AGILE Burndown Chart deviation - Predictive Analysis to Improve Iteration Planning

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Abstract - *While AGILE development aims mainly at incremental development and delivering product (solution) in a time-boxed fashion; measurement framework is still not matured to assess and benchmark performance at organization and/or industry level. Burn down chart is one such key metric that tracks adherence to scope, effort and indirectly to schedule and is mandatory for daily Stand-up meetings. Though ideal target would be ZERO deviation; in real life we observe both +ve/-ve slippage(s). This paper is aimed at providing pointers, possible roadmap to analyze Burn down chart deviation to setup a predictable band or operating limit that would help improving Iteration planning to include suitable risk contingency reserve (+ve slippage: means possible push back some scope to Product Backlog, while –ve slippage: means probable provisioning of more scope into Iteration). This would ensure, greater assurance of completing planned Iteration Backlog within specific Iteration; the critical success factor of Agile planning/ execution.*

Keywords: "AGILE", "Burndown", "Iteration", "Planning", "Statistical" "Predictive"

1 Introduction

AGILE development primarily aims at developing and delivering product and/or solution in a time-boxed fashion, focusing on iterative and incremental development towards delivering tangible outcome (set of functionality/ system behavior). Each time-box is essentially an Iteration (also called as 'Sprint' or 'Scrum'), where a subset (called Iteration or Sprint Backlog) of total work scope (called as Product Backlog) is selected. This selected scope could ideally be completed in a specific Iteration and be ready to go live after Iteration is complete or with selected Release or through additionally planned System Test and/or Acceptance Test Cycle. During Iteration, a Task plan is prepared (for decomposed scope, as selected in Iteration backlog), by the team with Ideal (effort) hours is assigned to decomposed tasks/ activities. As completion of selected scope is extremely important, an Iteration Burn down Chart is prepared to show how total planned/ allocated effort would be consumed (Total to Zero) from start to end of Iteration. This planned Effort Burn Down is prepared keeping in mind, how much equivalent scope would be completed/ remained on daily basis. During Iteration execution, a revised effort estimate is put to account for remaining Iteration scope at the end of each day.

Though ideal (expected) Burn down performance would be a ZERO deviation; in real life it is often observed to be deviating ('actual' VS 'planned') both in +ve and –ve direction. As Iterations are time-boxed, to understand this behavior is of extreme importance; as +ve slippage indicates growing possibility of some amount of scope may have to be pushed back to Product or Release Backlog from Iteration backlog (due to probable unfinished scope), while –ve slippage means; possible under-utilized resource and more scope could have been provisioned into this iteration. It also guides to evaluate process effectiveness and trigger improvement cycle in regard to Scope management, Planning and Estimation, Risk Management, Issue (Impediments) Management and Resource Utilization etc.

This paper provides a framework and roadmap towards how, at an organization level, an expected and predictable band could be established and benchmarked, by analyzing a number of AGILE projects and a good number of Burndown chart behaviors. This requires periodic refinement and calibration based on future Organization data and Industry Benchmark, if available. This could be initiated at project level, then at organization level etc.

2 Burn down chart – what is it?

A Burndown chart is a simple but powerful tool to measure AGILE Project progress and manage deviation. Iteration Burndown represent, daily, the remaining work (basis iteration backlog) over specific iteration lifetime. It could be at Iteration, Release and/or Project level. It's a great management tool as it provides both project team and all other stakeholders with a common view of iteration and/or project progress.

Sample Burndown charts are shown below with possible interpretation and opportunities for improvement, towards better planning, monitoring and control of AGILE projects.

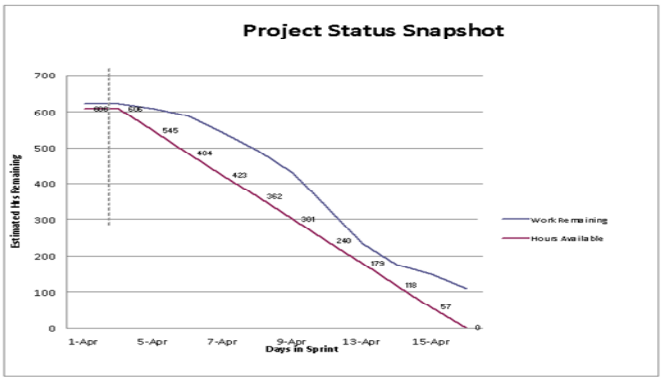


Figure 1: Sample Burndown chart #1

Possible interpretation: Iteration Planning and Estimation – Scope/ Task was under estimated.

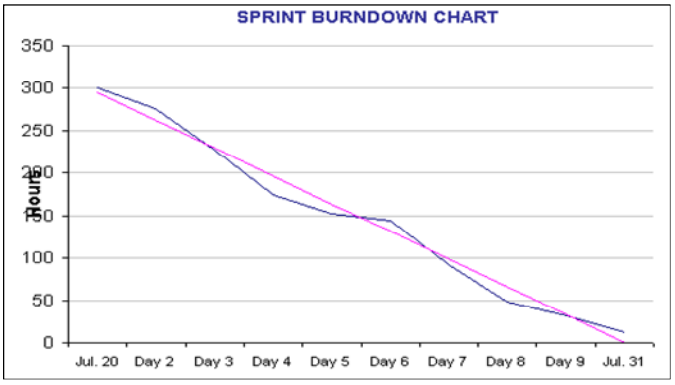


Figure 2: Sample Burndown chart #2

Possible interpretation: Normal expected performance and variation.

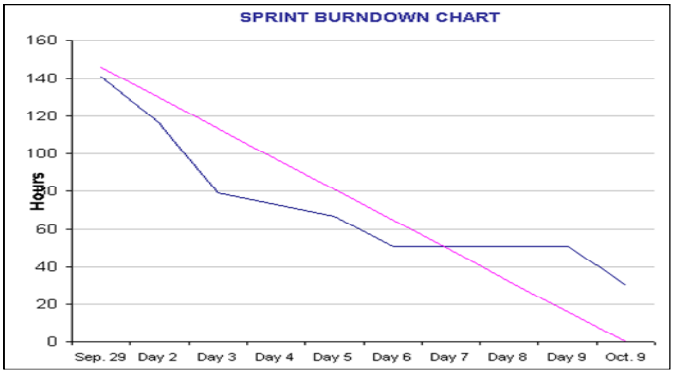


Figure 3: Sample Burndown chart #3

Possible interpretation: i) 1st part - Iteration Planning and Estimation – Scope/ Task may have overestimated and ii) 2nd part - Some tasks may have underestimated or some special cause/ impediments (issues) may have caused this.

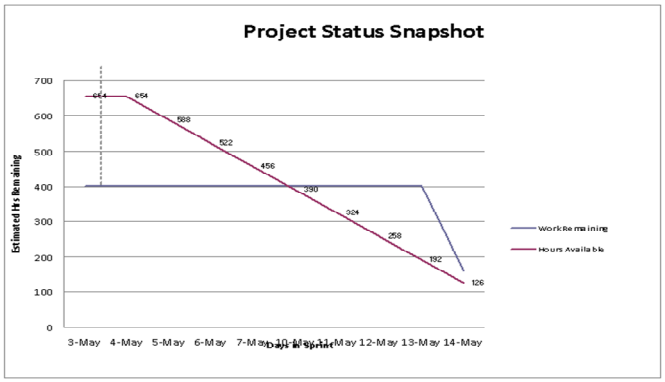


Figure 4: Sample Burndown chart #4

Possible interpretation: Typical scenario or special cause – for half of the iteration timeline, iteration Burndown didn't happen; then scope may have cut down (though scope adjustment is not allowed during iteration, and unfinished scope would automatically be returned to Product or Release backlog) to match rest of the iteration timeline. Or, the estimation was grossly on the higher side.

3 Improvement Opportunity, Objective and Business Case

3.1 Opportunity for Improvement

No Industry and/or Organization level guideline and Benchmark available to i) quantitatively understand and analyze Burndown Chart behavior, as a metric and ii) build predictability and enable better Iteration planning & execution.

3.2 Objective

Establish Organization, Unit, Account, Project Level Metric for i) Internal Benchmarking and ii) Drive process improvement and maturity in AGILE execution.

3.3 Business Case

Better planning of Iteration Backlog and Ideal Estimation to i) include risk reserve (both +/- deviations), ii) understand impediments and causes for these deviations and integrate with process improvement to attain next level maturity. iii) Improved Iteration Task Planning and Estimation.

4 Burn down chart analysis – proposed benefits

Table 1 – Benefit Articulation of Burn down chart analysis

Measurement	Helps understand current performance and ability to deliver
Project Planning	Helps in Iteration Planning; deciding on Iteration Backlog Scope better keeping in mind the operating/ predictable limit of deviation: planning adequate reserve for possible +ve slippage and having a backup scope or other tasks that could be additionally completed, in case of –ve slippage
Trigger for Causal; enabling improvement and optimization	To understand reasons for +ve and/or –ve slippage and correct process controls; for example; i) Story point or Value scoring guideline ii) Ideal Task estimation iii) Decomposition of User Story into Tasks iv) Coverage of various tasks like SDLC, Review/ Testing, Project Management etc v) Competence and Productivity of Team v) Planned VS expected Velocity vi) Dependency, Issues/ Impediments causing delay and resolution cycle time etc
Sprint Retrospective (Learning and Feedback loop)	Iteration Retrospection to analyze these deviation, identify improvement opportunities and adopt continuous improvement cycle
Baseline and Benchmark	Baseline performance in order to improve own performance and benchmark with other (different relationship, Organization Unit, Organization, Industry etc) performance and if better, adopt Best Practice(s) and/or learn from failure reasons
Effective Risk Management	Looking for key triggers and effective planning of Risk mitigation and contingency reserve
Time to Market	Greater assurance of completion of Iteration and Release Backlog on Time-boxed fashion

5 Burn down chart performance – predictive analysis approach

- Data collected for three different project execution, for same account and customer
- For each project, Burndown chart data captured, for various iterations
- Burndown chart behavior analyzed –
  - To understand daily deviations (planned vs. actual)
- Extreme outliers (special cause) eliminated
- Statistical Data Analysis done on data –
  - Normality & Descriptive Statistics, Box Plot, Dot Plot, Time Series, CNTL Charts etc
- Predictable Band (sample) selected based on outputs, it's interpretations and finally team's decision
- Same is carried out at Account/ customer level to understand overall predictability
- Need periodic calibration based on
  - Causal analysis, elimination of Special cause
  - Influence of Common cause
  - Corrective action taken to improve Iteration Planning and monitoring

6 Burn down chart monitoring – Data collection mechanism

Normally, day wise Ideal (planned/ expected) hours and actual (revised) hours to complete remaining scope of work, is captured; from which % variation is derived, as experienced and recorded in different days in iteration. Similarly, data is captured for other iterations, as well.

Day #	Ideal	Actual	% Deviation
1	280	285	1.79
2	245	250	2.04
3	210	200	-4.76
4	180	165	-8.33
5	145	149	2.76
6	120	120	0.00
7	80	70	-12.50
8	60	50	-16.67
9	20	25	25.00

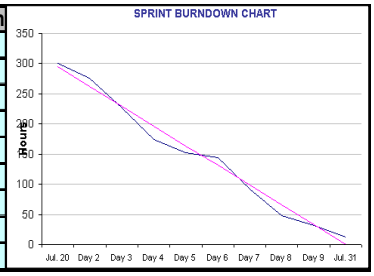


Figure 5: Sample Burndown chart and Data Collection

7 Burndown Chart Analysis: Determination of Predictive Band

7.1 Project level

Burndown chart analysis, for three sample projects (for same customer) were conducted using various standard techniques like Box Plot, Time Series, Dot Plot, Descriptive Statistics etc., and the same has been depicted below for reference. Three sample projects are represented as 'Case1', 'Case2' and 'Case3'.

Case 1

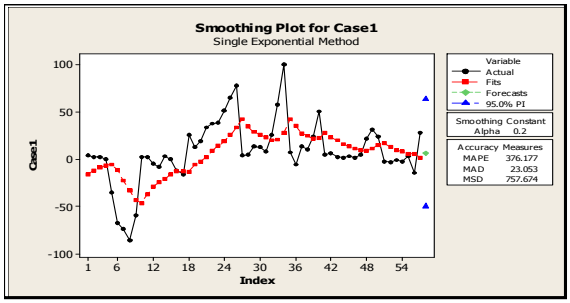


Figure 6: Time Series (Smoothing Plot) for Case 1

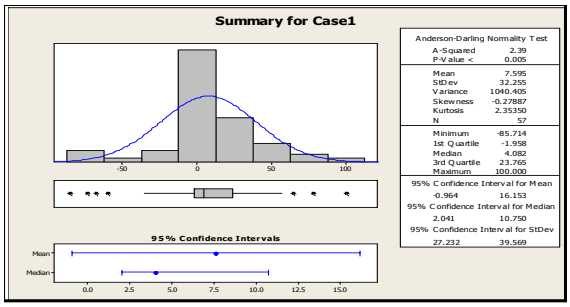


Figure 7: Normality & Descriptive Plot for Case 1

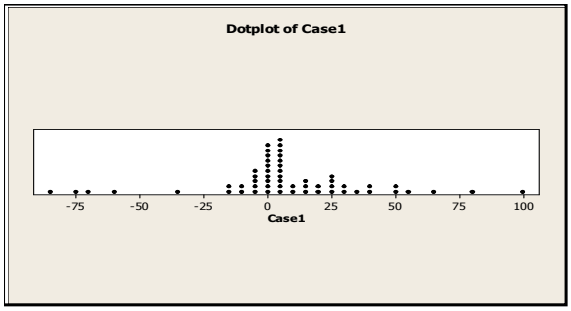


Figure 8: Dot Plot for Case 1

Case 2

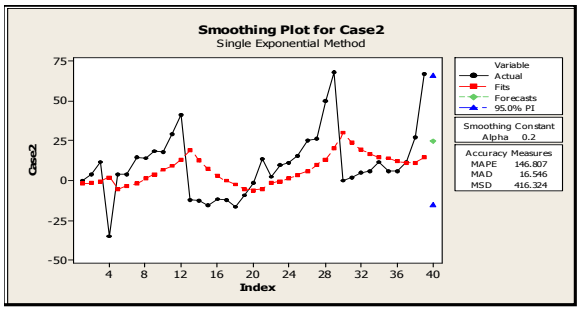


Figure 9: Time Series (Smoothing Plot) for Case 1

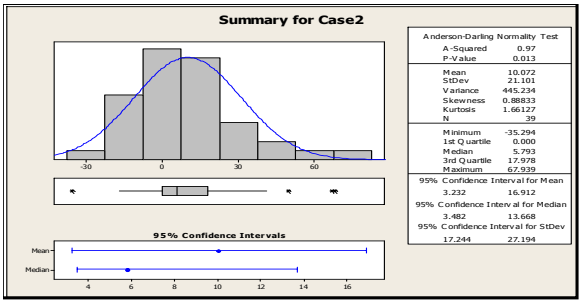


Figure 10: Normality & Descriptive Plot for Case 1

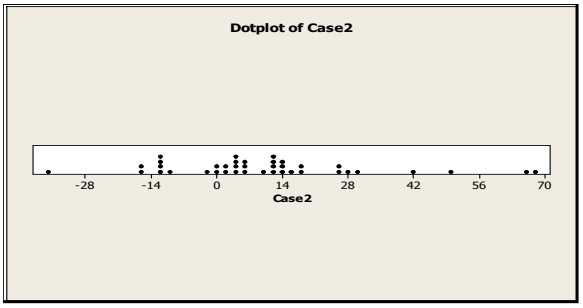


Figure 11: Dot Plot for Case 1

Case 3

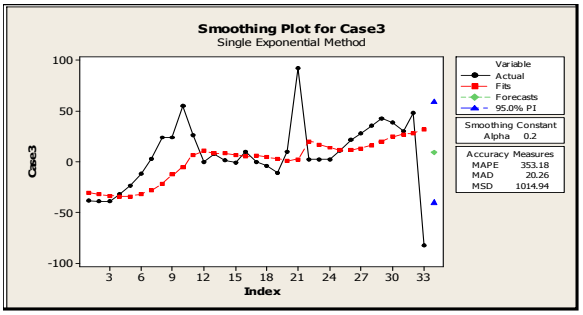


Figure 12: Time Series (Smoothing Plot) for Case 1

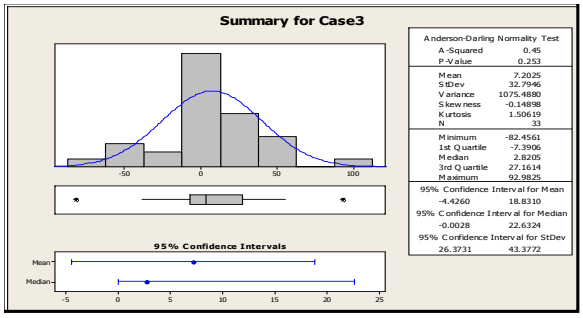


Figure 13: Normality & Descriptive Plot for Case 1

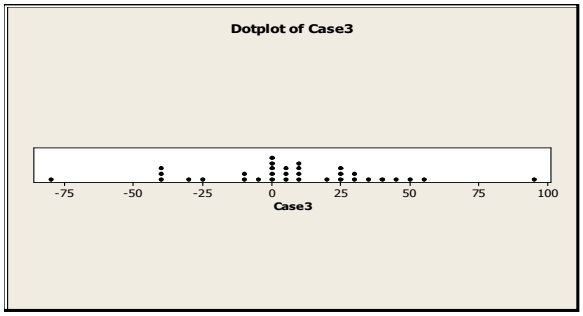


Figure 14: Dot Plot for Case 1

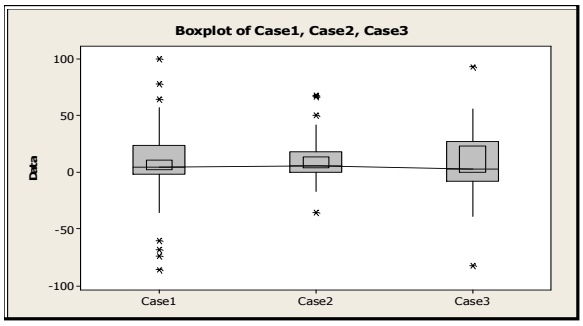


Figure 15: Box Plot for Case 1, Case 2 and Case 3

High level observations:

1. Case 1 and Case 2: Distribution is not Normal. Guidance is taken from other statistical analysis also.

2. Time Series (Smoothing): LCL and UCL limits are too wide, because of variations in both positive and negative directions.

3. Box Plots provide a good starting point to understand behavioral pattern and setup initial baseline (operating limits).

4. Time Series predicted value lies between Box Plot 95% CI for Median (except for Case 2, where variation is minimum)

5. Two prediction bands have been chosen as; i) ***Planning band***: This deviation could be considered as normal (most probable) scenario during Iteration planning, while ii) ***Risk band***: Risk/ Contingency reserve (Scope, Effort etc) may be required during Iteration planning.

6. For the *Planning band*; Box Plot 95% CI for Median has been chosen and for *Risk band* 1st Quartile and 3rd Quartile range has been picked up. Only exception considered for Case 2, as Time series prediction was out of both 95% CI for Median and 1st Q & 3rd Q range.

	Box Plot - 95% CI for Median			Time Series			Descriptive Stats	
Instance	LCL	UCL	Median	Predicted	LCL	UCL	1st Q	3rd Q
Case 1	2.04	10.75	4.08	6.24	-50.23	62.72	-1.95	23.76
Case 2	3.48	13.67	5.79	24.75	-15.78	65.29	0	17.97
Case 3	-0.002	22.63	2.82	9.28	-40.36	58.92	-7.39	27.16

	Predicted Band - Planning		Predicted Band - Risk	
Instance	LCL	UCL	LCL	UCL
Case 1	2.04	10.75	-1.95	23.76
Case 2	3.48	13.67	-15.78	24.75
Case 3	0	22.63	-7.39	27.16

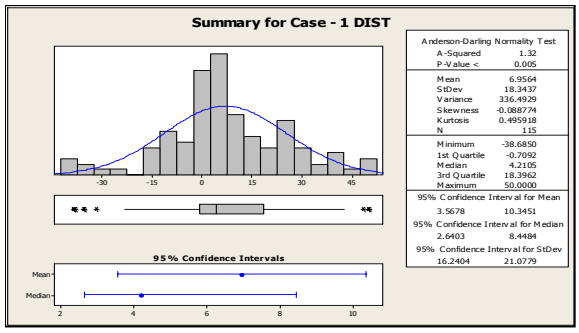
Figure 16: Sample selection of predictive bands

Note: In this case, the *'Planning Band'* has been considered as Voice of Process and is expected to be factored into normal course of Iteration Planning exercise, while for *'Risk Band'*, it would be advisable to plan for additional (contingency) reserve; as it is assumed that process is not matured enough and may still have wide variations in these range(s).

7.2 Account or Customer level

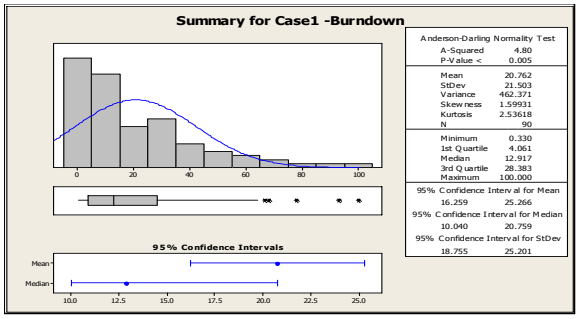
Here, all three (3) projects' data was analyzed together and consolidated, for a specific customer; similar process applied on sample outputs (Box Plot, Time Series prediction, Dot Plots and Descriptive Statistics) to come up with desired prediction band.

Probability distribution analyzed together with all deviation points (positive and negative) and also all positive and all negative separately to understand distribution patterns. As distribution found not normal, guidance is taken from other statistical analysis.



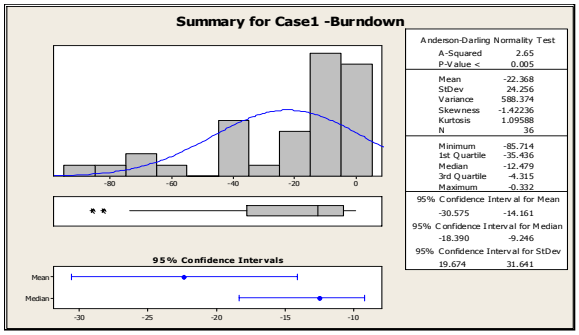
Overall Dist	Mean	Median	ST DEV		
	6.95	4.21	18.34		
95% CI	Median	LCL	UCL	1st Q	3rd Q
	4.21	2.64	8.44	-0.7	18.4

Figure 17: Overall distribution (basic statistics)



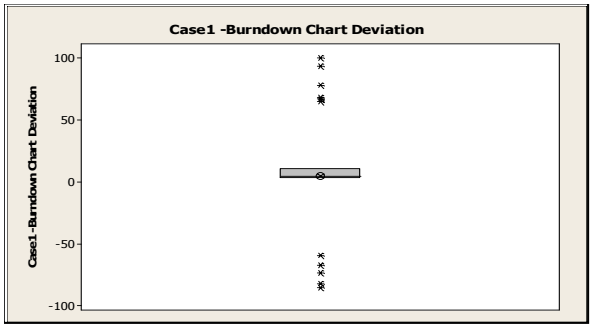
Positive Deviations	Mean	Median	ST DEV
	20.76	12.92	21.5
95% CI	Median	LCL	UCL
	12.92	10.04	20.75

Figure 18: Distribution of +VE deviations (basic statistics)



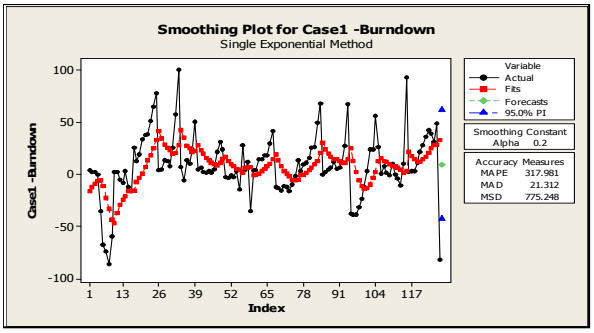
Negative Deviations	Mean	Median	ST DEV
	-22.37	-12.48	24.26
95% CI	Median	LCL	UCL
	-12.48	-9.25	-18.39

Figure 19: Distribution of -VE deviations (basic statistics)



95% CI	Median	LCL	UCL
	4.54	2.74	10.17

Figure 20: Box Plot statistics



95% CI	Predicted	LCL	UCL
	9.31	-42.81	61.52

Figure 21: Time Series (Smoothing) Plot

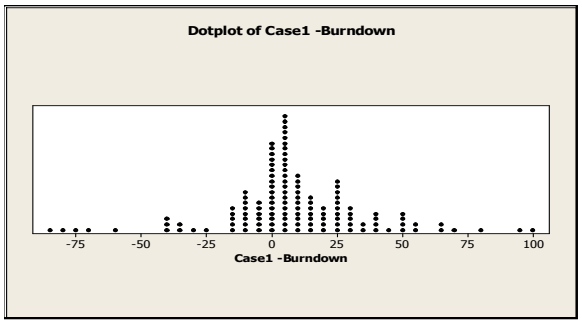


Figure 22: Dot Plot (Overall distribution)

Prediction Band	LCL	UCL
Optimistic Band	-9.25	10.17
Probable Band - Planning	-12.48	12.92
Possible Band - Risk	-18.39	20.75

Figure 23: Probable selection of three possible bands

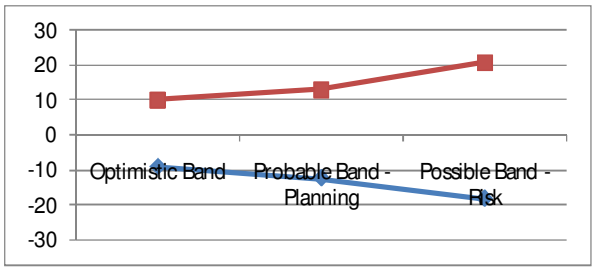


Figure 24: Graphical representation of possible bands

Notes:

i) Prediction bands, shown here, is indicative only and act as guidance, however, it may vary from project to project, customer to customer and team composition and maturity.

ii) Cells are highlighted with different colors to denote sample selection of possible prediction bands.

iii) Box plot is shown to be a good starting point taking guidance from Dot Plot to identify maximum density band.

iv) CNTL charts didn't provide useful prediction due to wide moving range variation, as deviation observed both in positive and negative direction, often.

v) Here, single exponential smoothing technique is used to observe meaningful prediction (if any), however, other variations of Time Series could also be used and accuracy measures (MAD, MAPE, MSE) could be observ

vi) Other predictive analysis techniques also could be explored for meaningful and best-fit outcome observed and found applicable.

vii) As we execute more Iteration(s), more Agile projects, calibration is required, as we gather more experience and data points.

8 Conclusions

This paper focuses on importance of analyzing Burndown chart behavior to come up with possible Prediction Band towards improving better planning and management of Iterations. Each deviation analysis helps us to identify improvement opportunities in scope/ task planning, estimation, competence, impediments, issue resolution, effort distribution, defect prevention, planning risk reserve (additional scope during iteration planning, if early finish or team sits idle etc).

9 References

[1] In-house tutorial on 'Statistical Techniques', Tata Consultancy Services Ltd., India
[2] Minitab Tool