Story Point Estimation: Methods and Challenges

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Abstract

Agile estimates are absolutely necessary for organizing and leading agile teams. Because there are insufficiently accurate estimates, most agile initiatives go over their budgets. Lack of accurate estimations causes inaccurate arrangement, design, improvement, and task management, which may result in the delivery of an unsatisfactory project or product to the client, leaving them—and the end user—unsatisfied. When the project's initial phase resulted in dishonest projections, the project's dangers were not identified. The main goal is to present different Agile Story Point judgment methods that are used in development settings along with their difficulties. Aids development teams in using accurate estimation techniques in their projects. Agile projects can be estimated using a variety of estimation methodologies. Planning Poker, T-Shirt Size, Dot Voting, Bucket System, Big/Uncertain/Tiny, Affinity Mapping, Ordering Method, Maximum Size or Less, Bottom-up estimation, Top-down projections, Expert Judgment, comparative or analogous estimation, Parametric Estimation, the Delphi Method, and the three-point method are a few examples of Agile estimating methodologies. The paper goes into detail about each Scrum estimate model and discusses the difficulties with each agile estimation method.

Mathematics Subject Classification: 11B39, 11B99

Keywords: Story point; Agile Estimation; Effort; Project Estimation; Fibonacci sequence.

1. Introduction

For the past few years, Scrum has been one of the most widely used frameworks in agile projects. Scrum is used to create, deploy, and maintain complex products. In the Scrum structure, sprint planning divides the work into tasks that may be finished in two to three weeks [6]. Scrum [9] is a software development phrase used in the agile framework to describe an incremental and iterative procedure for handling complex tasks. The scrum leader leads the spring development meeting as part of the Scrum process, and the development panel extracts the jobs according to precedence and estimations using various team-adopted approaches. Story Points are used to establish the Product Backlog Item's (PBI) size. Teams from different organizations utilize a variety of agile estimation methodologies depending on the nature of their projects and their prior knowledge. It is the Scrum leader's responsibility to select the best estimation model for

each task. The team can more accurately predict the Story points thanks to Scrum. One of the key considerations for team members when estimating Story Points is relative size. The entire team, including the Product vendor, Scrum leader, Scrum Developer, Scrum Tester, and Stakeholders, who is in charge of estimating the work,

In this study, various Story Points estimations methods are compared Dot Voting, Planning Poker, T-Shirt Size, Bucket System, Big/Uncertain/Tiny, Ordering Method, Maximum Size or Less, Affinity Mapping, [7],Bottom- Up Estimate, Top-down projections, Expert Judgment, Comparative/Analogous Estimation, Parametric Estimation, Delphi Method, Three point method elaborated along with their challenges.

The literature contains studies on various effort estimation techniques. The following is a brief summary of a few studies from the literature. Organizations have been utilizing agile for the past 20 years, and several trends and evolutions have taken place. Scrum, one of the best frameworks, is used in agile. Iterative development, targeted work objectives, cooperation, client participation, one-on-one communication, minimal certification, repeated testing, joint possession, and information transfer are some of the problems faced by agile development and maintenance projects [5]. In terms of adaptability and teamwork, the traditional and agile methods are superior. Agile risk is quantified in terms of the number of project personnel, team meetings, site visits, training, and poor communication [1]. Agile projects have a higher success rate than Waterfall projects (around 2X higher), with 42% successful, 50% challenged, and 8% failing. According to The Standish Group's 2018 Chaos Report [10], the success rate of agile projects is 60% higher than that of non-agile projects. Story points, which are now frequently used as a metric to estimate the magnitude of the work to be done, were introduced by Grenning in 2002 and planning poker, which Grenning first presented in response to the growth of agile approaches [2]. Fernandez-Diego and others [4]. A lack of data is one of the reasons why AI has not been extensively adopted in agile development. In some instances, agile project datasets are private, and only handfuls are available in online repositories [3]. Existing effort estimation methods can be categorized as expert judgment, algorithmic, machine learning, and statistical [8] and it is well known that expert judgment has been extensively used since the 1980s.

Novelty: In this research, we analyzed the available techniques for project estimation. We explained how we can estimate a project with the help of these techniques, as well as what the difficulties are in using them and how they can be solved. All these techniques are based on the Fibonacci sequence.

2. Methodology

There are numerous estimation methods for user stories. Story points are the most common method of measurement for user story size. The Fibonacci sequence enables the team to compare two narratives, and the sequence's distinguishable values aid in sizing the narrative to reflect uncertainties, thereby assisting the team in refining the narrative to eliminate those uncertainties.

In the Fibonacci sequence, the next term is the sum of the two preceding terms, e.g. 1,1,2,3,5,8,13,21,34,……… and so on.

Here the difference between 2 and 3 is 1, 3 and 5 is 2, 5 and 8 is 3, 8 and 13 is 5 this can be seen for the next term is well.

The Fibonacci series is a lagging exponential sequence that allows for accurate estimation of time and uncertainty over time. It is useful in agile development, where requirements and solutions change over time. The Fibonacci sequence encourages decision-making while increasing ambiguity over longer time periods. It requires the team to group and differentiate the sizes of user stories, as there must be a "this" or "that" for ambiguous user stories. The distance between story points varies in the Fibonacci series, making it easier to recognize the varying magnitudes. Due to their non-linear character, Fibonacci numbers are less likely to be overanalyzed because they contain certain prime numbers. Large user stories are not directly related to one another, and the risk of over-analysis is reduced by not supporting the claim that multiple individuals would progress faster if multiple individuals worked on them.

Imagine receiving two weights: one weighing 1 kg and the other 2 kg. you can probably tell them apart with one in each hand , even though you can't see which one is which. You will experience the two kg as being significantly heavier.
Instead of being handed weights of 20 kg and 21 kg. The weights one and two kg varied by the same amount. However, it would be considerably more difficult to tell which of the two weights is heavier.
Weber's Law is to blame for this. According to Weber's law, a percentage represents the difference between two objects that humans can detect.
One kg and two kg are 100% different. You can probably tell the difference in weight between two objects if it is 100%. But there is just a 5% difference between 20 and 21 kg. If you are unaware of the difference, you probably cannot tell it. And if you could, it would imply that you should be able to tell the difference between a weight of 1 kg and a weight of 1.05 kg because that difference would likewise be 5%
The Fibonacci scale's values are effective because they essentially match Weber's Law. Each number following the two, which is 100% greater than the preceding value of one, is around 60 % larger.

According to Weber's Law, if we can tell a 60% effort difference between two estimates, we can tell a 60% effort difference between other estimates as well.

Because they increase by roughly the same percentage each time, the Fibonacci values are effective.

The primary objective of this research paper is to determine how Fibonacci numbers can be used to estimate any project. And what are the challenges in these estimation techniques and how they can be solved. We used Fibonacci sequence for analysis of estimation techniques.

3. Agile Estimation Techniques

3.1. Planning Poker:

Planning Poker is a concession-based estimation method used in Scrum to estimation user stories' effort or relative magnitude. It involves a 52-card deck with Fibonacci sequence card numbers with the values 0.1,2,3,5,8,13,21,34, and 55. Each estimator has a deck of cards, with a moderator reading the user narrative description. The moderator reads the story and answers any concerns. Each estimator chooses a private card, and all cards are flipped over and held up for all team members to view.

Estimates may vary, and the moderator ensures equality. The group discusses the story and their estimates, with the moderator taking notes for future development. After the discussion, each estimator revises their estimate by selecting a card. The number of estimation rounds may vary depending on the story.

Figure1: Planning Poker

3.2.T-Shirt Size

Teams often over-analyze when estimating points, leading to the use of non-numerical systems like T-shirt sizing. This method allows for a more abstract approach to estimating points, removing the implied precision of numerical scores. T-shirt sizes are categorized according to

XS, S, M, L, and XL and can be assigned numerical values if necessary. This informal method can be applied quickly to large objects and is often developed through open, collaborative discussion. Engaging the team's playful, imaginative side can help shift them from an analytical to a more flexible, relative frame of mind. T-shirt sizes can be effective for agile teams, but eventually transitioning to a more rational numerical scale is recommended.

Figure2: T-Shirt Size Technique

3.3. Big / Uncertain /Tiny

Big/Uncertain/Tiny is an agile estimation method in which the group classifies the items to be estimated as Big, uncertain, or tiny. Teams estimate the remaining items using divide-and-conquer after discussing a few items collectively. The Bucket System resembles large, unsure, or tiny quantities. In the divide-and-conquer phase, the remaining items are assigned to each team member. Every team member places items on the scale without consulting other members. If someone has an item he does not fully comprehend, he can give it to someone else.

3.4. Ordering Method

An item is arranged at random on a scale (low to high) with multiple intermediate steps, such as the Fibonacci scale.

The team is then queried randomly, one by one. To move the item up or down on the scale, discuss, or pass. After everyone has had their turn, the procedure concludes. With limited time, your Product Owner can prioritize and select items.

3.5.Dot Voting

The Dot voting method is a Scrum method for evaluating a product backlog of most essential tasks and stories. Stakeholders vote on requirements, with each dot representing a requisite. The product owner rearranges backlog items based on the number of dots received, dividing the backlog into high, medium, and low priority groups. The team begins with the highest priority tasks and completes them within the allotted time. This method is quick, effective, and simple for evaluating a limited number of stories (up to 8–10).
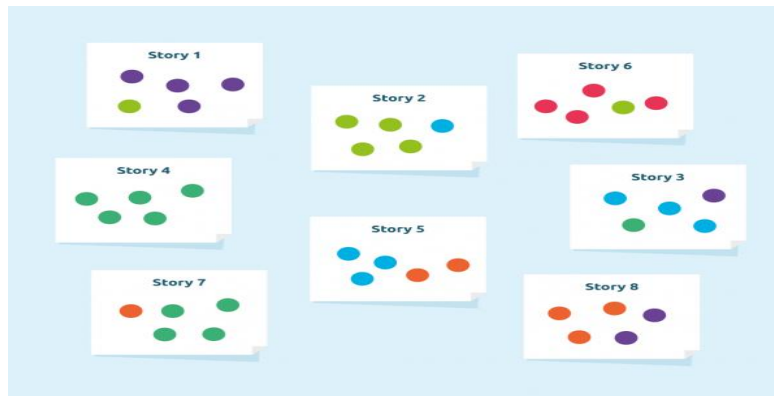
Figure3: Dot Voting Technique

3.6.Bucket System

This strategy is similar to planning poker and is most effective when utilized by larger teams with more vouchers or larger items. List the post-it notes according to the Fibonacci Sequence/Modified Fibonacci Sequence: 0, 1, 2, 3, 5, 8, 13, 20, 40, 100, 200. The facilitator begins by assigning a task at random to the 13 container. If necessary, realign the random items after a timed discussion. Divide the remaining items evenly among the participants and allow them to position them without further discussion. Everyone examines the items in silence, and if an item is out of place, it is brought to the group's attention, where a consensus is reached and it is placed in one of the buckets.

Figure4: Bucket System Technique

3.7. Bottom-Up Estimate

This method is employed when more precise results are required. The project manager divides the project down into small activities and estimates each activity's cost in great detail. The estimated cost of each activity at the lowest level is then added together to determine the total

project cost. The more specific each activity is described, the more precise the final result of the technique will be.

For instance, a painting company plans to paint a residence. First, they will have to divide the house into individual rooms, measure the total surface area of each wall, and determine the paint color for each room. Then, compare the values of each color and determine the total price of the paint. After that, it is necessary to estimate how long it will take to paint the entire home in order to calculate the labor hours. Lastly, it is necessary to precisely define the required instruments for the task.

This technique's disadvantage is that it requires the most effort and the most money of all the techniques. Especially for intricate projects, dividing the project into tiny individual activities can be extremely difficult. In addition, it may not be feasible to execute this technique in the project's early stages due to a potential lack of detail. Despite all of this, this method yields the most accurate and trustworthy results of all methods.

3.8. Top-down projections

Top-down estimation is the exact opposite of bottom-up estimation. In essence, continuing down this path signifies that you either have a fixed-price project or you know how much specific milestones could cost based on your past project experience. This method requires you to divide the project into profitable duties, which can be challenging if you do not understand how each activity influences your finances and the project baseline.

Top-down estimation is used when account administrators promote the project and project managers are hired to strike the ideal balance between client expectations and business objectives. Important in this situation are intelligent resource allocation, the ability to compare the initial estimate to actual costs, and adherence to the initial plan's boundaries.
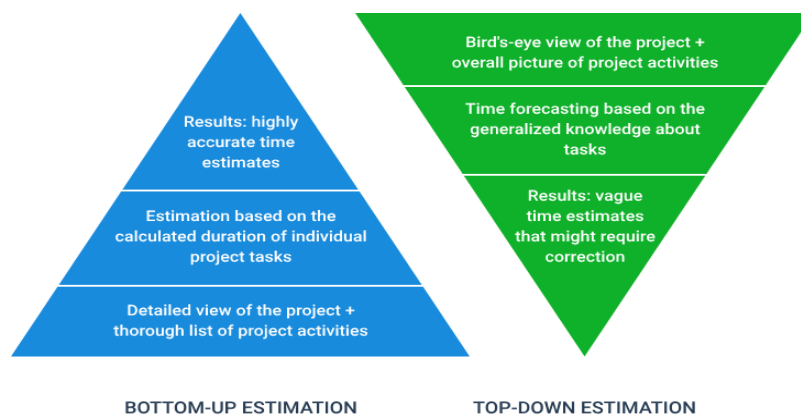

Figure5: Bottom- Up/ Top- Down Technique

3.9. Expert Judgment

This method of project estimation necessitates the use of specialized knowledge for forecasting. Occasionally, it requires the accumulation and analysis of pertinent data, followed by an expert's interpretation of the results. In other instances, it may be founded solely on the opinion of a specialist.

In either instance, the process of expert judgment itself adheres to predetermined criteria, is based on a professional's prior experience, and integrates theoretical knowledge with data and observations gleaned from practice. As for experts employed in time estimation, they need not be members of the project team; frequently, they are external specialists.

The technique permits the consideration of unique factors that cannot be taken into account during machine-supported analysis.

This strategy solicits personal judgments. Consequently, the outcome is frequently subject to human bias.

Expert judgment is most appropriate for complex projects where quantitative estimation alone is insufficient, and it is especially advantageous for managers who lack experience.

3.10. Comparative or Analogous Estimation

The term "analogous project estimation" refers to the comparison of forthcoming projects with data on the progress and outcomes of identical projects previously completed.

Both positive and negative outcomes are important; if the previous project was a success, it could serve as a model for estimating and planning the new endeavor. If the project was unsuccessful, the lessons learned could be applied to resource planning, risk mitigation, work scope management, etc.

Comparable estimation is one of the quickest and simplest methods for estimating resource needs.

Cons: It is characterized by low precision and a high risk of reaching incorrect conclusions.

When and where to use: The method is most effective for standard initiatives with comparable work scopes. It is frequently used in the early phases of a project's life cycle to generate a rough estimate of the required resources.

3.11. Parametric Estimation

The parametric method utilizes variables such as duration (or cost) and the number of work packages (i.e., groups of related project duties) to estimate future projects.

In order to implement this method, you must determine how many work packages your project will have and then calculate the time required completing a single work package. The final step is to calculate the cumulative estimate using the following formula:

Number of Work Packages: Single Unit's Estimated Duration

Note that historical data can be used to estimate the duration of work bundles, just as in the case of comparable project estimation.

The method guarantees the highest level of accuracy in the resultant estimate.

Cons: Parametric estimation necessitates a sophisticated data collection procedure and processing.

When and where to use: This method is most appropriate for projects with uniform work packages and repetitive duties. Thus, it is most effective in sectors with a lower level of creativity, where project parameters can be calculated relatively simply during the early stages of planning.

3.12. Delphi Method

The Delphi technique is an excellent method for obtaining expert opinions on crucial organizational decisions. This method assists experts in reaching a group decision that may be used to solve complex problems or implement large-scale decisions. If your organization seeks more efficient methods to conduct studies and make decisions, it may be beneficial to learn more about the Delphi method.

The Delphi method is used to generate group decisions that accurately reflect the panel's opinions.

In order to reach a conclusion, a panel of experts is subjected to multiple sessions of interrogation. These individuals can then consider alternative answers and modify their opinions.

How does the Delphi technique work?

The Delphi method entails assembling a council of experts and engaging in multiple rounds of questioning regarding how to make certain business decisions or resolve an organizational problem. Every answer provided by the specialists is anonymous. After each round, facilitators evaluate and organize all responses. They will find answers with common themes and concepts and share them with other specialists. Once the experts have heard and considered the responses

of the other panelists, they are given the option to modify their own responses accordingly. The primary objective of the Delphi method is to encourage these experts to reach a consensus and reach a mutual understanding. Numerous industries and organizations may employ this technique for business forecasting or structural decisions, including industry forecasts, government planning, and financial strategies.

3.13. Affinity mapping

Agile teams can utilize the affinity estimation technique when there are fewer backlog items and smaller team sizes. The following stages comprise affinity mapping:

a) Silent Relative Sizing:

In this phase, two cards titled smaller and larger are placed on opposite corners of a wall or board. Next, each participant receives a subset of items from the product proprietor and is instructed to individually measure each item. Here, participants can pose clarifying inquiries to the product owner. In the case of complex product backlog items, they are separated and removed from the fold. This exercise takes between five and twenty minutes.

b) Editing the Wall: In step 2, team members may transfer items from one location to another at their discretion. Within the allocated twenty to sixty minutes, team members may also discuss the design and implementation aspects. In the event that there is negligible discussion, team members may conclude the activity.

c) Positioning of Items in Appropriate Locations: In this phase, members of the team place items in their proper locations and post discussions. Here, the Agile scaling technique for t-shirts, the Fibonacci series, etc., can be utilized to estimate the relative item size.

d) Product Owner's Responsibility: Product owners use this step to inform team members of estimation discrepancies, discuss features, and convey requirements. It is crucial because addressing all these factors before finalizing estimates prevents confusion.

e) Export into the Project Backlog Management: Application In this final stage, the product owner can export the finalized estimates to a product backlog management tool for storage. Affinity Mapping applications - Estimating a project's long-term plan, Gaining team consensus, Dealing with substantial backlog, Conducting early-stage estimations.

3.14. Maximum size or less

The base value is defined by the Scrum team as the item's maximum size for estimating (for example, 8 hours of effort in the project). During the grooming session, each product backlog is

evaluated to determine whether the Story is more or less than the expected base value. The Story is divided into numerous stories to support the projected base value if it exceeds the maximum size allowed. The process keeps going until every product backlog item is inside the permitted size range.

3.15. Three-Point Approach

This approach repeatedly considers the most likely, the worst, and the best case scenarios. The final estimate is then generated by taking the average of each of these estimates. The team must gauge time and effort using the following criteria in this method:

Optimistic Value (O): If everything goes as planned, how much time and effort will it require?

Pessimist Value (P): If things go wrong or there are roadblocks along the way, how much time or effort will it require?

Most Likely Value (M): What is the most likely and realistic estimate for finishing the task?

Use one of the two approaches listed below to determine the average:

Triangular average: Estimate= (O+P+M)/3

Beta average: Estimate= (O+P+4M)/6

4. Result and Analysis

Agile Scrum estimation methods involve a collaborative process, with all project stack holders participating. The Scrum leader selects stories from the product backlog, discusses requirements, and generates estimates using Agile methods. User Story Points are used for velocity comparisons, measuring team work during sprint cycles. The Scrum leader must select the appropriate estimation technique based on job extent, resource knowledge, and extent. Information on which estimating technique should be used when is detailed in Table 1.

Table 1

	Small Team	Medium Team	Large Team	New Team	Establised Teams	Large Backlogs	Prioritised Backlogs	Small Items	Medium Items	Large Items	Early-Stage Estimation	Late-Stage Estimation
Planning Poker	ϒ				ϒ		ϒ	ϒ				ϒ
T-Shirt Size		ϒ	ϒ	ϒ		ϒ					ϒ	
Dot Voting	ϒ				ϒ	ϒ		ϒ	ϒ	ϒ	ϒ	ϒ
Bucket System			ϒ	ϒ		ϒ				ϒ	ϒ	
Big / Uncertain / Tiny	ϒ			ϒ				ϒ	ϒ	ϒ	ϒ	
Affinity Mapping	ϒ				ϒ	ϒ		ϒ			ϒ	
Ordering Method	ϒ					ϒ		ϒ	ϒ	ϒ	ϒ	
Maximum Size or Less	ϒ	ϒ		ϒ	ϒ			ϒ	ϒ	ϒ	ϒ	
Bottom-Up Estimate												ϒ
Top-down projections											ϒ	
Expert Judgment				ϒ						ϒ		
Comparative/ Analogous Estimation	ϒ	ϒ						ϒ	ϒ	ϒ	ϒ	ϒ
Parametric Estimation				ϒ							ϒ	
Delphi Method					ϒ					ϒ	ϒ	ϒ
Three point	ϒ	ϒ		ϒ			ϒ	ϒ	ϒ	ϒ		ϒ

Where ϒ= method can be used

The team faced challenges in estimating tale points in agile scrum estimates, leading to misunderstandings about the process. Proper instruction and expertise are crucial for accurate

estimation. Training is essential for predicting narrative points and allowing the team to practice them for one to two sprints. Agile adoption is hampered by lack of scrum estimating engagement, and team members may exaggerate story elements. Retrospective sessions are encouraged to improve throughput capacity and estimate work completion during subsequent sprints. The difficulties with Agile Scrum estimation are listed in Table 2 below, along with solutions.

Table 2

Challenges	resolution
lack of estimate and anticipation of story points	Teams struggle to determine the story point from a backlog item. The team must receive extensive training from management on how to use Agile and create story point estimations.
There is no standardized estimating method.	Agile Scrum estimates are not defined and are relative in magnitude. The definition of a narrative point differs between projects. It is the responsibility of the Scrum leader to implement appropriate estimation techniques based on the size of the project and the team's level of experience.
bandwidths for culture and communication	A key aspect of Agile delivery is how well the resource understood the requirements. The daily standup meetings with the Product Owner are the Scrum leader's responsibilities in order to thoroughly understand the requirements for on-time delivery.
If the same type of job hasn't already been done in the past, the sprint will be overestimated.	Developers frequently exaggerate the story points when a team is working with a novel technology. The Scrum leader's job is to keep the team in check and educate them on new technologies, not to inflate the team's stories.
absence of project-specific indicators for size, effort, and velocity	If the data is accessible for other projects to predict the same task type, the majority of teams do not maintain track of the project's size, effort, and execution speed. The

	administration must encourage the team to document actions using Agile Management tools.
the incorporation of project management	For projects that need a plan-driven approach, the agile technique is not appropriate. Develop a hybrid Agile strategy to incorporate Project Management elements in projects with a defined plan.
lack of commitment to the resources	Self-managing, self-organizing teams foster innovation, creativity, and dedication.
oversized tasks or backlogs	Minimize backlog by focusing on smaller tasks, creating smaller teams, and utilizing individual effort for common objectives.

5. Conclusion

Organizations are developing a number of well-liked Scrum Story Point estimating approaches that have been in use over the past ten years. Various businesses use various estimating models depending on the objectives of the client. There are no estimating approaches that must be used according to the Scrum structure. Story Points and Planning Poker, for instance, are not included in the Scrum structure. The Scrum structure merely establishes the rules of the estimating game and provides teams the opportunity to select their preferred method. Therefore, based on their resource experience and the necessary size, the teams can select any estimating approach outlined in Section 3. Agile is being adopted by businesses at an accelerated rate, thus more research must be done to develop better methods for estimating effort in order to address the issues with current Agile Scrum Story Point estimates.

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