ANALYZING THE MAJOR CAUSES OF PROJECT DELAYS IN THE SOFTWARE INDUSTRY

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1. ABSTRACT

The two major issues facing the software industry currently are delayed projects and budget overruns. As part of this paper, I have tried to address the causes of project delays. There have been papers over the years discussing this particular issue but I did not find any recent papers on project delays. This led me to design my own survey and do a comparison study of the results with older papers. The conclusions that can be derived from this research is that improper planning and estimation is one of the main root causes of project delays in the software development industry. Most of the developers tend to think that project delays usually occur due to inefficient management whereas the management people are of the opinion that the delays are caused due to inefficient team members. The study has responses from various people currently working in the software development industry. Also the correlation of this with the past tells us that the problems have not really changed. Poor planning was an issue back in the 90s as well as now. This study can be further extended using machine learning models once enough data is collected.

2. INTRODUCTION

Software industries are now looking at better project management techniques for success. Around 600$ billion business is made by project managers around the world yearly [3]. Even in this high profit and competitive market not all projects are successful or even completed. Most industry trends suggest that even a 70% project completion is looked at as a success. But it is imperative to find the causes of projects failures. Most of the project failures are not essentially failed development processes but delayed projects. Projects that are not delivered on time due to various reasons. This is also known as schedule slippage. In an IBM survey [8], it was found that the major issue associated with project management is scheduled delay of projects.

There is a need to find, the major causes that inject delays in the project lifecycle thereby causing failure to meet customer's expectations and ultimately results in huge losses. Many factors contribute to project delays but one reason that comes to mind instantly is improper project management.

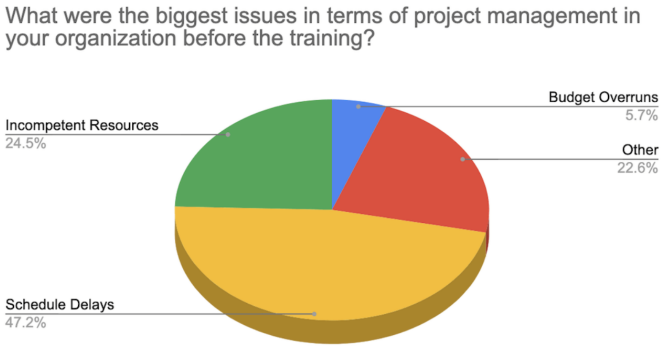

Fig. 1. Published in Master of Project Academy Blog based off an IBM survey

Most of the time, this simple factor is either ignored or not taken in to consideration because we don't relate those factors with project management practices.

In nutshell, good project management is about everything going on in the project that has a direct or indirect impact on project success. Furthermore, it deals with timely resolution of likelihood of problems and uncertainties that can make a successful project unsuccessful [1].

This research paper is my attempt to analyse the major causes involved in project delays so that we can develop and come up with better software management practises. Most of the data for the research is derived from literature especially [4],[5]. Another source is the survey that is conducted using some 25 people involved in the software development industry. This helped to see whether the assumed causes are close to the ground reality with respect to current industry practices. In the survey, I have tried to include people working in different companies on various designations, different geographical locations.

The goal of the paper is to get an understanding of the major causes of delayed projects happening currently in the industry and suggest ways to mitigate those. This paper also relates the problems causing the delays in meeting project deadlines with respect to effective project management. With this analysis my hope is that the industry trends improve and better project management techniques are adopted in the future.

3. LITERATURE SURVEY

[1] - S. R. Ayyubi, M. Ahmad and F. Faiz, "Schedule Slippage, its prevention factors & their adherence (Assessment of the Project Management Best Practices which contribute in successful completion of projects in the Software Industry of Pakistan)," 2007 International Conference on Information and Emerging Technologies, Karachi, Pakistan, 2007, pp. 1-8, doi: 10.1109/ICIET.2007.4381331.

This paper talks about project schedule slippage in the software industry of Pakistan. It analyses the role of project manager to deal effectively with the delays and also looks at various existing best practises for effective project management. This study is based on main factors/practices in all phases of software development that cause delays in project schedule if proper attention is not paid. The authors are also linking the best cases practices with the local industry standards. They are also talking about the impacts of project delays on budgeting and finances involved in the industry. Although the paper does a good job of analysing the reasons of schedule slippage it is not a recent example. The paper is over a decade old and that got me wondering if the techniques and methods used here can be applied to a current market.

[2] - Jones, C., 2004. Software project management practices: Failure versus success. CrossTalk: The Journal of Defense Software Engineering, 17(10), pp.5-9.

This paper is essentially a survey paper of around 250 large software projects that successfully achieved their cost and schedule estimates against those that ran late, were over budget, or were cancelled without completion. The major problems identified were all related to project management rather than technical issues. They concluded two major issues : poor quality management was the major contributor to schedule delays and the reason for poor quality management was poor project management. This paper is an interesting comparative study to show what works and what does not work in terms of project management. My thoughts after going through this was focused majorly on what are the successful projects doing correctly. This is what I will try to implement in my research as well for suggesting better project management practices.

[3] - Van Genuchten, M., 1991. Why is software late? An empirical study of reasons for delay in software development. IEEE Transactions on software engineering, 17(6), p.582.

This is an old paper discussing the reasons of delays caused in software development. The study targeted different activities in the software development life cycle. The author is analyzing around 160 activities spread across 15000 hours of work in the software engineering department during the 80s. He has done a survey on overrun development projects and found the reasons as to why there is a difference between planned and actual start/completion dates of projects. The conclusion that the author has come to is that most projects cannot be fulfilled in the estimated timelines because of external factors. Those external factors being product related, organization related, planning related and human related. He also concluded that the factors differed from department to department. The cooperation of developers and project leaders was of utmost importance if a project was to be completed on time.

4. RESEARCH METHODOLOGY

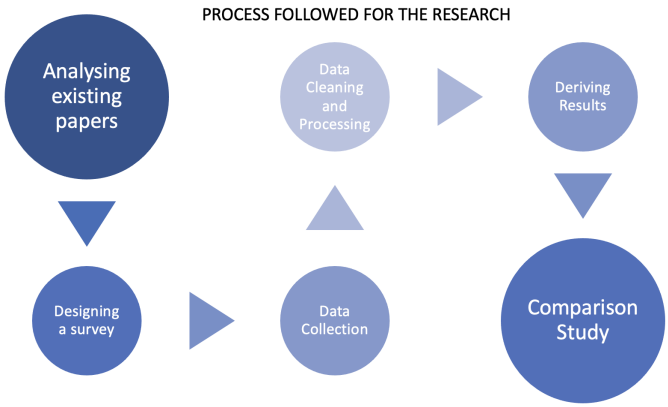

Fig. 2. Research Methodology

The process that was followed for researching this topic are summarized below :

4.1. Analysis of existing research papers

From a pool of research papers that talked about delays in software development projects I picked out a couple of papers that were closely related to my topic. Majorly the literature in the cited sources is used as my data. The papers used are mostly based on various case studies and empirical evaluation. They also consists of reports of various project delays that have happened in real time and minutes of the meetings provided by practitioners. The papers chosen for the study have been published during different decades. This is done so as to facilitate the comparison study. It helped to see the difference in the causes of project delays over the years. Obviously with the growth of projects over the years there has been an increase in the project delays as well. This fact has been kept in mind while making concluding statements. The number of citations of each of the papers that were chosen was above 10. This was important as I wanted to use as much authentic and quality material for the research. Below are the

five research papers that I ended up using, they are grouped into 3 decades : 1990s, 2000s, 2010s. The latest causes are expected to be answered as a result of this paper.

- Project management (PM) prosperity: A second half of the 20th century literature review. Journal of management and sustainability - **2011**
- Schedule Slippage, its prevention factors & their adherence (Assessment of the Project Management Best Practices which contribute in successful completion of projects in the Software Industry of Pakistan) - **2007**
- Software project management practices: Failure versus success. CrossTalk: The Journal of Defense Software Engineering - **2004**
- Identifying the causes of poor progress in software projects. In 10th International Symposium on Software Metrics - **2004**
- Why is software late? An empirical study of reasons for delay in software development. IEEE Transactions on software engineering - **1991**

4.2. Designing a Survey

A survey was designed on google forms and sent across to people from a diverse population to get their opinions. While designing the survey I tried to keep in mind regarding different people having different experiences. The intent for the survey was to give me two kinds of data. First being the user details which would help me analyse the kind of teams we are dealing with. The questions here consist mostly of the name, age, geographical location, role or position in the software industry. Secondly, the experiences of these professionals with project delays. These questions are dealing with how many projects they worked on which ended up being delayed, their experience with delays, their top causes for project delays, who are the people involved and also which methodology, phase of the software development lifecycle do they see most issues in. All the questions are short and too the point. The survey is intentionally kept short so as to not lose out on the unmotivated users who will not fill out longer surveys. Also, the options given for the answers have tried to include various mindsets. For example, for questions that are essentially a yes/no question I have also included a ”maybe” option. Options like ”Do not want to answer” have also been included.

Below is the google forms link :

Project Delay Survey for Software Professionals

4.3. Data Collection

As stated before the data used is majorly from the literature in the cited sources. Another source of my data has been a current industry survey which includes responses from 24 people who have worked or are currently working in the software industry in the United States of America, India, Australia and the Philippines. The survey consists of a questionnaire with responses having options for the users to choose from. I have tried to cover the causes of project delays in various phases of the software development lifecycle but project planning, development, testing and deployment are the major areas that have been looked at. The designed survey was sent across to people in different demographic groups to get a holistic point of view of the current situations in the software development industry. Having worked in the software development industry for over five years it was only imperative that I also answered the survey and give my personal opinion about project delays. My personal experience has also been an important data point in this research paper. The survey was in the form of a google form so that it can be easily accessed in various parts of the world. The data from the forms was converted into an excel file and used further.

Figure 3, 4, 5 and 6 show the demographic details of the people who took the survey :

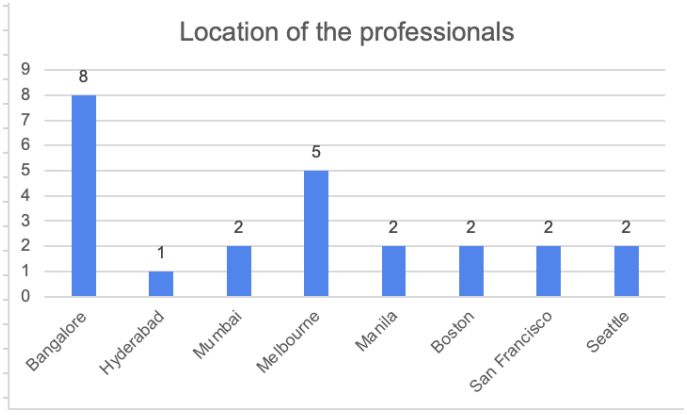

Fig. 3. Location

It is clear from the above charts that the survey was conducted on a varied range of professionals in different age groups. Certain biases are still there especially related to the age groups. Most of the people filling out the survey are between ages 20-40. Also I could not get a lot of testing professionals to answer the survey.

4.4. Data Cleaning and Processing

The excel file that was generated as part of the survey was unusable in its raw form. It had to be cleaned and pre-processed before the data could start making conclusions. The demo-

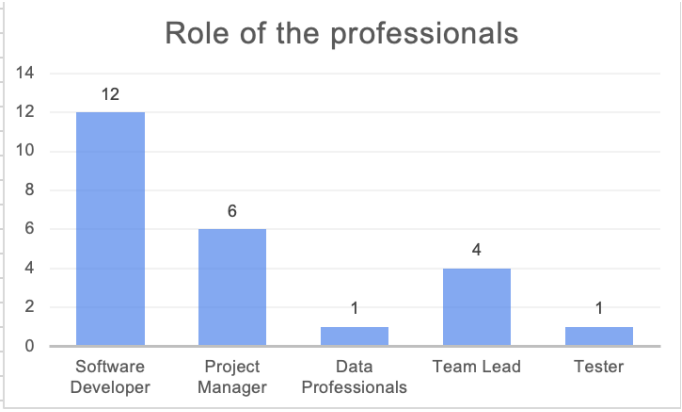

Fig. 4. Role

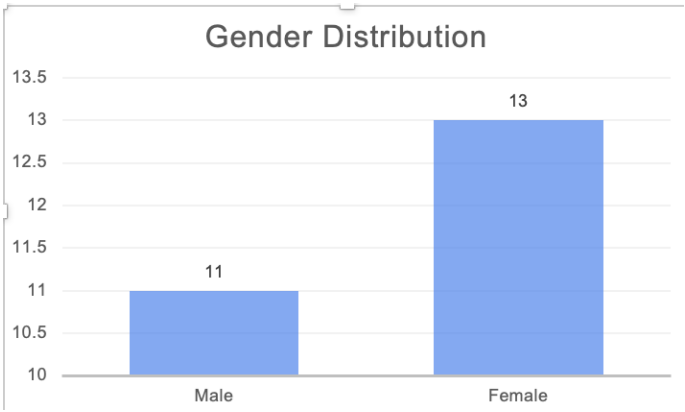

Fig. 5. Gender Distribution

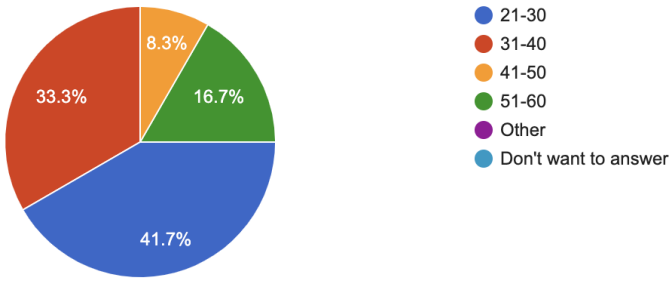

Fig. 6. Age of the professionals who took the survey

graphic details were collected as part of questions that had options for selection. But the question for project delay experiences were paragraph based and hence details had to be extracted from them. To eliminate noise and null values only data points which have valid answers have been kept. Hence the responses have been filtered down to 24 only. Out of these responses the paragraphs for the causes of project delays has been extracted. This list of answers was passed into a python program. This program was looking for specific keywords which were provided after analyzing the initial papers and the survey responses. Each time a response matched the counter variable for that particular keyword was increased. At the end the result which was received was a table with the list of causes and the points assigned to it. The points were assigned based on the counter and not on the number of users who answered the survey. This is because few professionals have given 5 reasons as probable causes, few have given 3 and others more than 5. To make it fair each reason is counted as a point in the counter variable. Below are the snippets of the raw data and processed data.

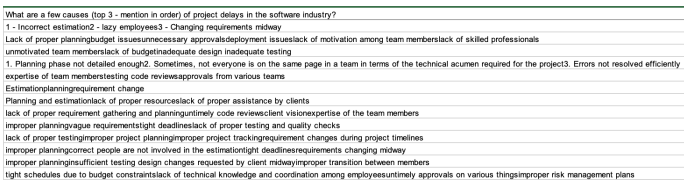

Fig. 7. Snippet of the raw data

Phase	Phase causing project delays
Planning and Estimation	14
Analysis and Requirement Gathering	2
Design	3
Development	2
Testing	3
Deployment and Maintenance	0
people	People Responsible
Team Members	8
Project Managers	13
Client	2
Entire Team	1
Third-Party vendors	0

Fig. 8. Snippet of the cleaned data

4.5. Deriving Results

Once the raw data was processed into a readable format it was quite useful in deriving the results. The results section of the paper explains the results in details correlating it with the users who answered the survey.

4.6. Comparison Study

The comparison study was the last step in the process. After getting the results from my survey, it was compared against the initial papers which were referred. This helps to see the changes in the causes of project delays over the years. This is also helpful as the methods of assessing the project delays is different but the final results are the same which is finding out the causes of these delays. This comparison has also been spoken about in detail in the results section of the paper.

5. RESULTS

After running the program the list that is populated is as shown as follows.

Causes of project delays	Points
Improper planning and estimation	22
Requirement changes or changes in the scope of the project	15
Lack of skilled employees or talent drain	12
Lack of coordination or cooperation among team members	8
Inefficient testing process	7
Tight schedules and deadlines	7
Unmotivated and unaccountable team members	5
Unecessary approval process	5
Unclear client vision	5
Budget issues	3
Lack of proper resources	3
Inefficient requirement gathering	3
Incorrect project tracking	3
Inadequate risk management strategies	3
Interference or issues of third-party vendors	3
Code reviews	2
Improper transition or knowledge transfer between team members	2
Development issues	2
Deployment issues	1
Inadequate design process	1

Fig. 9. Most common causes of software project delays

We can see here that majority of the votes are for improper planning or estimation. Project planning plays an important role in deciding the fate of the project including delays. For making proper estimation right knowledge, information, and data is required. Also project management processes must be followed in order to plan ahead. Often times there is a disconnect between the team leading the manager to plan without consultation of the developers and testers.

Another major cause is requirement changes midway during the project. This can be due to various reasons as the client having unclear vision of the finished product, feedback received for the prototype being unsavory, changes in management or employees. Changing the scope of the project causes delays as most of the things have to be reworked and redone.

The third top most cause turned out to be lack of skilled employees or talent drain. Most times people are trained for a particular project but the company is unable to retain the employee which can cause significant waste of time. The loss of a team member has more gravity and effect, especially if the person is a key player in your project. The result may lead to a delay. Not only the employee has to be replaced but also new employee trained and knowledge transferred. This is not always upto the mark and causes further delays in the project. Alot of the times the people involved in the project are unskilled or not suited for the project. It therefore becomes essential to choose members and assign them tasks based on their strengths.

No project can be successful without cooperation of all the people involved. Similar is the case for software development. A considerable cause is lack of coordination and cooperation among team members. A communication gap within the team or among different teams can also cause a delay. If there are action items that are waiting on a different team and no one is following up with them, it leads to delays.

Apart from these causes other causes that were listed high up were inefficient testing methods. Although I do feel that this is high up there because of data bias. Most of the people taking this survey were software developers. Unmotivated team members, strenuous schedules and approval processes also are considerable causes. Some people do feel that the delays can also be due to deployment issues, code reviews, design process, development issues, integration with third party vendors or inefficient requirement gathering. Overall the results can be divided into three classes **planning factors, implementation factors and human factors**. Most of the causes fall under one of these classes. It can be seen from the figure below that majority of the issues fall under planning factors - 41% and minority under human factors - 24%

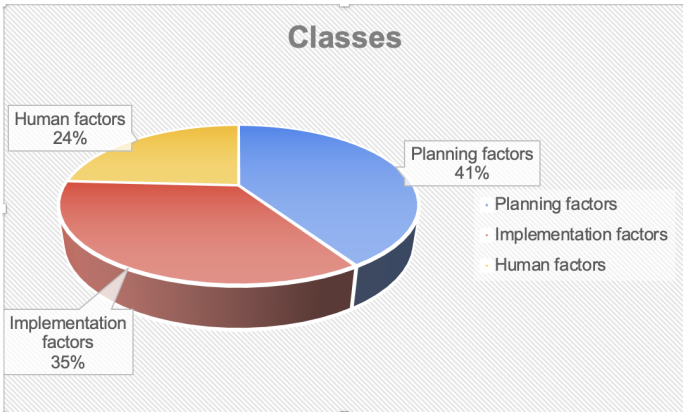

Fig. 10. Distribution of causes based on class

Some other interesting facts that were discovered as part of the survey are mentioned below. We can see that there is a higher percentage of people whose more than 60% of the projects were delayed. This tells us that the problem of project delays is much more dire than expected. Most professionals believe that a project manager is the reason to make or break a project. This fact was reiterated as my experimental results show most people blame the project manager for caus-

ing delay in the project one way or another. The percentage is above 50%, 54% to be precise. Another common opinion is that the software phase also has a correlation with delays. According to this study it can be seen that an overwhelming percentage believes that projects get delayed if the planning and estimation phase is not carefully handled. No one agreed that deployment or maintenance can cause delay in software development projects. Figure 11, 12 and 13 are showing these results as discussed.

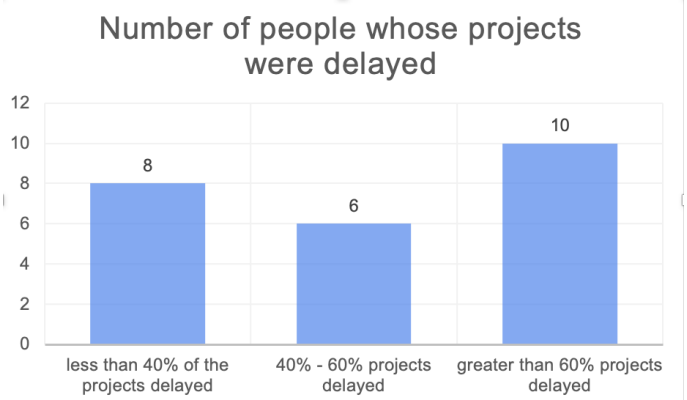

Fig. 11. Number of users and delay in their projects

Fig. 12. Who most users think is responsible in a big way for project delays

Other engaging experiences that were worth sharing from the survey are mentioned below :

- A professional talking about deployment says " *Although I do think that planning is where a project's fate is decided with respect to delays, I have experienced a situation wherein the project was delayed due to deployment issues. Because of an incorrect deployment that was done not only was the project delayed but it caused a major outage in one of the customer-serving databases.* "

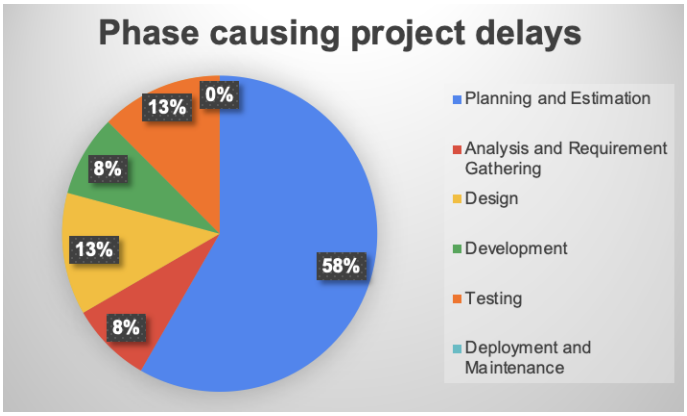

Fig. 13. Delay in different phases of SDLC

- Another professional talks about the importance of starting early and correct expectation setting with the client. He goes on to mention a successful case of project completion. In this they pushed back the schedules set up by the client by walking them through the entire process and setting correct expectations. Since that was done in the initial days of the project planning, the clients also had time to revisit their requirements.

- Project tracking is an key thing that managers often overlook which causes most projects to get delayed even if they start on time. A professional says " *I learnt this the hard way early on in my career when a couple of projects started well but because I lost track on my team members they started getting complacent and the work was delayed.* "

- Choosing the correct technologies and methodologies is an important task as well to reduce project delays. A lot of time is wasted in integrating components only to realize better alternatives were available. This does not always work because some systems are sensitive like healthcare and banking. These do require a specific set of technical tools to be used so as to make them secure and prevent data leaks.

- " *Most of the times the project was delayed because we weren't given the code by the development team on the exact dates we were supposed to start the testing. Due to this issue testing was delayed and therefore the project. Also if the requirements changed midway the entire team had to redo the test cases we had prepared and that took a significant amount of unaccounted for*

time. " I have included this only to show the variation in a tester's opinion compared to that of a developer.

Comparison over the years

When the current survey is compared to the research papers of previous years I can see that planning and estimation remains a common issue over the decades. Over optimistic planning has been the root cause of project delays from the 80s as per [3]. Another common cause that was found was the cooperation among team members and also changes in the scope of the project. One point of difference that can be seen is that of resource allocation. This was a major issue in the early 2000s but does not seem to be much of a problem now in causing project delays. Fixing of bugs and focus on development side of things was huge on the papers presented in 2000s. This does not seem to be an issue currently as most people agreed that development phase is causing least delays as per Fig 13.

6. CONCLUSION

As project managers or software developers, we all have come across many circumstances during several project implementations. Some of those have led the projects to the risky path and some have ended up becoming issues as well. Therefore the topic of project delays is important. Some people can easily point-out that, it's project manager's responsibility to avoid any delays. It's also true that managing risks is one of the 9 knowledge areas which every project manager should be familiar with.

By looking at the top 5 factors, it's quite thoughtful that these causes are rooted from various phases of project's life cycle i.e initiating stage, planning stage, executing stage. While conducting this research and also while working in a team for this class I came across this fact to be true. Our sprint 1 was delayed because of improper planning and lack of communication among team members. The good thing was that we were able to figure it out and the project was saved midway. This survey helped me realize the current issues in the software development industry. Although it is not an accurate representation but a pretty good one I would say.

Nevertheless, it's also mentioned that prevention is better than cure. I am pretty sure that, keeping an eye on above reasons and taking appropriate precautions will help us to make our projects successful. More and more teams are moving towards agile methodology which in my opinion is amazing so as to reduce project delays. We as an industry constantly have to keep evolving and adapting. With the advent different conditions some of these reasons might become redundant in the near future while some might still keep the project from getting completed on time.

7. FUTURE WORK

Although this study gives us a good insight into the current market causes of software project delays, it is limited in its scope. As is the case with most survey based studies, a larger dataset will enhance the study. According to me this study can also be enhanced by adding more data points. Not only more data points should be added but also varied opinions. This can be achieved by conducting the survey on different demographic groups. In this research, data that has been used includes that of industry professionals working in Asia, Australia and North America. It would be great if I can tap on the mindsets of people working in Africa, Europe and South America as well. Also tapping into different age groups will be essential. It would be interesting to see if any details like age, location, gender, position or role in the company, company would correlate with the views on project delays. What this essentially means is that whether people from a particular location are of the opinion that improper estimation or any other cause is the major cause of project delays. Maybe people belonging to a particular company feel that letting go of talented developers was the main reason of their project delays. These will be fascinating correlations to explore but it will only be possible if we have enough varied data.

Another idea I had was combining my knowledge of machine learning once I have a larger dataset and building a model. A machine learning model will be trained on data of the details of the project and team members. It will take these details as input and tell us what are the likely causes of the particular project being delayed. This will help software management teams to overcome the bottlenecks and prevent delays in completing their projects. Again, there are human factors involved in projects that can cause delays which the machine learning model might not be able to detect.

This study with the model can also be extended to different markets like the construction industry, manufacturing industry, marketing industry. During my research for this paper I came across many project delays in the construction industry.

8. REFERENCES

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