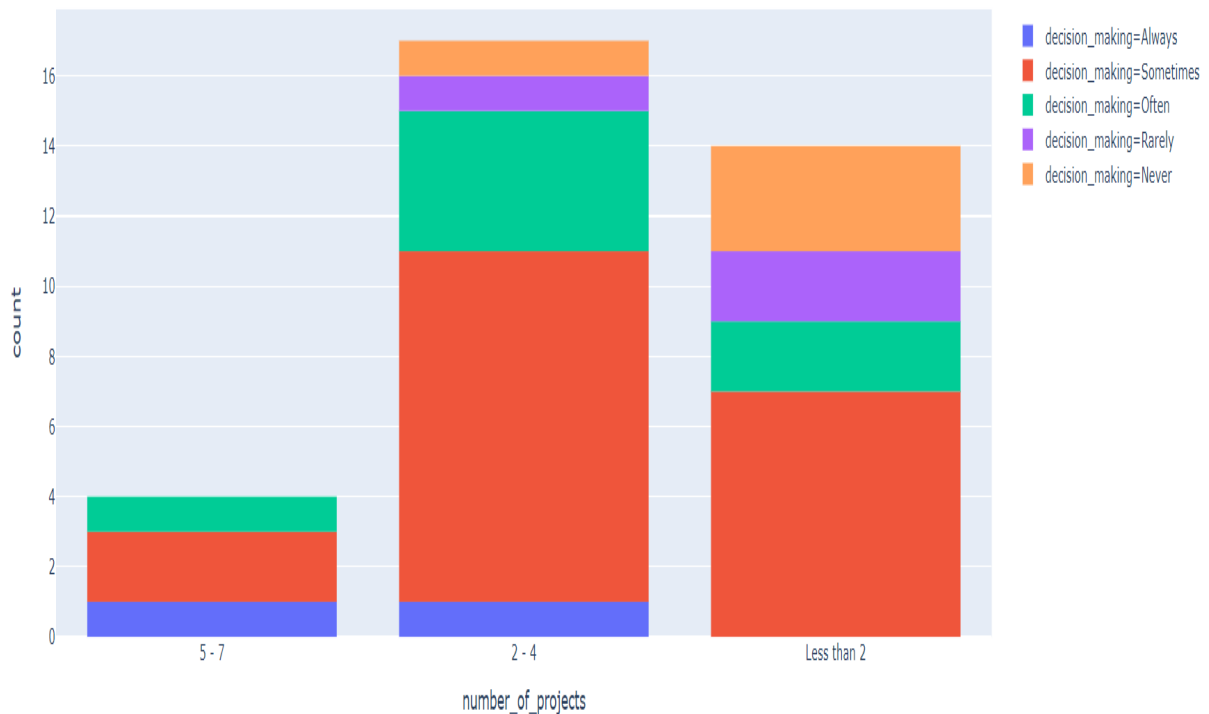


Fig: 6.3.2 (Number of Projects vs Decision Making)

From figure 6.3.2 we can see that, working on a few number of projects a year a developer gets less chance in decision making. But, developers who do a lot of projects in a year are more likely to participate in decision making.

6.3.3 CAREER GROWTH & NUMBER OF PROJECTS

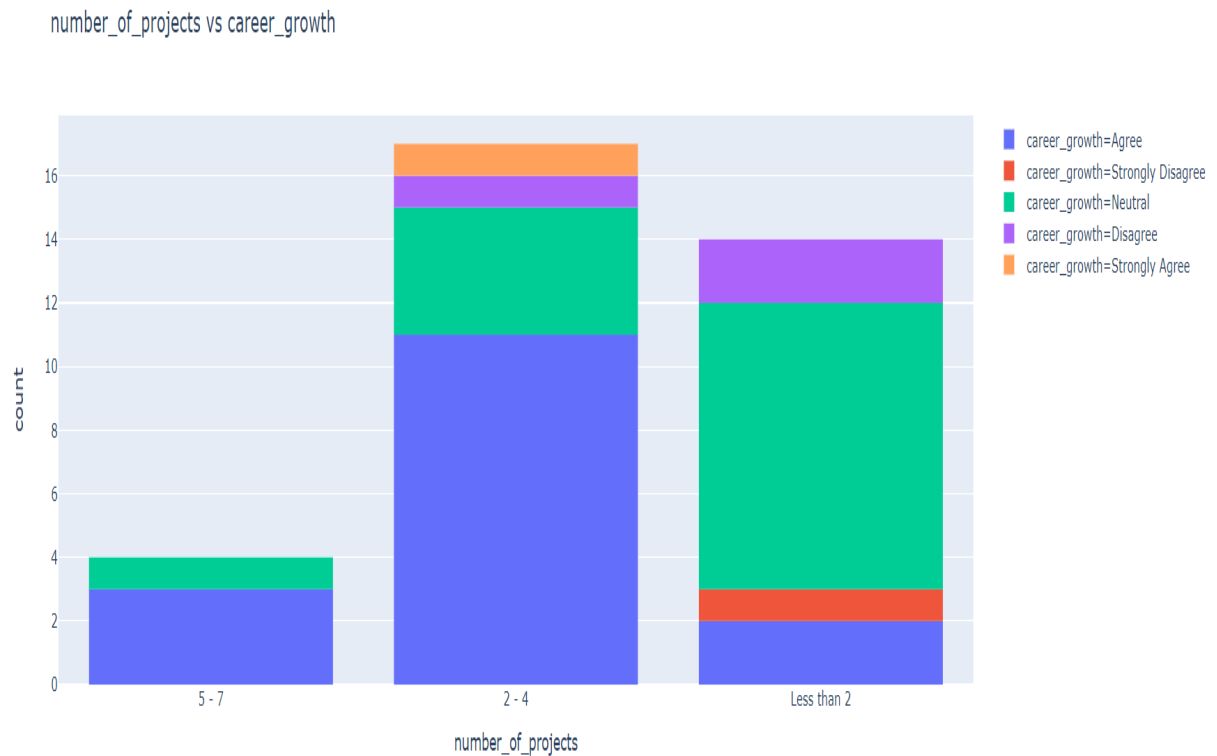


Fig: 6.3.3 (Career Growth vs Number of Projects)

From figure: 6.3.3 we can see that, people with lower number of projects are not really satisfied with their career growth whereas people with more projects tends to be happier with their career growth.

6.3.4 CAREER GROWTH & SCRUM MEETINGS

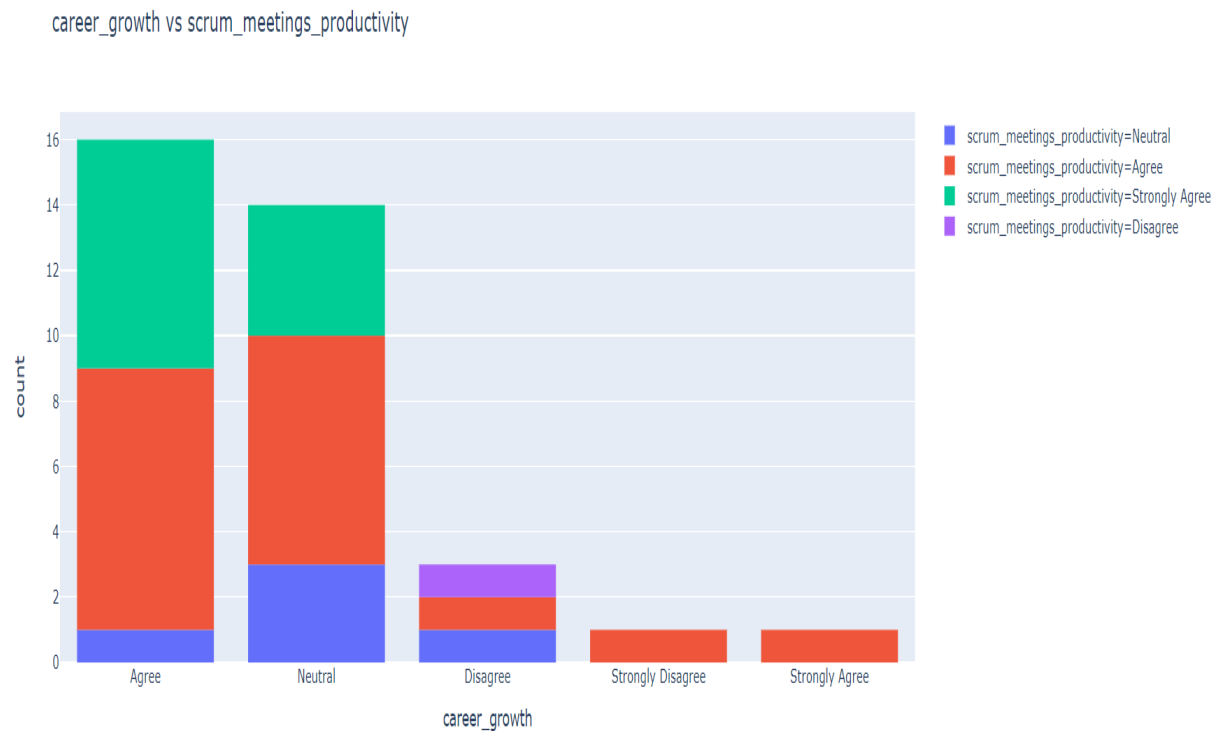


Fig: 6.3.4 (Career Growth vs Scrum Meetings)

From figure: 6.3.4 we find that, people who think scrum meetings as productive tend to be happier with career growth whereas those who think scrum meetings as ineffective are unhappy with their career growth.

6.3.5 TEAM HANGOUT & MOTIVATED TEAMMATE

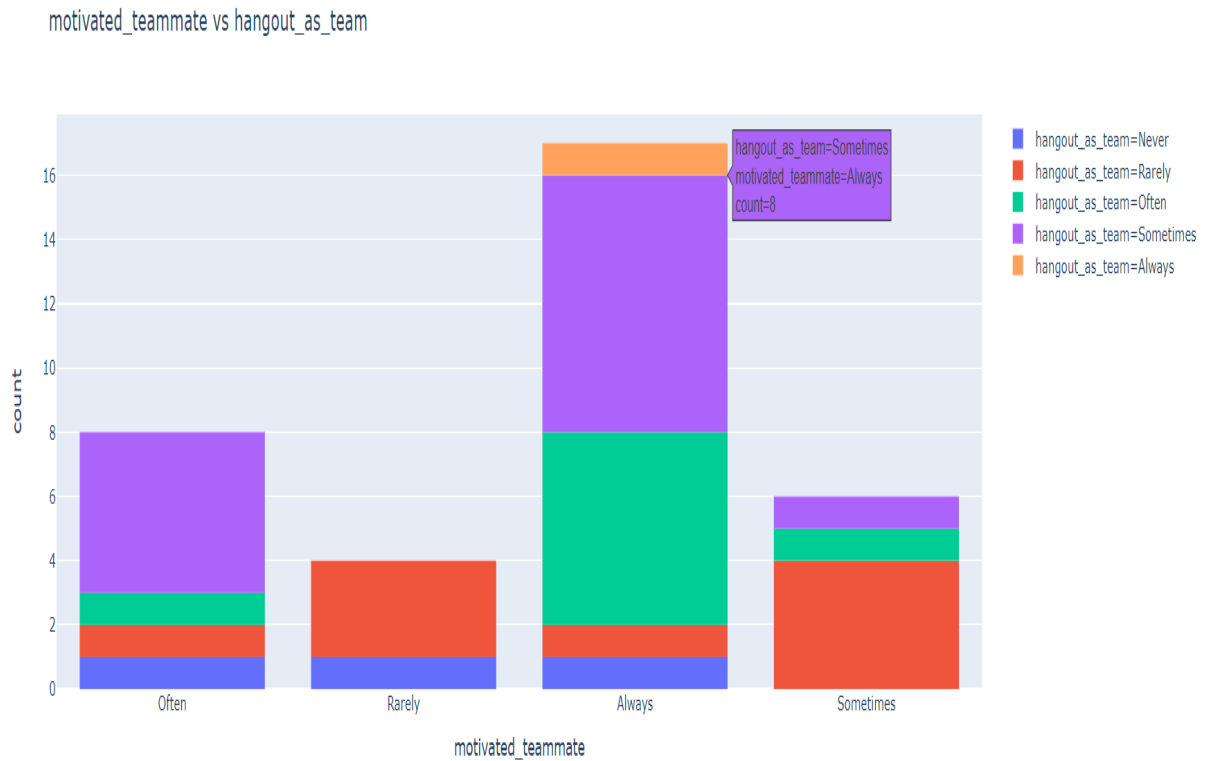


Fig: 6.3.5 (Team Hangout vs Motivated Teammate)

From figure: 6.3.5 we find that motivating teammates tend to hangout more whereas teammates who are less motivating hang out as a team rarely.

6.3.6 TEAMS INVOLVED (NOW) & WORKING TIME AS A DEVELOPER

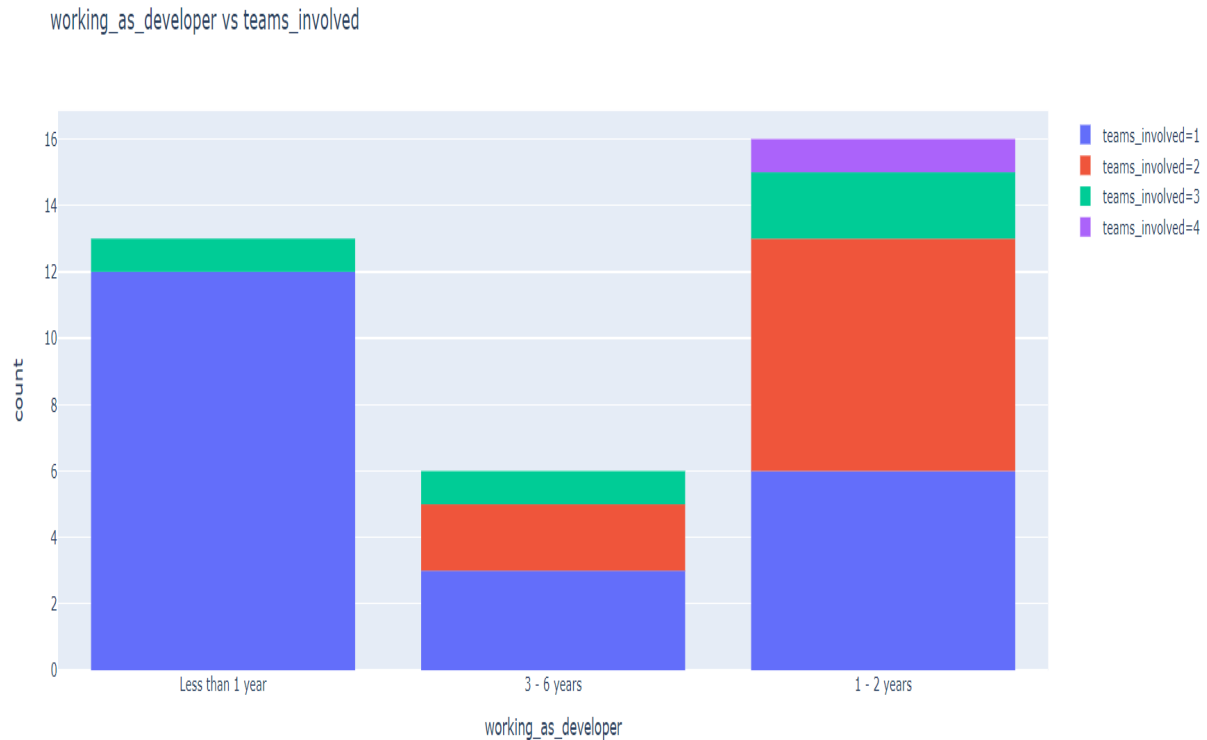


Fig: 6.3.6 (Working as developer vs Teams involved)

From figure 6.3.6, we find out that developers who have worked fewer years have been part of a smaller number of teams (now/ concurrently) while developers with more working years have been part of more teams (now/ concurrently).

6.3.7 TEAM LEADER FRIENDLY & MOTIVATED TEAMMATE

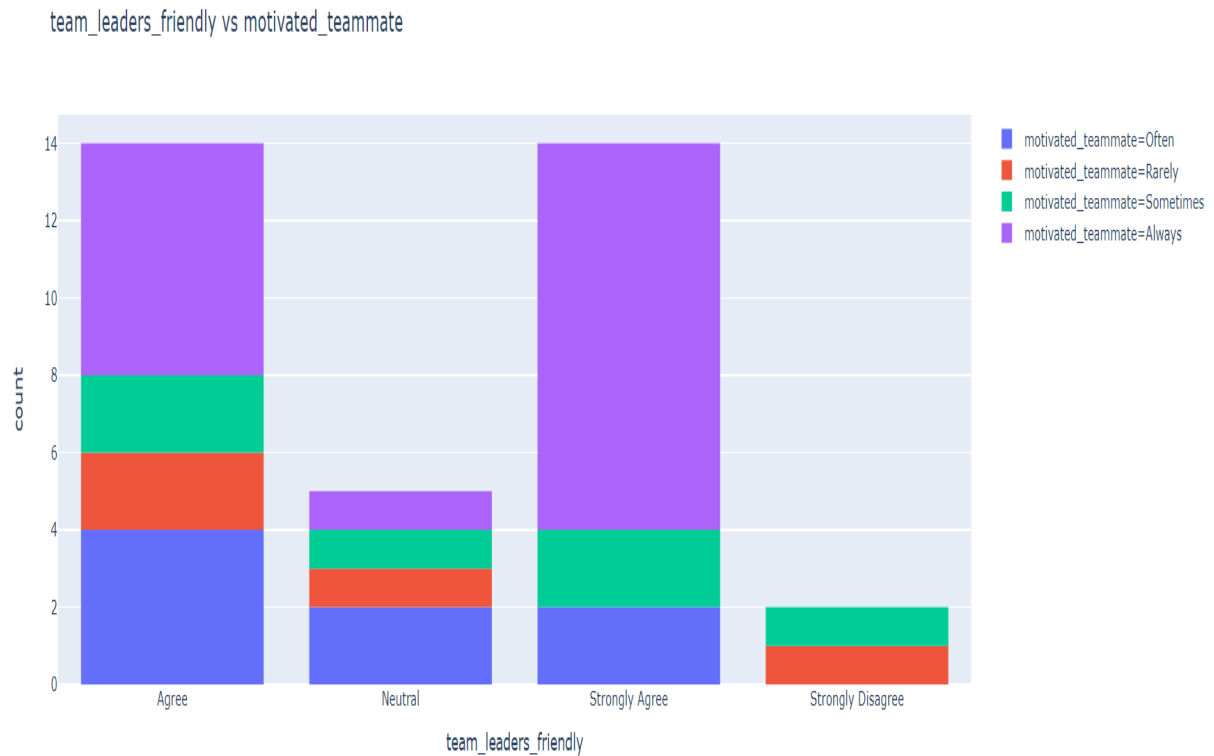


Fig: 6.3.7 (Motivated Teammates vs Team Leaders Friendly)

From figure: 6.3.7 we find that developers who have motivating teammates tend to find their team leaders friendly whereas developers who have less motivating teammates find their team leaders hostile.

6.3.8 TEAM LEADER FRIENDLY & NUMBER OF PROJECTS

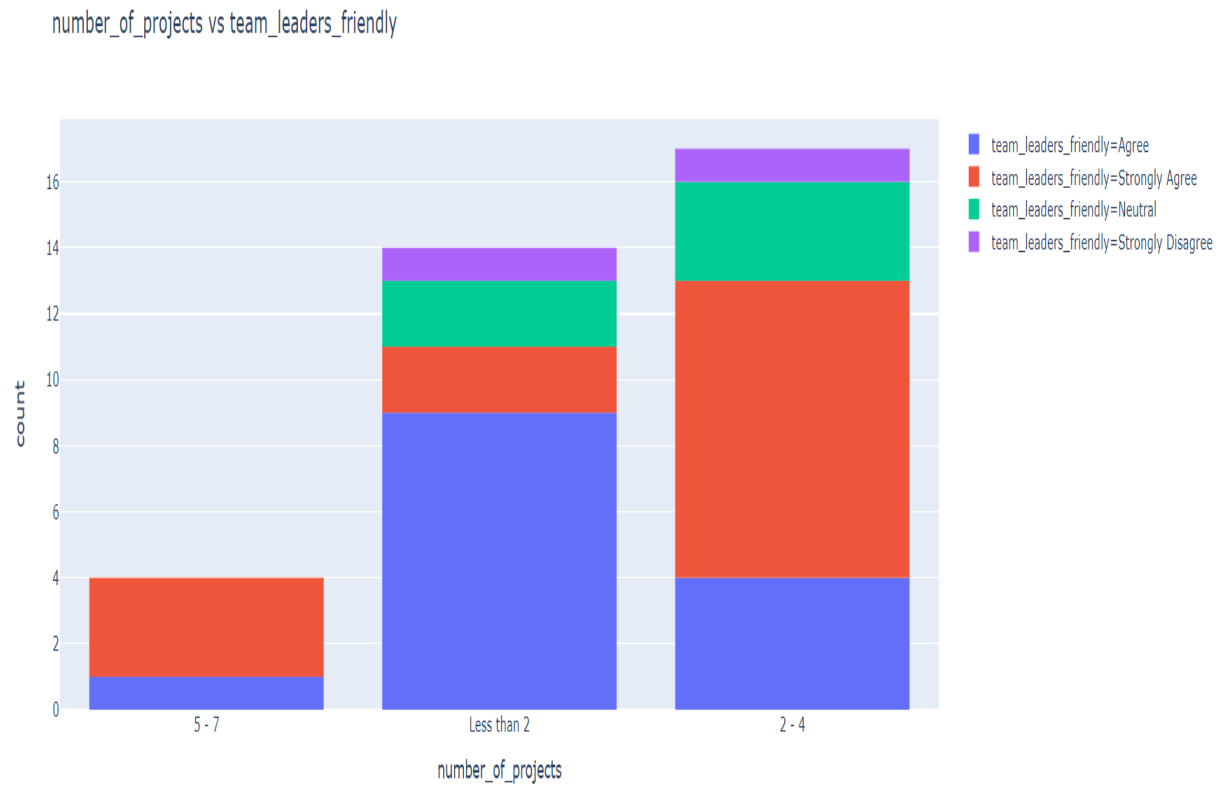


Fig: 6.3.8 (Number of Projects vs Team Leaders Friendly)

From figure 6.3.8 we find that the data is a bit tricky and the developers experience mixed feelings. All of them have experienced both friendly and hostile team leaders. So, it is difficult to come to a conclusion.

6.3.9 NUMBER OF TEAMS & WORKING AS A DEVELOPER

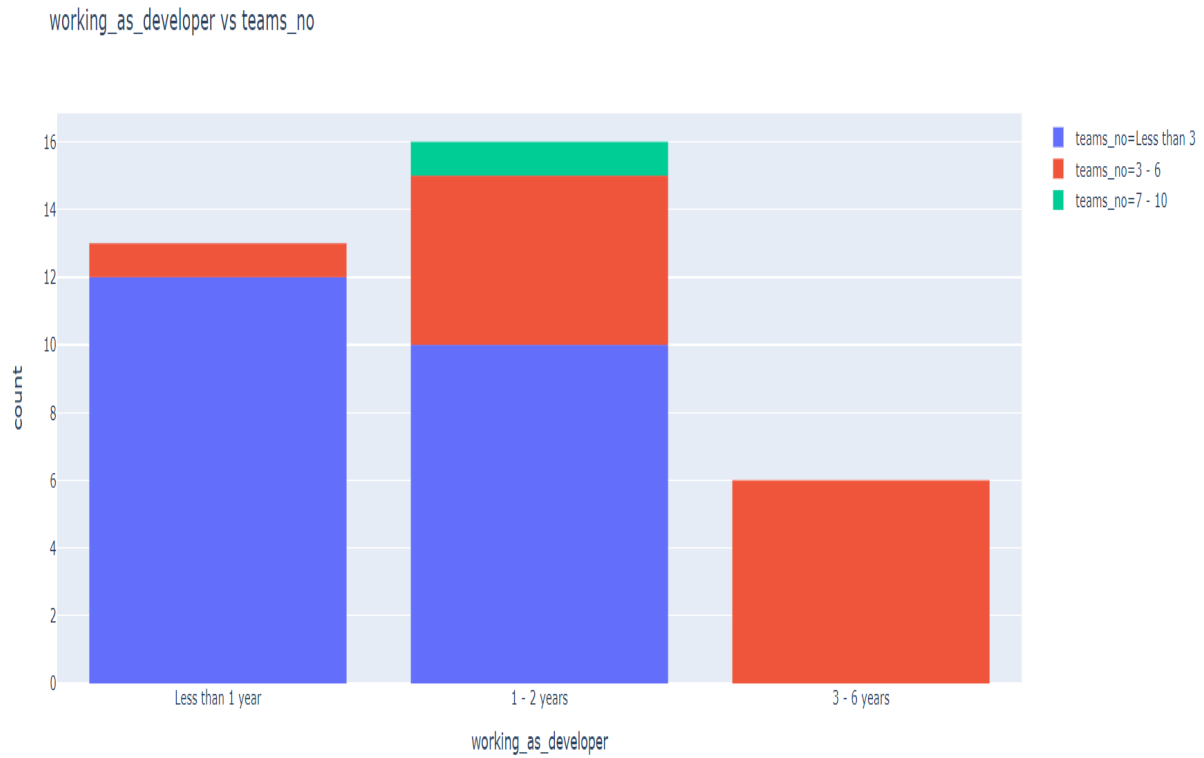


Fig: 6.3.9 (Number of Teams vs Working as a Developer)

From figure 6.3.9 we find that developers with more years of experience have worked in more teams whereas developers with less number of years experience have worked in lesser teams.

6.3.10 NUMBER OF TEAMS & DECISION MAKING

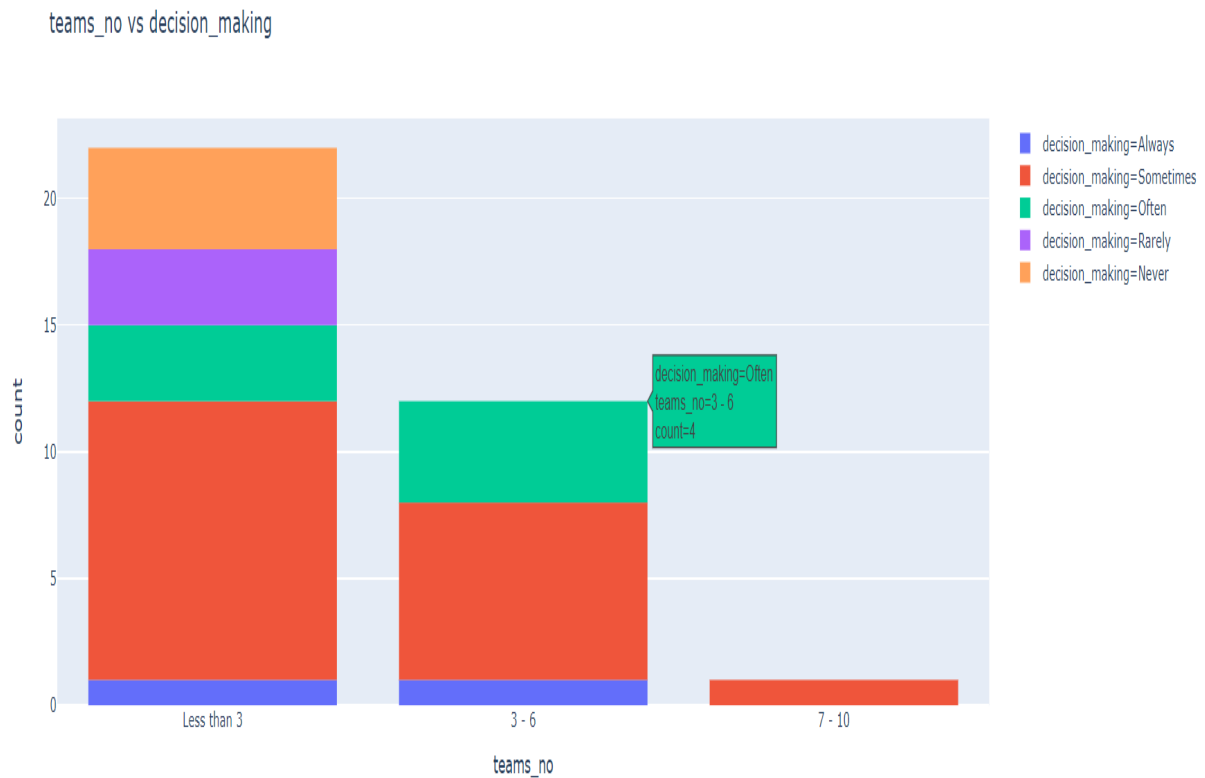


Fig: 6.3.10 (Number of Teams vs Decision Making)

From figure 6.3.10 we can see that developers who have worked in less number of teams have participated less in decision making whereas developers who have worked in more teams up to now have participated more in decision making.

STATISTICAL TEST (Chi-square testing)

Null hypothesis: There is no association between productivity and team work.

Alternative hypothesis: There is significant association between productivity and team work.

	High Productivity	Low Productivity	Total
Good Team-work	19	5	22
Poor Team-work	4	7	13
Total	23	12	35

Alpha = 0.05

The statistic has **1 degree of freedom**. The critical value of the test statistic is chi-square: 3.84146. Our observed chi-square value: 4.380884250109793, exceeds the critical value. **P-value = 0.0363441381405895 < 0.05**. We can reject the null hypothesis at 5% level of significance. There is a significant difference. We can conclude that good team work increase productivity significantly more than poor team work.

7. Conclusion

In this document, we have described how we defined the goal of this project using the GQM framework. We stated how we defined our goal based on the purpose, perspective and environment, identified the questions and derived the questions that must be answered to determine whether the goal has been met, and decided what must be measured in order to be able to answer the questions adequately. Starting from questionnaire preparation, we explained data collection, metric implementation, result analysis and interpretation in this document.

After exploring the relationship between the teamwork-related factors and the productivity-related factors, we can conclude that teamwork-related factors have an overall positive impact on their productivity.

RESOURCES

Survey Questionnaire Link:

<https://forms.gle/VeJVk4gXswfrmrnh8>

Project Source Code:

<https://github.com/Nazmul1932/Productivity-and-Team-Work>