Systematic study on Agile Software Metrics

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Abstract: A number of studies have been done that look into the success / failure rates of projects. These studies show focus on the serious problems that exist across a broad cross-section of industries and it arises an important question as to why so many software projects fail. The possibility of software projects failing can be due to various reasons such as miscalculated time & budget frames, lack of communication, no end-user involvement, lack of periodic assessment, failing to see the bigger picture, all this pose a tangible threat to companies. This brought the need for "Agile software development" [1].
This paper discusses about the breakthrough caused by Agile in the Conventional development methodology. It will give an idea about Agile Mindset and Enterprise Transformation needed to adopt Agile. It deeply focuses on Agile variant Scrum and its implementation. It analyzes different Agile Metrics and examines their impact on Development Lifecycle of a product. It concludes by explaining the Industrial shift towards Agile and gives a sneak-peak into the future of Agile.

1. INTRODUCTION:

As Software companies grew larger, they increased emphasis on governance. Top-down control became a significant part of the process which made developers spend majority of their time dealing with control structures, as every step of the development process became rigid. This development environment was in contrast with the smaller, more adaptive software development companies that brought more customer value to the process by creating products that were closer to what the customer wanted, taking less time to create and costing less to develop.

This is where Agile Methodology came in to rescue.

A Manifesto [2] for Agile Software Development was created in 2001 and was signed by its 17 cosigners.

Agile approach is beyond traditional & formal rules; it allows the development process to be flexible & responsive. It gives highest priority to Customer Satisfaction and therefore increases the level of communication between the Client and the development team.
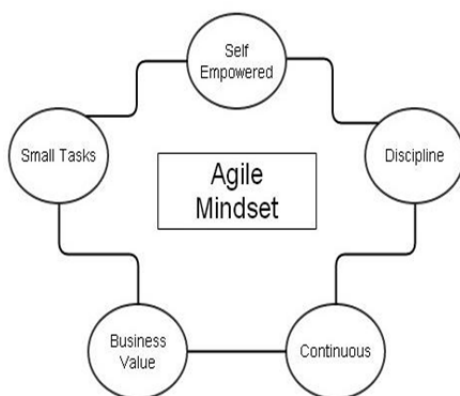
Fig.1:   Agile Mindset

2. SCRUM METHODOLOGY
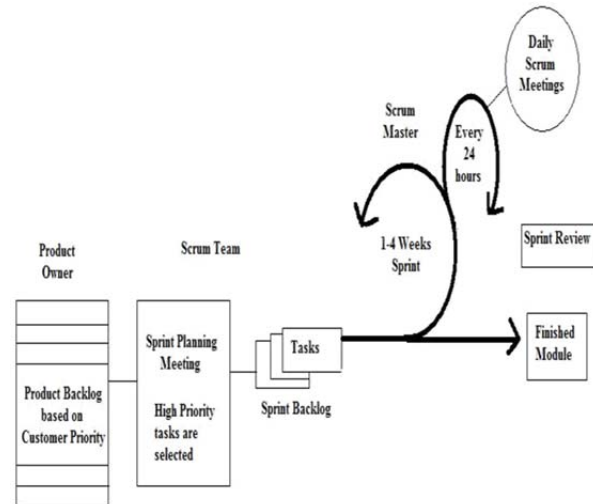
Fig 2: Scrum Execution

Scrum is a particular variant of Agile and the most popular variant today.

Scrum lets you bring Agile to your organization and make it work. In Scrum, you break a task into a series of iterations, called *sprints.*

In Scrum, you execute projects in successive iterations known as *sprints.* The Product Owner creates a product backlog and lists out all the product-related requirements and also specifies the priority and acceptance criteria for each requirement.

In a sprint planning session, items are taken from the product backlog and moved to the sprint backlog, based on the priority set by the Product Owner. The goal of the sprint is to accomplish the items in the sprint backlog. The team then estimates a sprint velocity target, and this gives an indication of the team's development capacity.

Sprints are intended to be 2-to-4-week work iterations. In the End-of-Sprint Review meeting, each task is enumerated, along with its acceptance criteria.

The Product Owner validates the results and a potentially shippable product is delivered to the Product Owner for review[3].

2.1. Sprint Planning accomplishes these things:

It ensures that the team is on the right track, keeps a check on the time spent and velocity of work.

Sprint Planning together with effective story writing practices provides a possibility that the product can be delivered sooner than estimated.

The End-of-Sprint Review combined with the Parallel Testing team ensures that what the team delivers is more closely aligned with what the customer wants and therefore leading to less number of defects and low cost to quality.

3. SCRUM METRICS

The common reasons for complication in project development are an unrealistic deadline, changing customer requirements, honest underestimate of effort or resources, overlooked risks and miscommunication.

Metrics are used for scaling project's development. These metrics help the team to set a benchmark and provide key insights that improve performance and help in overcoming complications. Metrics help in providing governance to an Agile Project [4].

Metrics help in effort estimation and ensure that resources are allocated evenly. The goal of metrics is to increase output per iteration and simultaneously reduce Defect Density.

Metrics act as measurement tools for Quality Management in Agile Software Development [5].
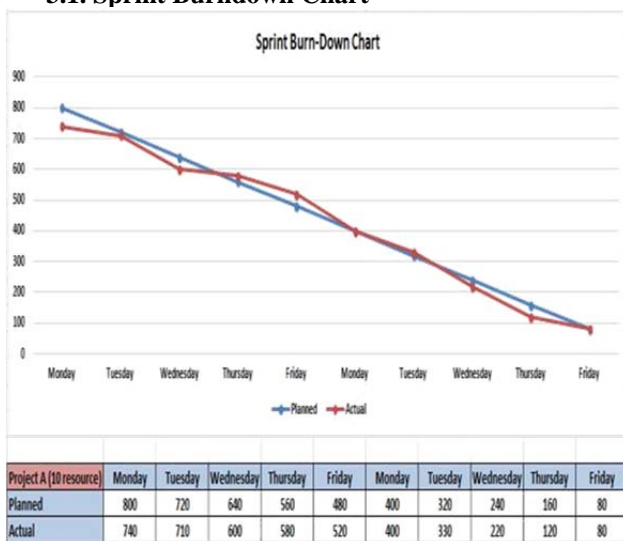
3.1. Sprint Burndown Chart

Project A (10 resource)	Monday	Tuesday	Wednesday	Thursday	Friday	Monday	Tuesday	Wednesday	Thursday	Friday
Planned	800	720	640	560	480	400	320	240	160	80
Actual	740	710	600	580	520	400	330	220	120	80

Fig 3: Sprint Burn-Down Chart

This graphical technique provides a means of displaying team's progress during a sprint. With the story points getting completed, the chart displays the rate and the amount of progress. [6]

Advantages of Sprint Burn-Down charts:

- Single Planning & Tracking tool for the team- The team comes up with a task breakdown structure, it divided the work over a number of iterations and estimates the effort and time required. The entire team updates estimated effort and the team also updates the effort remaining. This helps in planning, tracking and maintaining schedule.
- Risk Mitigation by Daily Visibility-Schedule and cost overrun are two metrics that can be easily measured using burn-down charts.
- Communication Tool- It provides visibility of project progress on a daily basis and can be shared with relevant stakeholders.
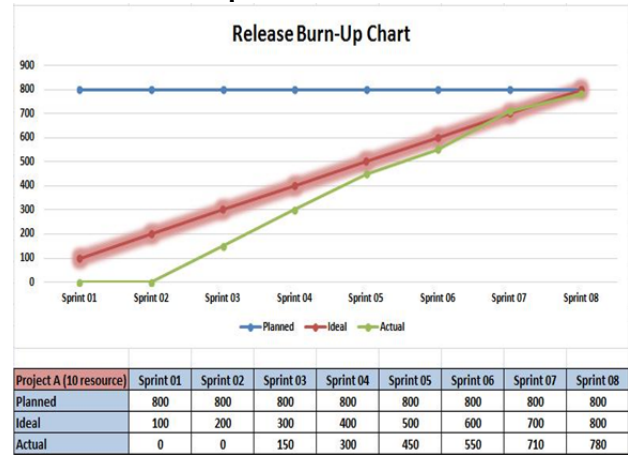
3.2. Release Burn-Up Chart

Project A (10 resource)	Sprint 01	Sprint 02	Sprint 03	Sprint 04	Sprint 05	Sprint 06	Sprint 07	Sprint 08
Planned	800	800	800	800	800	800	800	800
Ideal	100	200	300	400	500	600	700	800
Actual	0	0	150	300	450	550	710	780

Fig 4: Release Burnup Chart

With each sprint getting completed, the delivered functionality grows, and the release burn-up chart depicts this progress.

A burn up chart depicts the work completed and the project scope. It is used for indicating the stakeholders how any extra feature will affect the deadline, and at the same time for ensuring them that good progress is being made.

A burndown chart does not provide accurate measurements in cases where a lot of work is added by the clients in the middle of the project.
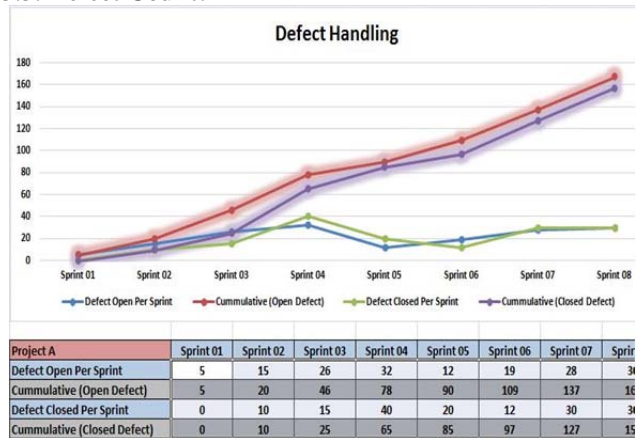
3.3. Defect Count:

Project A	Sprint 01	Sprint 02	Sprint 03	Sprint 04	Sprint 05	Sprint 06	Sprint 07	Sprin
Defect Open Per Sprint	5	15	26	32	12	19	28	3(
Cummulative (Open Defect)	5	20	46	78	90	109	137	16
Defect Closed Per Sprint	0	10	15	40	20	12	30	3(
Cummulative (Closed Defect)	0	10	25	65	85	97	127	15

Fig 5: Defect Handling

As defects get encountered during the development process, they are stored in the defect backlog.

The respected team reviews the defect backlog and if the issue gets resolved, the defects are closed else they are termed as open defects. They help in identifying the defect density in the project.

3.4. Running Tested Features(RTF)

In this the software is broken down into stories and each story has one or more automated acceptance tests that it needs to clear. The RTF Metric is well explained in [9] and it is defined as the number of stories that are able to pass the acceptance criteria.
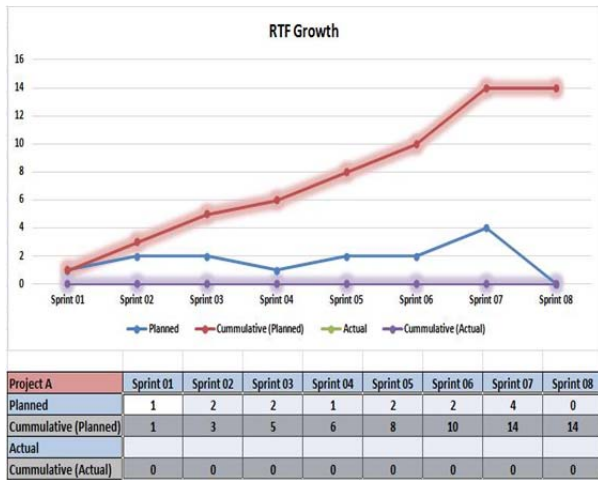
Fig 6: Running Tested Features

Project A	Sprint 01	Sprint 02	Sprint 03	Sprint 04	Sprint 05	Sprint 06	Sprint 07	Sprint 08
Planned	1	2	2	1	2	2	4	0
Cummulative (Planned)	1	3	5	6	8	10	14	14
Actual								
Cummulative (Actual)	0	0	0	0	0	0	0	0

3.5. Velocity

Velocity (the number of story points delivered on a given sprint) is a metric primarily intended to guide the development team to understand the realism in delivery commitments. The feedback provided at the end of each sprint informs the planning for the next sprint.

Teams growing accustomed to working together display a pattern in the velocity of sprints whereby a gradual rise in velocity is seen in the first few sprints. However, Newly formed teams tend to take a minimum no. of sprints to adapt to new conditions and new people, therefore such teams take few sprints to get their

"velocity". This time period is called velocity lag.

After the velocity lag period is over, one can truly judge a team's performance.

The coefficient of variation (CoV) indicates the stability of a team's velocity.

Coefficient of Variation= (Standard Deviation / Average) * 100

4. INDUSTRIAL SHIFT TOWARDS AGILE:

Many organizations are adopting Agile methodology and many are giving great amount of attention to the factors that should be taken into account while considering an Enterprise Agile Transformation.

Company	
TCS[7]	The Company Report states that the organization needs to adopt a Lean-Thinking Management that supports team and promotes commitment, involvement & active decision making. They need to foster cross-functional, dedicated and co-located development teams. Reinforce team accountability as much as individualaccountability.

Company	
KPMG[8]	It presents how the development & integration of the modules under the guidance of the product owner can avoid any scope of conflict in terms of the requirements specified and the actual deliverable produced. The report promoted the concept of 2-Pizza team size. Due to prioritization of requirements, high-valued features are implemented first hence higher return on investment is realized in the early stages.
IBM[9]	IBM has launched Jazz Agile platform. Essential attributes of Jazz: Collaborate: Deliver transparency of teams and projects for context sensitive collaboration Automate: Automate non-creative tasks with automated processes and workflows

Report: Delivers insight into programs, projects and real time resource utilization.[10]

CONCLUSION

With growing size of organizational projects, the use of Agile Methodology has become inevitable. Agile has its domain in the IT industry and is customarily used for Software Life Cycle Development. But one could see Agile spreading across multiple domains as organizations are willing to reap its benefits.

In Agile, due to client and project team's collaboration the team has a clear understanding of client's vision. Frequent module releases keep the stakeholder's trust in the development team's ability. The methodology provides a benefit of transparency to the client. Also, the team allows the client to prioritize deliverables hence the focus is on the Business Value. By using fixed iterations, the amount of work that needs to be done as well as the required cost and effort can be estimated with ease.

Agile uses user stories that come along with an Acceptance Criteria, this assists in the Beta testing and provides a valuable feedback early in the project which allows the team to make necessary changes.

In Agile, Work Breakdown Structure divides the work into manageable units which enables high-quality development, testing and collaboration. Agile addresses most of the project pitfalls, such as cost and schedule predictability, it is able to prevent obstacles in the development phase and achieve the objectives in a leaner and more business-focused way. This methodology has great scope for capturing multiple domains as it provides an ideal project development environment.

	Burn-Down Chart	Velocity Metric	RTF	Release burn-up	Defect Density	Annual Revenue
Cognizant	✓	✓	✓	✓	✓	$10.26 billion (2014) [11]
Accenture	✓	✓	✓	✓	✓	US$ 31.0 billion (August ,2015) [12]
KPMG	✓	✓	✗	✓	✗	$24.8 billion (2014) [13]
BMC Software	✓	✓	✓	✓	✓	$2.2 billion [14]
Carbonite	✓	✓	✓	✓	✓	$30.3 million (II Qtr 2014) [15]
PWC[16]	✓	✓	✓	✓		$34.0 billion in FY 2014

FUTURE WORK

Agile Methodology has revitalized the software development industry. It has changed the way developers plan and coordinate work. Emphasis on communication with customers and external stakeholders has uplifted the degree of software quality and customer satisfaction. Agile software development is spreading its wings across multiple domains, from the telecom and healthcare sectors to games and interactive media. With this expansion there is a need to develop more Agile metrics in order to measure and identify every aspect of the project.

Companies such as Microsoft are working to improve Agile methodology support in TFS[17], they also do iterative development for many of their product, IBM has launched Jazz Agile platform. Agile which is typically used in lean and small organizations is now being implemented by SAP on a mammoth scale. Scrum, Kanban and Extreme Programming are the most successful Agile methodologies which are widely being implemented by various development companies, however studies are being conducted and many other methodologies such as Crystal Technologies and Feature-driven Development are being developed, recognized and adopted.

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