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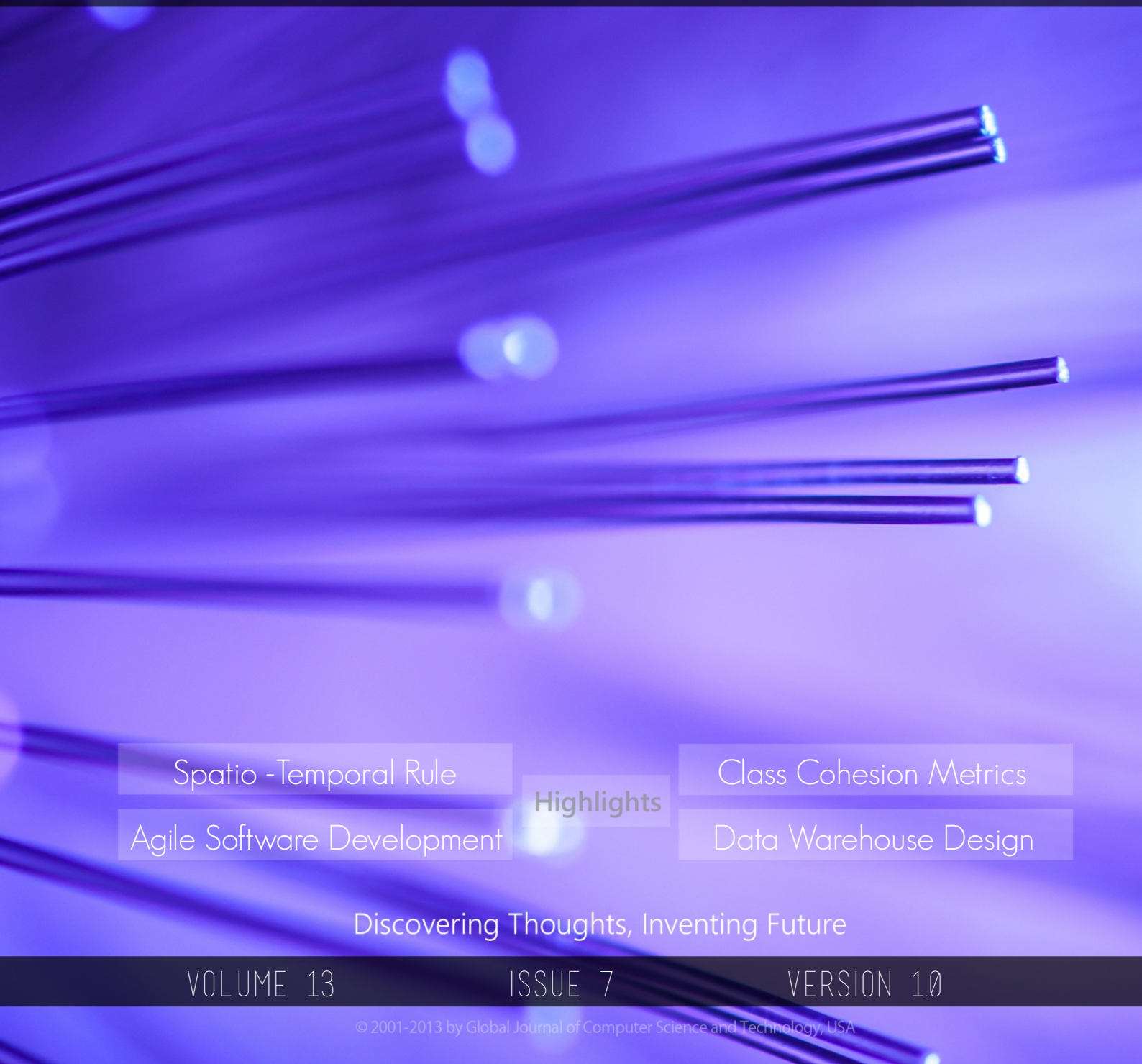

Highlights

- Spatio -Temporal Rule
- Agile Software Development
- Class Cohesion Metrics
- Data Warehouse Design

Discovering Thoughts, Inventing Future

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Reducing Testing Effort in the Test Driven Development

By Naveed Khan, Muhammad Shahid Khan, Muhammad Ahmed Javed & Muhammad Abid Khan
Gandhara University, Pakistan

Abstract - Test-driven development (TDD) is a software development process that relies on the repetition of a very short development cycle: first the developer writes a failing automated test case that defines a desired improvement or new function, and then produces code to pass that test and finally refractors the new code to acceptable standards. TDD is a good approach for the development of the new software but it is more time consuming process model when test the existing software system. In this research we are introducing a new technique which reduces the effort of the TDD approach.

GJCST-C Classification : D.2.5

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Reducing Testing Effort in the Test Driven Development

Naveed Khan [α], Muhammad Shahid Khan [σ], Muhammad Ahmed Javed [ρ] & Muhammad Abid Khan [ω]

Abstract - Test-driven development (TDD) is a software development process that relies on the repetition of a very short development cycle: first the developer writes a failing automated test case that defines a desired improvement or new function, and then produces code to pass that test and finally refractors the new code to acceptable standards.

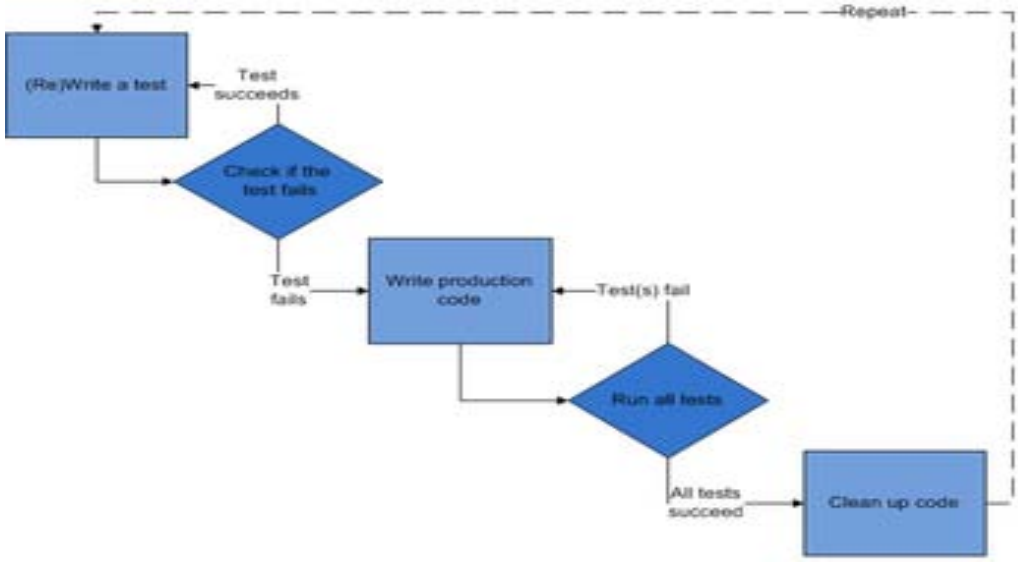
TDD is a good approach for the development of the new software but it is more time consuming process model when test the existing software system. In this research we are introducing a new technique which reduces the effort of the TDD approach.

I. Introduction

Test driven development works on test first programming concept. In test driven development the programmer writes the code and then passes the code through test. If test was successful then stop the process of testing. So pass another code of the project through test if it fails then programmer will modify the code and pass the modified code again through test. Process will repeat again and again until test of the code will be successful.

II. Research Question

The existing test driven development model for unit testing work very fine for the newly software but it is time consuming process for the existing software. In order to reduce the testing effort for the existing software in test driven development we need some improvements. Test Driven Development Model is shown bellow.



In the above model "write a test" and "write production code" a lot of typing effort is required by the programmer so testing effort will be increase if we implement this model for the existing system. Our research question is that how we reduce the testing effort in the test driven development?

III. Key Hypothesis

- For test driven development input a module of the existing system.
- Test for module performance.
- If the code of module is working fine then test is successful.
- If test is unsuccessful then Go to module library.
- So select a specfic module from the module library.
- Repeat the first step and test the selected code of the module of module library.

This research is practically is very important and challenge because in this area only newly software are tested no one work on the existing system.

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IV. Literature Review

Test-driven development (TDD) is a software development process that relies on the repetition of a very short development cycle: first the developer writes a failing automated test case that defines a desired improvement or new function, then produces code to pass that test and finally refactors the new code to acceptable standards. Kent Beck, who is credited with having developed or 'rediscovered' the technique, stated in 2003 that TDD encourages simple designs and inspires confidence.[1]

Test-driven development is related to the test-first programming concepts of extreme programming, begun in 1999,[2] but more recently has created more general interest in its own right.[3]

Programmers also apply the concept to improving and debugging legacy code developed with older techniques.[4]

A 2005 study found that using TDD meant writing more tests and, in turn, programmers who wrote more tests tended to be more productive.[7] Hypotheses relating to code quality and a more direct correlation between TDD and productivity were inconclusive.[8]

Programmers using pure TDD on new ("greenfield") projects report they only rarely feel the need to invoke a debugger. Used in conjunction with a version control system, when tests fail unexpectedly, reverting the code to the last version that passed all tests may often be more productive than debugging.[9]

Test-driven development offers more than just simple validation of correctness, but can also drive the design of a program.[10] By focusing on the test cases first, one must imagine how the functionality will be used by clients (in the first case, the test cases). So, the programmer is concerned with the interface before the implementation. This benefit is complementary to Design by Contract as it approaches code through test cases rather than through mathematical assertions or preconceptions.

Test-driven development offers the ability to take small steps when required. It allows a programmer to focus on the task at hand as the first goal is to make the test pass. Exceptional cases and error handling are not considered initially, and tests to create these extraneous circumstances are implemented separately. Test-driven development ensures in this way that all written code is covered by at least one test. This gives the programming team, and subsequent users, a greater level of confidence in the code.

While it is true that more code is required with TDD than without TDD because of the unit test code, total code implementation time is typically shorter.[11] Large numbers of tests help to limit the number of defects in the code. The early and frequent nature of the testing helps to catch defects early in the development cycle, preventing them from becoming endemic and expensive problems. Eliminating defects early in the process usually avoids lengthy and tedious debugging later in the project.

V. Working of the Proposed Model

a) Steps

- For test driven development input a module of the existing system.
- Test for module performance.
- If the code of module is working fine then test is successful.
- Otherwise test is unsuccessful.
- So select a specfic module from the module library.
- Repeat the first step and test the selected code of the module of module library.

Modules of the existing software are stored in the module library. In this way your test effort will be reduced in the existing system. You just test the module code and attach it to the specfic software.

b) Results

In this research we are testing the developed system not a newly system.

Test#	Time taken by Test Driven Development Model	Time Taken by the Proposed Model
1	5 mints= 300 sec	3sec
2	50 mints= 3000 sec	5sec
3	100 mints= 6000 sec	7 sec
4	150 mints=9000 sec	8 sec
5	200 mints=12000 sec	10sec

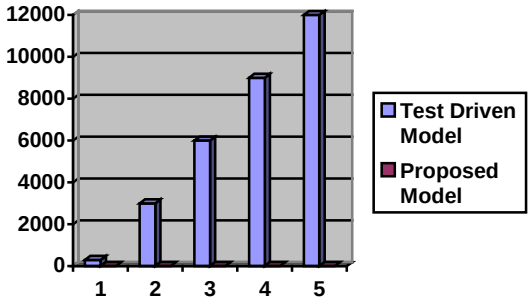

Figure 1.1 : Test cases for both test driven development model and proposed model

VI. Discussion

In the above fig(1.1) shows that proposed model is more efficient then the existing test driven development model. In these tests we write manu lay code in the test driven development model and copy and paste code in the proposed model. Because in test driven development model programmer manually write the code which is time consuming process but in the proposed model we just copy and paste code of the testing module. The above graph shows that the proposed model is 100% reduced the test effort.

VII. Conclusion

The existing test driven development model for unit testing work very fine for the newly software but it is time consuming process for the existing software. In order to reduce the testing effort for the existing software in test driven development we introduced a new approach and practically result shows that the new approach is more efficient for test driven development for the existing systems.

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Comparative Study on Agile Software Development Methodologies

By A B M Moniruzzaman & Dr. Syed Akhter Hossain
Daffodil International University, Bangladesh

Abstract - Today's business environment is very much dynamic, and organizations are constantly changing their software requirements to adjust with new environment. They also demand for fast delivery of software products as well as for accepting changing requirements. In this aspect, traditional plan-driven developments fail to meet up these requirements. Though traditional software development methodologies, such as life cycle-based structured and object oriented approaches, continue to dominate the systems development few decades and much research has done in traditional methodologies, Agile software development brings its own set of novel challenges that must be addressed to satisfy the customer through early and continuous delivery of the valuable software. It's a set of software development methods based on iterative and incremental development process, where requirements and development evolve through collaboration between self-organizing, cross-functional teams that allows rapid delivery of high quality software to meet customer needs and also accommodate changes in the requirements. In this paper, we significantly indentify and describe the major factors, that Agile development approach improves software development process to meet the rapid changing business environments. We also provide a brief comparison of agile development methodologies with traditional systems development methodologies, and discuss current state of adopting agile methodologies.

Keywords : *agile, traditional methods, agile adoption, SCRUM, XP.*

GJCST-C Classification : *D.2.9*

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Comparative Study on Agile Software Development Methodologies

A B M Moniruzzaman [α] & Dr. Syed Akhter Hossain [σ]

Abstract - Today's business environment is very much dynamic, and organizations are constantly changing their software requirements to adjust with new environment. They also demand for fast delivery of software products as well as for accepting changing requirements. In this aspect, traditional plan-driven developments fail to meet up these requirements. Though traditional software development methodologies, such as life cycle-based structured and object oriented approaches, continue to dominate the systems development few decades and much research has done in traditional methodologies, Agile software development brings its own set of novel challenges that must be addressed to satisfy the customer through early and continuous delivery of the valuable software. It's a set of software development methods based on iterative and incremental development process, where requirements and development evolve through collaboration between self-organizing, cross-functional teams that allows rapid delivery of high quality software to meet customer needs and also accommodate changes in the requirements. In this paper, we significantly indentify and describe the major factors, that Agile development approach improves software development process to meet the rapid changing business environments. We also provide a brief comparison of agile development methodologies with traditional systems development methodologies, and discuss current state of adopting agile methodologies. We speculate that from the need to satisfy the customer through early and continuous delivery of the valuable software, Agile software development is emerged as an alternative to traditional plan-based software development methods. The purpose of this paper, is to provide an in-depth understanding, the major benefits of agile development approach to software development industry, as well as provide a comparison study report of ASDM over TSDM.

Keywords : agile, traditional methods, agile adoption, SCRUM, XP.

I. Introduction

A lot of people have been asking the question "What is Agile Software Development?" and invariably they get a different definition depending on who they ask. Here's a definition that conforms to the values and principles of the Agile Manifesto[1]. An iterative and incremental (evolutionary) approach to software development which is performed in a highly collaborative manner by self-organizing teams within an effective governance framework with "just enough" ceremony that produces high quality solutions in a cost effective and timely manner which meets the changing needs of its stakeholders [6].Agile software development is actually a group of software development methods based on iterative and incremental development, where requirements and solutions evolve through collaboration between self-organizing, cross-functional teams [4]. In 2001, the "agile manifesto" was written by the practitioners reveals which items are considered valuable by ASDMs [1]. As shown in Table 1.

More Valuable Items		Less Valuable Items
Individuals and Interactions		Processes and tools
Working software	over	Comprehensive Documentation
Customer collaboration		Contract negotiation
Responding to change		Following a plan

Table 1 : Agile Manifesto (Source: [1])

a) Research Review

Agile software development (ASD) is major paradigm, in field of software engineering which has been widely adopted by the industry, and much research, publications have conducted on agile development methodologies over the past decade. The traditional way to develop software methodologies follow the generic engineering paradigm of requirements, design, build, and maintain. These methodologies are also called waterfall–based taking from the classical software development paradigm. They are also known by many other names like plan–driven, (Boehm and Turner, 2004), [39]; documentation driven, heavyweight methodologies, and big design upfront, (Boehm, 2002), [16]. Boehm and Phillip [72] report that during their project development experience, requirements often changed by 25% or more. Due to constant changes in the technology and business environments, it is a challenge for TSDMs to create a complete set of requirements up front [26]. Williams and Cockburn, [18] also mentioned that one of problems of TSDMs is the inability to respond to change that often determines the success or failure of a software product.

The agile approach to software development is based on the understanding that software requirements are dynamic, where they are driven by market forces

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(Fowler, Title 2002; Cockburn & Highsmith, 2001); [16], [36]. Agile systems development methods emerged as a response to the inability of previous plan-driven approaches to handle rapidly changing environments (Highsmith 2002), [55]. Williams and Cockburn [18] state that agile development is "about feedback and change", that agile methodologies are developed to "embrace, rather than reject, higher rates of change".

Agility is the ability to sense and response to business prospects in order to stay inventive and aggressive in an unstable and rapidly shifting business environment (Highsmith, 2002), [55]. The agile approach to development is about agility of the development process, development teams and their environment (Boehm & Turner, 2004), [39]. This approach incorporates shared ideals of various stakeholders, and a philosophy of regular providing the customers with product features in short time-frames (Southwell, 2002), [45]. This frequent and regular feature delivery is achieved by team based approach (Coram & Bohner, 2005), [47]. Agile teams consist of multi-skilled individuals (Fowler, 2002), [16]. The development teams also have on-site customers with substantial domain knowledge to help them better understand the requirements (Abrahamsson, Solo, Ronkainen, & Warsta, 2002), [37]. Multiple short development cycles also enable teams to accommodate request for change and provide the opportunity to discover emerging requirements (Highsmith, 2002), [55]. The agile approach promotes micro-project plans to help determine more accurate scheduling delivery commitments (Smits, 2006), [48].

M Lindvall, V Basili, B Boehm, P Costa, (2002), [17] summarize the working definition of agile methodologies as a group of software development processes that must be iterative (take several cycles to complete), incremental (not deliver the entire product at once), self-organizing (teams determine the best way to handle work), and emergent (processes, principles, and work structures are recognized during the project rather than predetermined). In the paper by (Abrahamsson, Warsta, Siponen & Ronkainen, 2003), in general, characterized agile software development by the following attributes: incremental, cooperative, straightforward, and adaptive [24]. Boehm, B., & Turner, R. (2005), generalize agile methods are lightweight processes that employ short iterative cycles, actively involve users to establish, prioritize, and verify requirements, and rely on a team's tacit knowledge as opposed to documentation [30].

II. Agile Methods

For over a decade now, there has been an ever increasing variety of agile methods available includes a number of specific techniques and practices of software development. Agile methods are a subset of "iterative and evolutionary methods" [83, 84] and are "based on iterative enhancement" [85] and "opportunistic development processes" [86]. Most of agile development methods promote development, teamwork, collaboration and process adaptability throughout the life-cycle of the project [4].

The major methods include eXtreme Programming (Beck, 1999), [82], Scrum (K. Schwaber & Beedle, 2002), [53], Dynamic Systems Development Method (Stapleton, 1997), Adaptive Software Development (Highsmith, 2000), Crystal (Cockburn, 2002), and Feature-Driven Development (Palmer & Felsing, 2002). [58], [59], [60], [61]. Figure 1 shows an agile software development methodology process flow (Scrum).

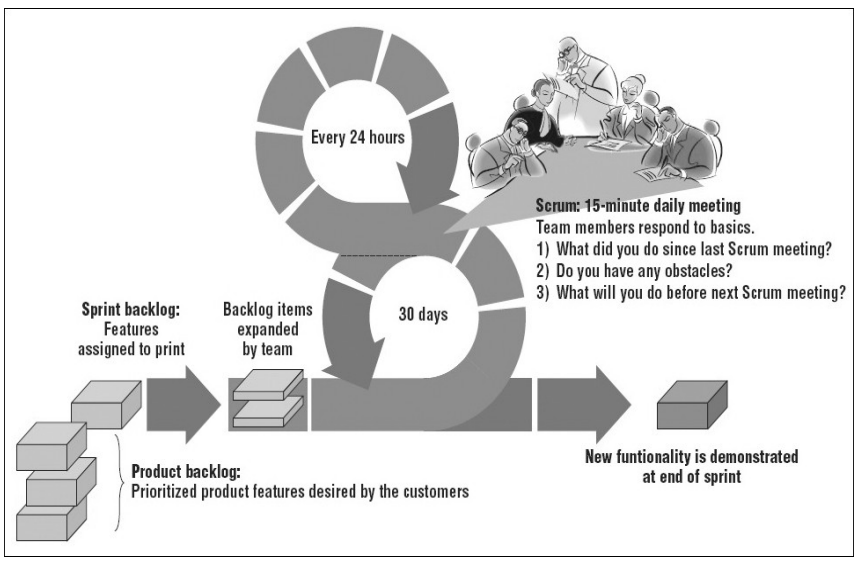
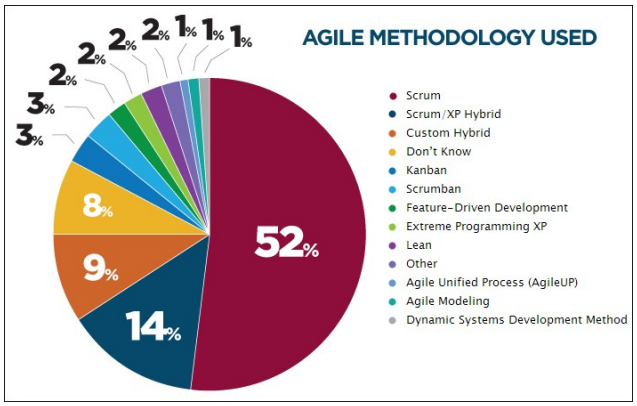


Figure 1 : An example of agile software development methodology: Scrum (Source: [53])

The Agile Manifesto articulates the common principles and beliefs underlying these methods (Cockburn, 2002), [16]. Among the first and perhaps best known agile methods are Scrum and XP (Salo, & Abrahamsson, 2008), [49]. See Figure 2 shows the current rate of Agile methodologies used. Scrum is aimed at providing an agile approach for managing software projects while increasing the probability of successful development of software, whereas XP focuses more on the project level activities of implementing software. Both approaches, however, embody the central principles of agile software development [31].

Figure 2 : State of Agile Survey Results 2011 by Version One Inc.



Source: http://www.versionone.com [10]

Agile software development processes -- such as the Rational Unified Process (RUP), Extreme Programming (XP), Agile Unified Process (AUP), Scrum, Open Unified Process (OpenUP), and even Team Software Process (TSP) -- are all iterative and incremental (evolutionary) in nature [63]. Some these modern approaches, in particular XP and Scrum, are agile in nature. The agile methods are focused on different aspects of the software development life cycle. Some focus on the practices (extreme programming, pragmatic programming, agile modeling), while others focus on managing the software projects (the scrum approach) [12].

III. Comparison Agile Software Development Methodologies over Traditional SDMs

There are many different characteristics between ASDMs and TSDMs. Boehm [16], for example, reports nine agile and heavyweight discriminators. He believes the primary objective of ASDMs is on rapid value whereas the primary objective of TSDMs is on high assurance.

Study performed S. Nerur, R. Mahapatra, G. Mangalaraj [22] state a comparison of traditional and agile development, they report seven issues to differentiate traditional and agile development. Their fundamental assumption of traditional development: "system are fully specifiable, predictable and are built through meticulous and extensive planning", whereas agile development: "high-quality adaptive software is developed by small teams using the principles of continuous design improvement and testing based on rapid feedback and change".

T. Dyba, & T. Dingsoyr, [74] summarize the differences between Agile development and traditional development basis on the of an unpredictable world, as well as emphasizing the value competent people and their relationships bring to software development. Agile methods address the challenge of an unpredictable world, emphasizing the value competent people and their relationships bring to software development [74].

Different researchers compare traditional and agile approaches, in their different perspectives, are summarized in Table 2 (All sources from additional information).

Table 2 : Traditional and agile perspectives on software development (Sources: from literature review)

Issues	Traditional Approach	Agile Approach
Development life cycle (Charvat, 2003); (Nerur, Mahapatra, & Mangalaraj,2005),[34],[22]	Linear; Life-cycle model (waterfall, spiral or some variation)	Iterative; The evolutionary-delivery model
Style of development (Leffingwell, 2007), [50]	Anticipatory	Adaptive
Requirements (Boehm, 2002); (Boehm and Turner, 2004), [16], [39]	Knowable early, largely stable; Clearly defined and documented	Emergent, rapid change, unknown – Discovered during the project
Architecture (Boehm, 2002); (Wysocki, 2009, 2011) , [16], [56]	Heavyweight architecture for current and future requirements	YAGNI precept ("You aren't going to need it")
Management (Boehm, & Turner, 2005), (Vinekar, Slinkman,& Nerur, 2006),[30], [51]	Process-centric; Command and control	People-centric; Leadership and collaboration
Documentation (Boehm and Turner, 2005) ,[30]	Heavy / detailed Explicit knowledge	Light (replaced by face to face communication) Tacit knowledge
Goal (Dybå & Dingsøyr, 2009), [74]	Predictability and optimization	Exploration or adaptation
Change (Boehm and Turner, 2003), [19]	Tend to be change averse	Embrace change
Team members (Boehm, 2002) , (Sherehiy, Karwowski, & Layer, 2007), [16], [41]	Distributed teams of specialists; Plan-oriented, adequate skills access to external knowledge	Agile, knowledgeable, collocated and collaborative; Co-location of generalist senior technical staff;
Team organization (Leffingwell, 2007), [52]	Pre-structured teams	Self-organizing teams
Client Involvement (Highsmith & Cockburn, 2001), [21]	Low involvement; Passive	Client onsite and considered as a team member; Active/proactive
Organization culture (Highsmith, 2002) , (Nerur, Mahapatra, Mangalaraj, 2005), [55], [22]	Command and Control Culture	Leadership and Collaboration Culture
Software development process (Salo, & Abrahamsson, 2007), [42]	Universal approach and solution to provide predictability and high assurance	Flexible approach adapted with collective understanding of contextual needs to provide faster development
Measure of success (Highsmith, 2010), [1]	Conformance to plan	Business value delivered

a) Major agile benefits in comparison to the traditional approach

In this section, we presenting list and explain some of agile benefits in comparison to the traditional approach which significantly improves software development in many ways. We try to provide an in-depth understanding (in some cases with figures), of these merit issues:

i. *Evolutionary Approach*

Agile software development is a highly collaborative and evolutionary approach [101]. Agile methods become more popular in the software development industry. In their different research papers, (Boehm, & Turner, 2005; Larman & Basili, 2003; Greer, & Ruhe, 2004; Dybå, & Dingsøyr, 2008; Paetsch, Eberlein, 2003; Abrahamsson, Warsta, 2003; Dagnino, 2002), they believe, Agile methods are iterative, evolutionary, and incremental delivery model of software development [30], [79], [29], [20], [80], [24], [81].

Entire application is distributed in incremental units called as iteration. Development time of each iteration is small (couple of weeks), fixed and strictly adhered to. Each iteration is a mini increment of the functionality and is build on top of previous iteration. Agile software development of short iterative cycles offers an opportunity for rapid, visible and motivating software process improvement [75]. Traditional approaches to the data-oriented aspects of software development; however, tend to be serial, not evolutionary and certainly not agile, in nature.

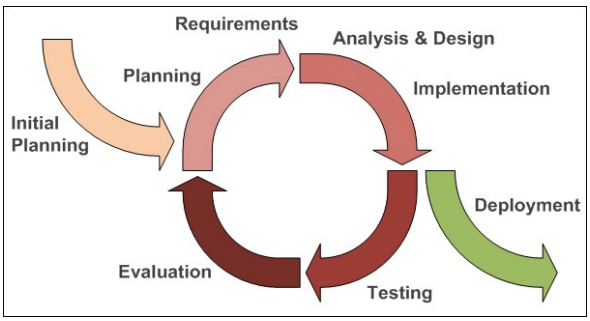


Figure 3 : Iterative and incremental agile development process (source: agile-development-tools.com)

ii. *Lightweight Methods*

Boehm, B., & Turner, R. (2005), generalize agile methods are lightweight processes that employ short iterative cycles, actively involve users to establish, prioritize, and verify requirements, and rely on a team's tacit knowledge as opposed to documentation [30]. G Perera, & MSD Fernando (2007), also describe Agile practice is a customer oriented, light-weight software development paradigm, best suited for small size development teams in projects under vague and changing requirements [65]. A number of agile software development methods such as extreme programming (XP), feature-driven development, crystal clear method, scrum, dynamic systems development, and adaptive software development, fall into this category [22]. Traditional Software Development Methods (TSDMs) including waterfall and spiral models are often called heavyweight development methods [26]. These methods involves extensive planning, predefine process phases, heavy documentation and long term design process. Lightweight methodologies put extreme emphasis on delivering working code or product while downplaying the importance of formal process and comprehensive documentation [23].

iii. *Rapid delivery of software products*

Agile development methodologies emphasize rapid delivery of software products to the clients. According to (Boehm & Turner, 2005), Fast cycles, frequent delivery: Scheduling many releases with short time spans between them forces implementation of only the highest priority functions, delivers value to the customer quickly, and speeds requirements emergence [30]. ASD methods are iterative and incremental development [4], and each successful completion of development iteration, it delivers software product increment to client, thus Agile software development is satisfying the customer through early and continuous delivery of the valuable software [66]. Traditional, lifecycle based software development delivers the software only after entire completion of development process and before that clients have no clear idea and view of software to be developed.

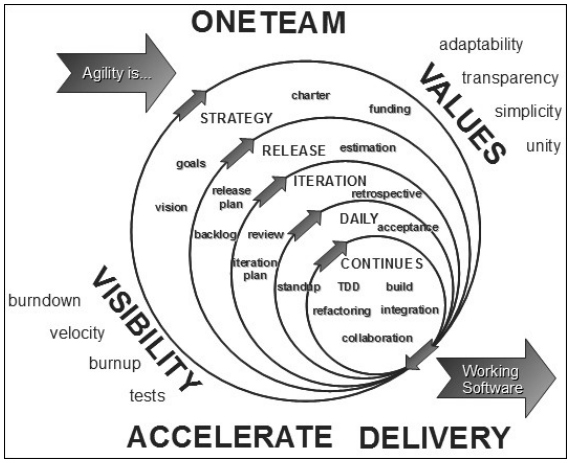


Figure 4 : Iterative process and incremental delivery software products (source: [4])

iv. *Highly tolerant of change requirements*

The main difference between heavyweight and agile methodologies is the acceptance of change. It is the ability to respond to change that often determines the success or failure of a software project [18]. Heavyweight methods freeze product functionality and disallow change. Agile systems development methods emerged as a response to the inability of previous plan-driven approaches to handle rapidly changing environments (Highsmith, 2002). As second principle of Agile Manifesto [1] - ―welcome changing requirements, even late in development‖, all agile method(s) is well organized, accommodate to change requirements. According to B. Boehm, (2002), organizations ―are complex adaptive systems in which requirements are emergent rather than pre-specifiable‖ and agile approaches ―are most applicable to turbulent, high-change environments‖ [16]. Agile software development promotes adaptive planning, evolutionary development and delivery, and encourages rapid and flexible response to change [4].

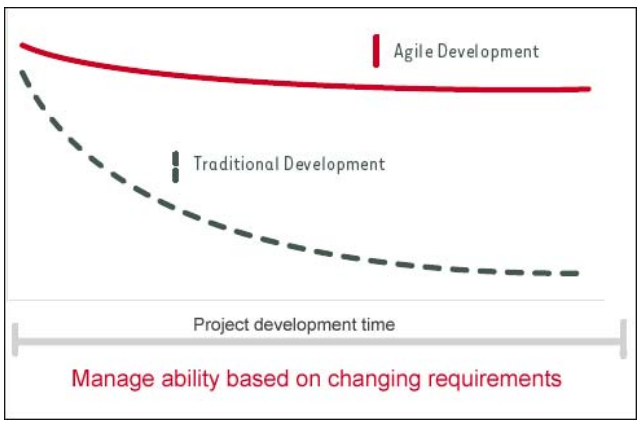


Figure 5 : Agile vs. traditional requirements change management (Source: www.versionone.com)

Agile development inherently welcomes requirement changes as well as inclusion or exclusion of features throughout the development lifecycle. It is possible to accept requirement changes while in development phases because of iterative developments involve with agile development approach. As a result of this iterative planning and feedback loop, teams are able to continuously align the delivered software with desired business needs, easily adapting to changing requirements throughout the process.

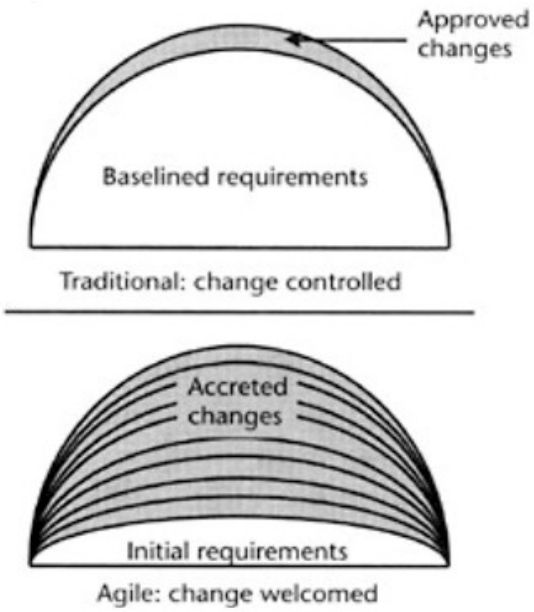


Figure 6 : Agile vs. traditional requirements change management (source: [57])

In contrast, agile development framework allows both customers and developers to change the requirements throughout the project, but only the customers have the authority to approve, disapprove and prioritize the ever-changing requirements (Koch, 2005), [57]. In traditional SDMs it increases complexity for accepting changing requirements while developing, and also increases development and delivery time, as well as cost to deliver software product.

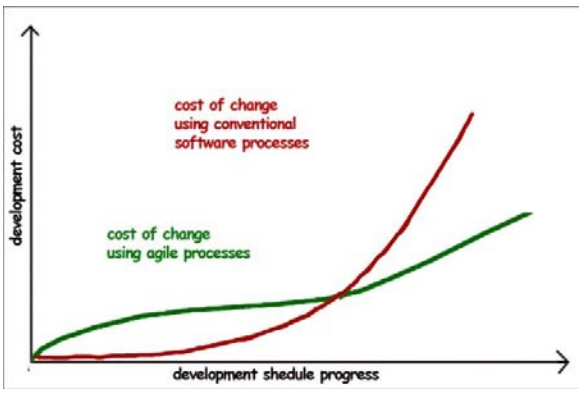


Figure 7 : Cost of change for agile and conventional development process

v. *Accept prioritizing requirements*

In agile software development, requirements always provided by client and these requirement features are prioritized by client itself. Agile methods break development tasks into small increments with minimal planning and do not directly involve long-term planning. Iterations are short time phases that typically last from one to four weeks. Thus, top prioritized features can be delivered each of development iteration. Agile requirements prioritization techniques to support and deal with frequent changes in priority lists which have been identified as success issue to accommodate over changes [73]. In traditional development, software product with all features will be delivered at a time only after completion of software project.

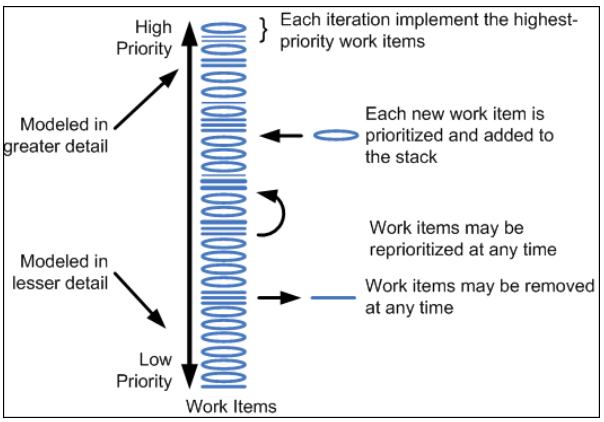


Figure 8 : Agile approach prioritized requirements (Source: www.agilemodeling.com [6])

vi. *Active customer involvement & feedback*

Customers are actively involved, and get higher priority in agile approaches rather than any traditional approaches. There is face to face communication and continuous feedback from customer (product owner) always happen in agile approach.

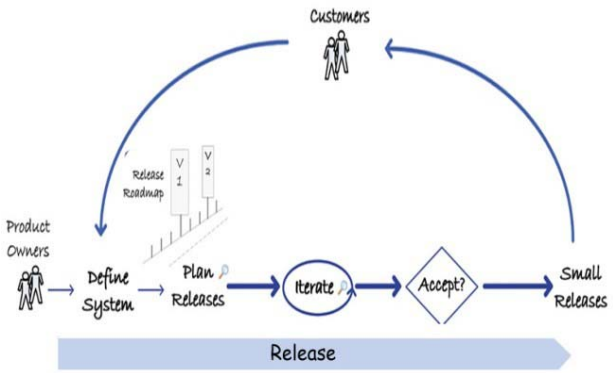


Figure 9 : Active customer involvement in agile approach

Customers appreciate active participation in projects as it allows them to control the project and development process is more visible to them, as well as, they are kept up to date [73]. This customer involvement

mitigates one of the most consistent problems on software projects: "What they will accept at the end of the project differs from what they told us at the beginning". This interaction helps the customer to form a better vision of the emerging product. Along with the ability to visualize the functionality that is coming based on having seen what was built so far, the customers develop a better understanding of their own needs and the vocabulary to express it to the developers [9]. Agile projects require a meaningful client involvement in every part of the project to provide constant feedback in an open and honest way (Wysocki, 2009), [57]. This feedback is a key element of agile methodologies, which is why the customer must be committed, knowledgeable, collaborative, representative, and empowered to avoid risk of failure (Boehm, 2002), [16]. People are the primary drivers of agile projects and agile teams work best when people are physically close and document preparation and dissemination are largely replaced by face-to-face communication and collaboration (Cockburn & Highsmith, 2001), [21].

vii. *Reduce cost and time*

The study reports conducted by B. Bahli and ESA Zeid [77] that the development team found using the waterfall model to be an "unpleasant experience", while XP (an agile method) was found to be "beneficial and a good move from management". The XP project was delivered a bit less late (50% time-overrun, versus 60% for the traditional), and at a significantly reduced cost overrun (25%, compared to 50% cost overrun for the traditional project). Agile development involves less cost of development as rework, management, documentation and other non-development work related cost is reduced.

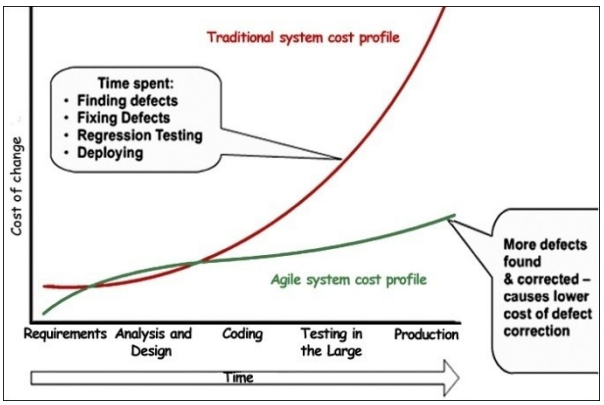


Figure 10 : Cost for agile development process and conventional development
(Source: http://www.thoughtworks.com)

viii. *Short design phase involves early feedback from clients*

In traditional, lifecycle based developments usually follow Big Design Up Front and Big Requirements Up Front development techniques. With these approaches, comprehensive requirements document and design document are developed early in the project lifecycle which is used to guide the design and implementation efforts. It is typically months, if not years, before stakeholders are shown working software which implements their requirements and design. In terms of the traditional project phases (requirements, analysis, architecture, design) these take sixty percentage development time of project and still then there is no working software is ready for the client feedback.

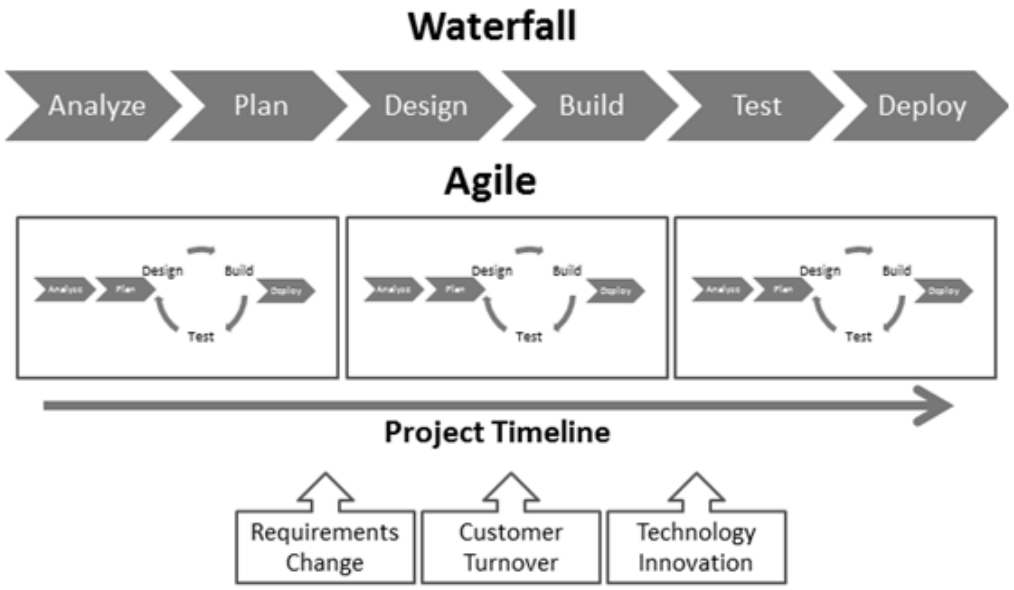


Figure 11 : Design phase composition between waterfall and agile development

According to (Boehm & Turner, 2005), agile approach design is simple which involves Designing for the battle, not the war. The motto is YAGNI (You Aren't Going to Need It). The antimotto is BDUF (Big Design Up Front). Strip designs down to cover just what you're developing. Since change is inevitable, planning for future functions is a waste of effort [30]. Customer gets to know regular and frequent status of the application and delivery is defined by fixed timescale. So, customer is assured of receiving some functionality by a fixed time period. Due to the short development life cycle through an iterative and incremental process, the agile methods have been used widely in business sectors where requirements are relatively unstable [26].

ix. *Self organized team*

Agile teams are self organizing and roles and relationships evolve as necessary to meet objectives (Leffingwell, 2007). Team composition in an agile project is usually cross-functional and self-organizing, without consideration for any existing corporate hierarchy or the corporate roles of team members [4]. Agile product development practices introduce changes in team culture in an attempt to bringing reciprocal effects of roalty and commitment to the team and projects (Sherehiy, Karwowski, & Layer, 2007). Team members normally take responsibility for tasks that deliver the functionality an iteration requires. They decide individually how to meet an iteration's requirements. Teams develop applications collaboratively and in cooperative environment. Agile alliance [5], claims that for a given problem size, "fewer people are needed if a lighter methodology is used, and more people are needed if a heavier methodology is used," and asserts that, "There is a limit to the size of problem that can be solved with a given number of people" [44].

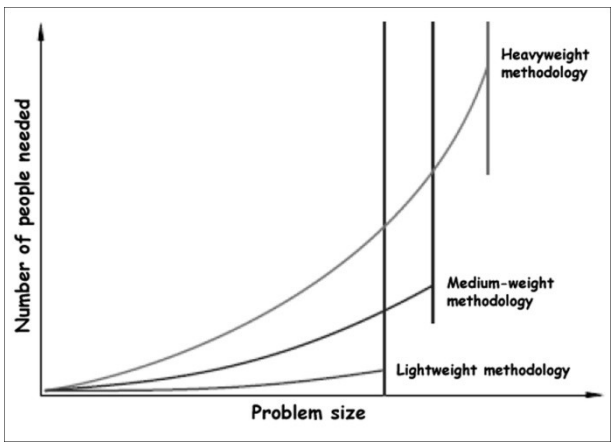


Figure 12 : Problem size; number of people needed
(Source: Cockburn, 2007)

x. *Documentation*

Agile development improvement in productivity, reduction development cost and reduction in time-to-market (Reifer, 2002), [40]. Agile approaches, emphasis more is on developing the application only, and not on documentation. According to Wysocki, non-value-added work involves the consumption of resources (usually people and time) on activities that do not add business value to the final product or process [56]. Simple and minimal documents are used to exchange the views. Reducing intermediate artifacts that do not add value to the final deliverable means more resources can be devoted to the development of the product itself and it can be completed sooner.

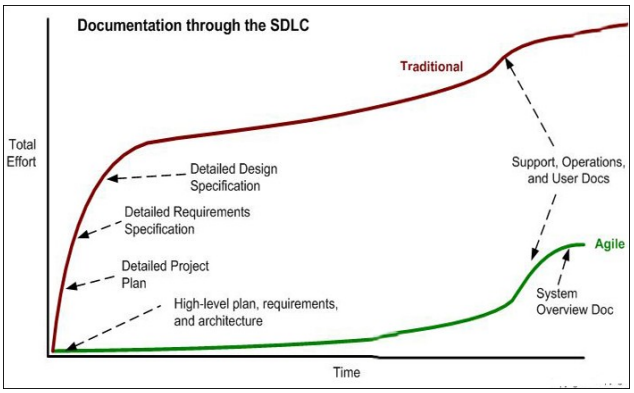


Figure 13 : Agile vs. Traditional development documentation through the SDLC
(Source: www.agilemodeling.com [6])

xi. *Design Simplicity*

According to (Boehm & Turner, 2005), agile approach design is simple which involves Designing for the battle, not the war. The motto is YAGNI (You Aren't Going to Need It). The anti-motto is BDUF (Big Design Up Front). Strip designs down to cover just what you're developing. Since change is inevitable, planning for future functions is a waste of effort [30]. In their research paper [46], (K Molokken & Ostvold, 2005), define agile method(s) as a flexible software development model(s), basis on evolutionary and incremental models; and also claim that, among the benefits of using these models are reduced software project overruns.

xii. *Improves Software Quality*

Boehm, B., & Turner, R. (2004, May), Agile development methodologies (such as XP, Scrum, and ASD) promise higher customer satisfaction, lower defect rates, faster development times and a solution to rapidly changing requirements. Plan-driven approaches such as Cleanroom, the Personal Software Process, or methods based on the Capability Maturity Model promise predictability, stability, and high assurance [38].

The regular and continuous interaction between the customer and the developers have as their primary objective assuring that the product as built does what the customer needs for it to do and assures the usability of the product as well. The strong technical focus results in much better testing on an Agile project than in most other methods [9]. According to Charvat, (2003), agile practices: iterative and adaptive life cycles have the

advantage of a continual testing throughout the project, which has a positive impact on quality [43].

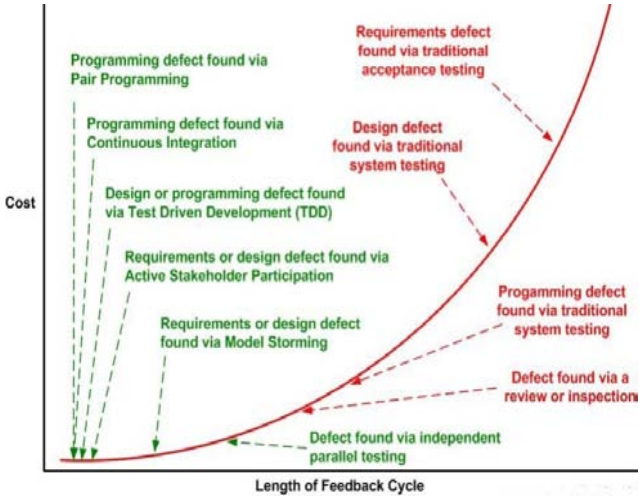


Figure 14 : Comparison of feedback cycles with traditional approaches
(Source: http://www.ambysoft.com)

Agile developers take responsibility for the quality of the code they write. In addition to producing cleaner code, it means that if there are testing specialists on the project, they will start their testing with better software, which always results in more effective testing and a better resulting product. In addition to, developers value the technical focus on testing and refactoring of agile methods increasing their motivation. There is also a perception of increased quality in software products and higher productivity when using some agile teams use practices like coding standards, peer reviews, and pair programming to assure that the code they produce is technically solid [73].

xiii. *Increase business value, visibility, adaptability and reduce cost*

Agile software development accelerates the delivery of initial business value, and through a process of continuous planning and feedback, ensures that value continues to be maximized throughout the development process. ASD provides customer satisfaction through collaboration and frequent delivery of implemented features. By delivering working, tested, deployable software on an incremental basis, agile development delivers increased value, visibility and adaptability much earlier in the life cycle, significantly reducing project risk.

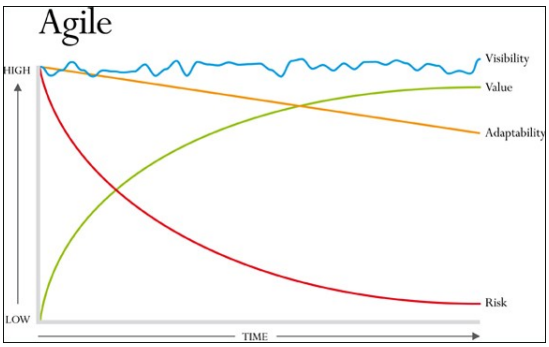


Figure 15 : Agile development value proposition
(Source: [10])

xiv. *Success Possibility Increased*

According to various studies, almost 70% of all software projects fail. Materially fail to meet their objectives, in terms of cost, time, features, or all of the above. Traditional methods of managing software delivery have failed to deliver the predictability they promise. Agile practices benefit in terms of increased project success rate and user acceptance, better risk management, delivery of quality content on time and most important adjust to changing requirements [66].

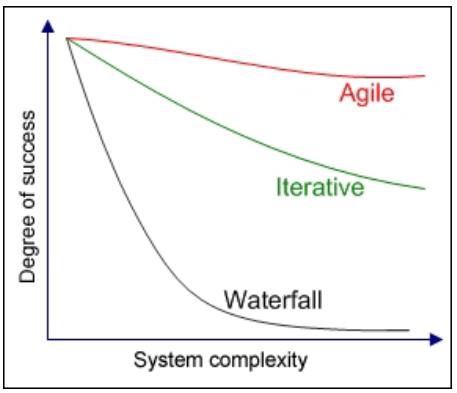


Figure 17 : Agile development degree of success

In a study by Boehm and Papaccio [72] discovered that a typical project experiences a 25% change in requirements, while yet another [Johnson] showed that 45% of features were never used. Agile approach aims to reduce waste and over-production by determining which parts are actually needed by the customer at each stage. In Agile approaches, delivering software on an incremental basis, customers give continuous feedback and agile team will always deliver products on time and on budget. As traditional project management isn't succeeding, more and more companies are turning to Agile development. According to the Standish Group's, [11] famous CHAOS Report of 2000, 25% of all projects fail outright through eventual cancellation, with no useful software deployed. Sadly, this represents a big improvement over CHAOS reports from past years. Recently, they conduct a survey for Agile implementation success rate, see figure 19.

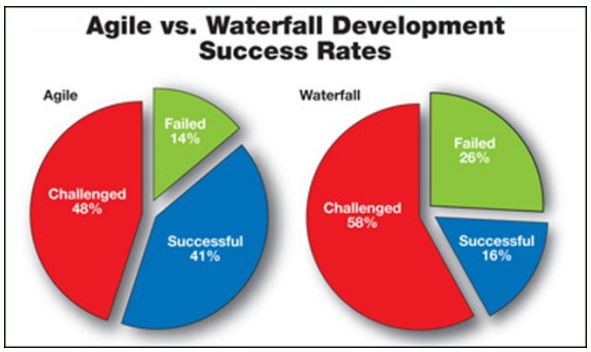


Figure 19 : Agile implementation success rate by The Standish group
(Source: http://bolg.standishgroup.com/) [11]

Survey result shows: most of the clients are asking for Agile implementation due to unprecedented benefits of Agile, over the other methodology, such as time to market, quality, defect rate, customer satisfaction, continuous end user feedback. This requires vendors to quickly turnaround and respond, to market demands, which eventually forces the organization to reevaluate the present onshore-offshore model.

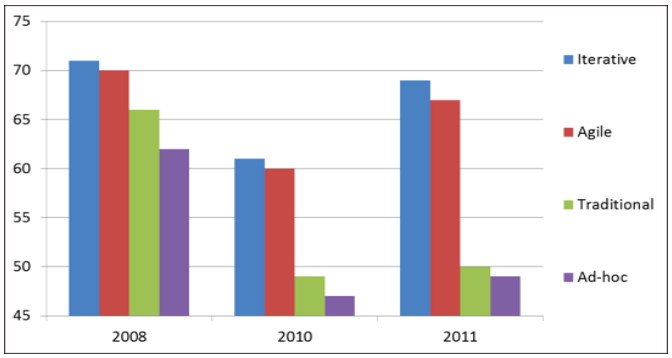


Figure 20 : Agile projects success rate by Scott Ambler
(Source: www.ambysoft.com/surveys/)

Another survey conducted by Scott Ambler has consistently (2008, 2010 & 2011) shown that Agile and Iterative Projects have been more successful. Apart from the fact that Agile has been consistently been more successful compared to traditional approach.

IV. Agile Adoption

Agile methods are highly being adopted because of expectations that these methods can bring development success (Esfahani, Yu, & Annosi, 2010). One of the main reasons for success with agile methods is that they are highly adaptive (Boehm & Turner, 2003), [38]. Figure 1 reveals the current levels of agile adoption. In this case, 71% of respondents indicated that they work in organizations that have succeeded at agile and an additional 15% work in organizations that have tried agile but have not yet succeed at it.

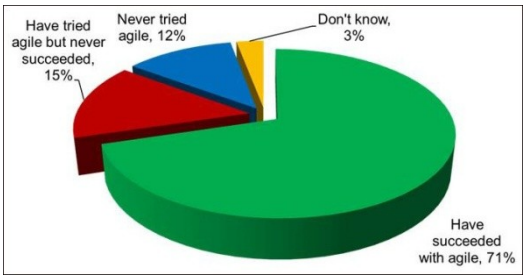


Figure 21 : Agile adoption rates
(Source: http://www.ambysoft.com/surveys)

Salo, O., & Abrahamsson, P. (2008), argue that scientific publications and anecdotal evidence demonstrate that organizations worldwide are adopting agile software development methods at increasing speed [31]. In the study report, conducted by Forrester Research in 2011, agile development approaches adoption increases 35.4% to 38.6% whether as, traditional as well as, iterative approaches decreases. See figure 0.

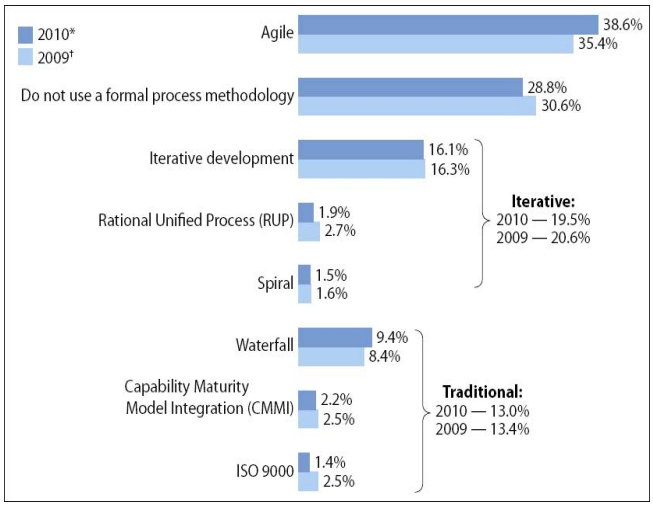


Figure 22 : Forrester Research Agile Adoption rate rises
(Source: http://www.forrester.com [13])

According to (West & Grant, 2010), "in the past few years, Agile processes have not only gained increasing adoption levels; they have also rapidly joined the mainstream of development approaches" [28]. Mary large companies including HP, IBM, Oracle, and Microsoft use Agile methodologies [76] — and more and more smaller organisations turn Agile each year. In their study (West & Grant, 2010), conducted by Forrester Research in 2009, agile software development processes were in use in 35% of organizations, and another 16% of organizations used an iterative development approach, while only 13% of organization use a Waterfall approach. However, nearly 31% did not use a formal development methodology [28].

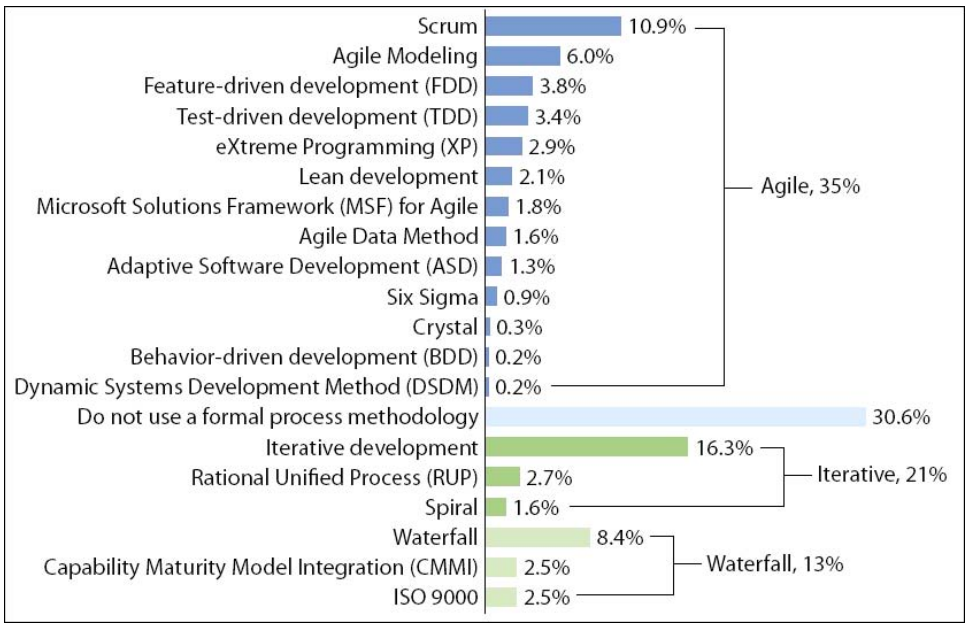


Figure 23 : Agile adoption rates by Forrester Research in 2009 (Source: [28])

The main reasons behind for adopting Agile approaches rather than plan-driven approaches relate to: rapid changes; need for rapid results; emergent requirements (Boehm & Turner, 2003), [38]. According to Charvat, (2003), Leffingwell, (2007), & Perrin, (2008), Agile methodologies have numerous advantages including that they: adapt very well to change and dynamism; are people-oriented and value-driven, rather than process-oriented and plan-driven; mitigate risks by demonstrating values and functionalities up front in the development process; provide a faster time to market; improve productivity (by reducing the amount of documentation) and will fail early/quickly and painlessly, if a project is not doable [34], [33], [32].

A state of Agile survey 2011, conducted by versionone Inc. result shows: the top three reasons for adopting Agile to - accelerate time to market, increase productivity, and to more easily manage changing priorities.

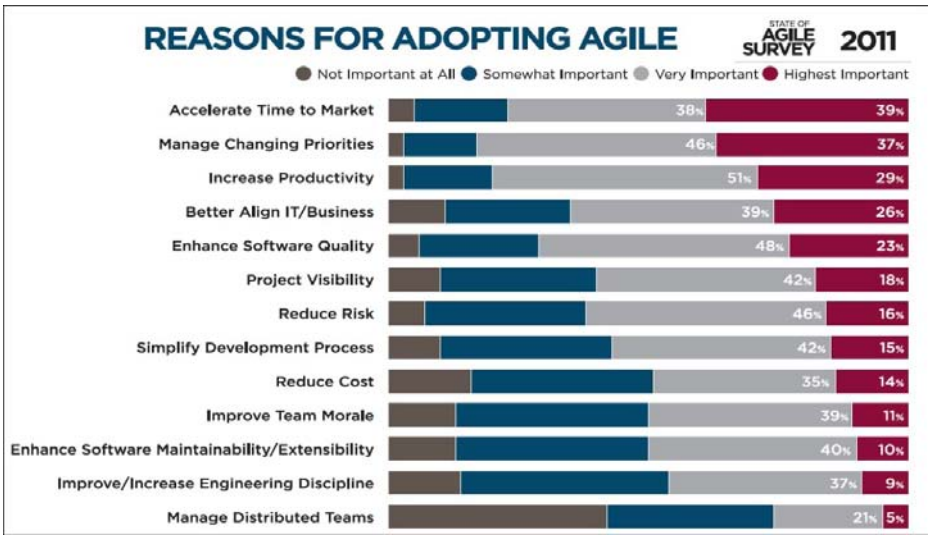


Figure 24 : Reasons for adopting Agile from "A state of Agile survey 2011" (Source: www.versionone.com)

Prior to adoption, respondents said productivity and time to market ranked as their top reasons to adopt agile. But experienced agile users said actual benefits were primarily project visibility (77%) and the ability to manage changing priorities (84%). 5. Conclusion Agile software development methodologies are evolutionary and incremental models have become increasingly popular in software development industry. Through, in many organizations, agile system development methods at adoption stage, agile methods might start to become well-established processes of these small, mid-level, even large organizations. There is increasing need to have a deeper understanding of agile methods in use in software development industry; as well as, have a better

understanding – the benefits of agile approach as for accepting agile methods into their development style and for cope-up with their dynamic business needs. In this paper, we present main issues of agile numerous benefits in comparison to the traditional approach which significantly improves software development process in many ways. We also provide with this paper, the current adoption state of Agile software development with different current survey results with graphs. The purpose of this paper is to provide an in-depth understanding-the benefits of agile development approach into the software development industry, as well as provide a comparison study report of ASDM over TSDM.

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Next Generation Data Warehouse Design with Big Data for Big Analytics and Better Insights

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Abstract - Traditionally organizations invested more in decision support systems. With the evolution of business intelligence tools many organizations were able to get analytical reports based on OLAP systems. Now with the frequently changing trends in customer behaviour and customer markets there is a huge necessity for enterprises to get analytical reports beyond OLAP system based analysis. There is huge innovation in the area of hardware and software which helps enterprises to gain advantage of all available formats of data and help enterprise to get business insights based on that data. Big data is one of the key factors to be focused which can help to get real time analytics on all available formats of data. This document presents the overview of the next generation data warehouse architecture based on Big data for better business insights.

Keywords : *big data, big data analytics, business i ntelligence, real time analytics.*

GJCST-C Classification *: D.2.11*

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I. Introduction

Organizations are now generating and recording huge volume of data. There are many business intelligence tools available which could extract these data and provide analytical reports for better decision making. But the business is changing now, consumers buying behaviours are changing rapidly, the market is unpredictable which all makes a necessity to further make use of all forms of data that is available. The organizations in future will succeed if its executives can reliably forecast the future demand and based on that effectively asses the alternative business strategies and implement them with optimal technology and right business solutions. Many enterprises now record terabytes, peta bytes of data. These data are left unanalyzed. With the huge growth in the internet based enterprises and availability of many social networks there is huge volume of data that is available for analysis. Though there are enough business intelligence and reporting tools available for analytical reporting purpose these data are not considered for the analytics purpose.

When we think about these unused data now it creates a Question.

"Will it be possible to have analytical reports based on these Big data, is there any scope for Big data analytics which could provide further insights into the business and help organizations to utilize the full potential of data that is ;;abundantly available?"

If it is possible to achieve this type of analytical reporting based on the Big data as a business intelligence tool it will be a step towards next generation data warehouse design and this will enable business and users to react to business events more quickly through the insights provided by big data and with availability of real–time analysis over big data will help management to take analytical decision with innovative ideas and critical business decisions in real time.

II. Introduction to Big Data

Your Gartner defines big data as below [1]"Big data is high-volume, high-velocity and high-variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making".

When termed about variety companies are digging out amazing insights from text, locations or log files. Elevator logs help to predict vacated real estate, shoplifters tweet about stolen goods right next to the store, emails contain communication patterns of successful projects. Most of this data already belongs to organizations, but it is sitting there unused — that's why Gartner calls it dark data. Similar to dark matter in physics, dark data cannot be seen directly, yet it is the bulk of the organizational universe. [2]

When termed about velocity it is frequently equated to real time analytics. Yet, velocity is also about the rate of changes, about linking data sets that are coming with different speeds and about bursts of activities [2]

Volume is about the number of big data mentions in the social media [2]

Every day, enterprisers create 2.5 quintillion bytes of data so much that 90% of the data in the world today has been created in the last two years alone. This data comes from everywhere: sensors used to gather climate information, posts to social media sites, digital pictures and videos, purchase transaction records, and cell phone GPS signals to name a few. This data is big

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data [3]. Hence Big data is more than simply a matter of size; it is an opportunity to find insights in new and emerging types of data and content, to make your business more agile and to answer questions that were previously considered beyond your reach. Until now, there was no practical way to harvest this opportunity [3]

Just how big a phenomenon big data actually is was eloquently captured in a remark by Google's Eric Schmidt. He pointed out that we are creating as much information every two days as we did from the dawn of civilization up until 2003. On a daily basis, this translates into around 2.5 Exabyte's of data. [4]

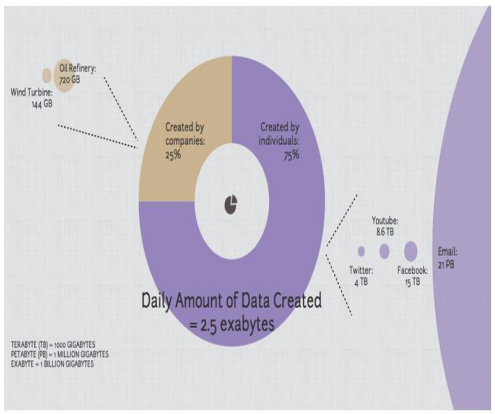

Figure 1 : Daily Amount of Data Created [5]

Upon checking the Facebook for the data manipulated per day Facebook recently gave a look into the massive amount of data that the company has to deal with on a daily basis [6]

Figure 2 : Facebook data per day [7]

III. Big Data Analytics

Big Data is everywhere, from sensors that monitor and manage traffic loads to the flood of tweets and Facebook "likes." But how do organizations make sense of the mountain of structured and unstructured data that now shape how world work, live and play? More importantly, how do they sort through a maze of information in different data structures, formats and sources that traditionally was presented in mind-numbing tabular formats and one dimensional pie charts? [8]

Big data analytics is where advanced analytic techniques operate on big data sets. Hence, big data analytics is really about two things—big data and analytics—plus how the twohave teamed up to create one of the most profound trends inbusiness intelligence (BI) today. Let's start by definingadvanced analytics, then move on to big data and thecombination of the two.[9]

New and evolving analytical processing technologies now make possible what was not possible before. Examples include: [10]

- New systems that handle a wide variety of data from sensor data to web and social media data. Improved analytical capabilities (sometimes called advanced analytics) including event, predictive and text analytics.
- Operational business intelligence that improves business agility by enabling automated real-time actions and intraday decision making.
- Faster hardware ranging from faster multi-core processors and large memory spaces, to solid-state drives and virtual data storage for handling hot and cold data.

Cloud computing including on-demand software-as a service (SaaS) analytical solutions in public clouds and data platforms and virtualization in private clouds.

The architecture of the big data will be like this given below:

- The data can be extracted from multiple sources such as unstructured data across net, Internet based data and various data from social networking sites etc.
- The data is stored and cleansed as the same process of the traditional data warehouse system.
- The big data is then used for the analytical reporting purpose.
- The data is taken from within and outside of the organization
- When there is an system that is optimized for these kind of acquiring, cleansing and storing it will be very effective.

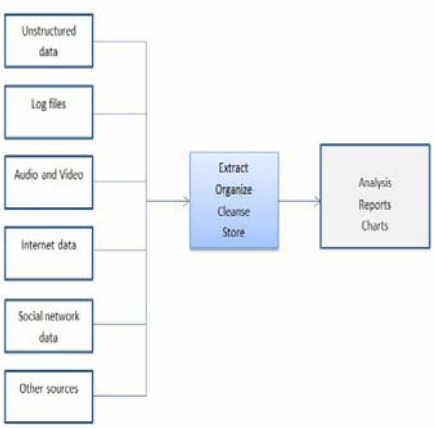

Figure 3 : Architecture of Big Data Analytics

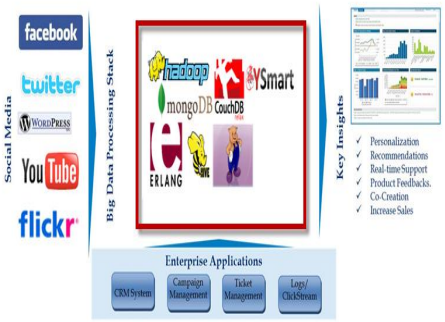

Figure 4 : Big data and social media [10]

IV. Need for Big Data Analytics

Companies are capturing and digitizing more information than ever before. According to IDC, the world produced approximately 1.8 zetta byte's of data in 2011. Fuelling this data explosion are over 5 billion mobile phones, 30 billion pieces of content shared on Facebook per month, 20 billion internet searches per month, and millions of networked sensors connected to mobile phones, energy meters, automobiles, shipping containers, retail packaging and more. As the volume of data continues to grow, businesses struggle to get the right information at the right time to remain relevant. Big data is a platform for transforming all of this data into action able intelligence for business decision making [11].

Between now and 2020, the sheer volume of digital information is predicted to increase to 35 trillion gigabytes –much of it coming from new sources including blogs, social media, internet search, and sensor networks. [12]

The way organizations do business is changing rapidly much business try to predict the frequently changing consumer behaviour. With the huge growth in internet and huge volume of data accumulated through the social networking sites makes it an advantage for large enterprise to drill down to get more detailed analytical reports.

Big data can and will impact every nation, industry, company and individual around the globe, whether it's in terms of understanding our galaxy, optimizing healthcare, selecting an ideal retail location or finding the perfect date.

A study by McKinsey Global Institute estimates that big data can add $300 billion worth of value to the US healthcare system and can increase retailers' operating margins by as much as 60%.[13] There is no doubt that those who collect, analyze and act on their data success fully will gain a competitive advantage in their market.

V. Big Data Analytics Adoption

In March 2012, The White House announced a national "Big Data Initiative" that consisted of six Federal departments and agencies committing more than $200 million to big data research projects.[14]

The initiative included a National Science Foundation "Expeditions in Computing" grant of $10 million over 5years to the AMPLab [15] at the University of California, Berkeley.[16] The AMPLab also received funds from DARPA, and over a dozen industrial sponsors and uses big data to attack a wide range of problems from predicting traffic congestion[17] to fighting cancer.[18]

The White House Big Data Initiative also included a commitment by the Department of Energy to provide $25million in funding over 5 years to establish the Scalable Data Management, Analysis and Visualization (SDAV)Institute,[19] led by the Energy Department's Lawrence Berkeley National Laboratory. The SDAV Institute aims to bring together the expertise of six national laboratories and seven universities to develop new tools to help scientists manage and visualize data on the Department's supercomputers.

The U.S. state of Massachusetts announced the Massachusetts Big Data Initiative in May 2012, which provides funding from the state government and private companies to a variety of research institutions.[20] The Massachusetts Institute of Technology hosts the Intel Science and Technology Center for Big Data in the MIT Computer Science and Artificial Intelligence Laboratory, combining government, corporate, and institutional funding and research efforts.[21]

The European Commission is funding a 2-year-long Big Data Public Private Forum through their Seventh Framework Program to engage companies, academics and other stakeholders in discussing Big Data issues. The project aims to define a strategy in terms of research and innovation to guide supporting actions from the European Commission in the successful implementation of the Big Data economy. Outcomes of this project will be used as input for Horizon2020, their next framework program.[22]

VI. Advantages of Big Data

The traditional analytics system have been fetching data from the source system such as ERP and CRM system, many analytics query will involve the aggregated form of data like "Sales in the north region during the year" which will be helpful in making future analytical decision. But now there is need for much better analytics with changing customer behaviour there is need for organizations to do predictive analysis, there is a need to go beyond the general OLAP analysis, organizations now need systems that can fully utilize the potential of hardware innovations such as In-Memory computing and In-Memory analytics. With the availability of mass storage devices it is possible to have Big data analytics for any enterprises.

Big Data analytics not only enable organizations to quickly access and track the ongoing stream of

global tweets, status updates, texts, videos and blog posts. It also empowers decision makers with the deep-dive capability they need to accurately query and analyze the opinions shared by their organization's customers, suppliers, stakeholders, shareholders, and employees [23]

Probabilistic logic could become instrumental in using Big Data analytics because it can help organization slever age the probabilities of future events that the software predicts. By adopting a probabilistic mindset, organizations can gain flexibility that is not possible when using a cause and-effect (objective logic) approach [SAP]

Organizations can no longer focus solely on delivering the best product or service. To succeed they must uncover hidden customer, employee, vendor and partner trends and in sights. Organizations need to anticipate behavior and then take proactive action and empower the team with intelligent next steps to exceed customer expectations. Predictive analysis helps organizations to achieve real time in sights that increase the understanding of customer behavior, improve response to customer and deliver tangible business value to customer which ultimately drive profitability in business. [24]

VII. Real Time Analytics

With the huge volume of data across all platforms generally it will impact the performance of any system. Hence performance is an important consideration in building the business intelligence systems that use Big data for real time analytics. But With the availability of high speed multi-core processors and dual core processors, 64 bit processors and the availability of main memory for less price in the market along with the emergence of new generation software that has ability to run on effectively on these hardware platforms enable organizations to think about real time analytics based out of big data. It will be the next big shift in the business intelligence field. When enterprises have In Memory database with 64 bit processors along with good servers with better performance and storage considerations the real time analytics based on the big data can be easily achieved.

VIII. Future Research

Cloud computing is one of the emerging technologies. A comprehensive study on using Big data over cloud data warehouse will be promising. There are various challenges in storing the Big data currently hence a study on better storage option for Big data will be good future research. The usage of big data, text analytics and unstructured data for the data warehousing needs to be deeply studied along with integration with cloud in the future research.

IX. Conclusion

Today's business needs real time analytics to succeed in the market there are many business intelligence tools that help organizations to extract data from various source system and provide analytical reports based on that. But with the changing consumer behaviour and unpredictable markets it is tough to decide on a good business strategy. The best business decision can be made only if there is the knowledge based on all available data that any organizations have among that big data plays a vital role. When the business intelligence and data warehousing systems can be well equipped to handle these huge volume of unused bigdata it will provide further deeper insights into business and help the enterprise to make better decision making. When there is enough real time analytical data along with there ports based on big data any enterprises will make better business decision to make their business to run better.

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By Mr. M. Jayakameswaraiah & Dr. S. Ramakrishna
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GJCST-C Classification : H.2.8

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Keywords : spatial data, data mining, location based services, spatio-temporal rule mining.

I. Introduction

A spatio-temporal database is a type of database that supports aspects of both time and space. It offers spatial and temporal data types in its data model. Perhaps most importantly, global positioning systems (GPS) are becoming increasingly available and accurate. In the coming years, we will witness very large quantities of wirelessly Internet–worked objects that are location–enabled and capable of movement to varying degrees. These objects include consumers using GPRS and GPS enabled mobile–phone terminals and personal digital assistants, tourists carrying on–line and position–aware cameras and wrist watches, vehicles with computing and navigation equipment, etc. These developments pave the way to a range of qualitatively new types of Internet–based services. These types of services, which either make little sense or are of limited interest in the context of fixed–location, desktop computing, include: traffic coordination and management, way–finding, location–aware advertising, integrated information services, e.g., tourist services.

A single generic scenario may be envisioned for these location–based services. Moving service users disclose their positional information to services, which use this and other information to provide specific functionality. To customize the interactions between the services and users, data mining techniques can be applied to discover interesting knowledge about the behavior of users. For example, groups of users can be identified exhibiting similar behavior. These groups can be characterized based on various attributes of the group members or the requested services. Sequences of service requests can also be analyzed to discover regularities in such sequences. Later these regularities can be exploited to make intelligent predictions about user's future behavior given the requests the user made in the past. In addition, this knowledge can also be used for delayed modification of the services, and for longer–term strategic decision making. An intuitively easy to understand representation of this knowledge is in terms of rules. A *rule* is an implication of the form A ⇒ B, where A and B are sets of attributes. The idea of mining association rules and the sub problem of mining frequent itemset was introduced for the analysis of market basket data Informally, the task of mining frequent itemsets can be defined as finding all sets of items that co–occur in user purchases more than a user–defined number of times. The number of times items in an itemset co–occur in user purchases is defined to be the *support* of the itemset. Once the set of high–support, so called *frequent* itemsets have been identified, the task of mining association rules can be defined as finding disjoint subsets A and B of each frequent itemset such that the conditional probability of items in B given the items in A is higher than a user–defined threshold. The conditional probability of B given A is referred to as the *confidence* of the rule A ⇒ B. Given that coffee and cream are frequently purchased together, a high–confidence rule might be that "60% of the people who buy coffee also buy cream." Association rule mining is an active research area.

Spatio–temporal (ST) rules can be either *explicit* or *implicit*. Explicit ST rules have a pronounced ST component. Implicit ST rules encode dependencies between entities that are defined by spatial (north–of, within, close–to,. . .) and/or temporal (after, before, during,. . .) predicates. An example of an explicit ST rule is: "Businessmen drink coffee at noon in the pedestrian street district." An example of an implicit ST rule is: "Middle–aged single men often co–occur in space and time with younger women." This paper describes experiences with ST rule mining in the Danish spatial data mining company, Geomatic. The task of finding ST rules is challenging because of the high

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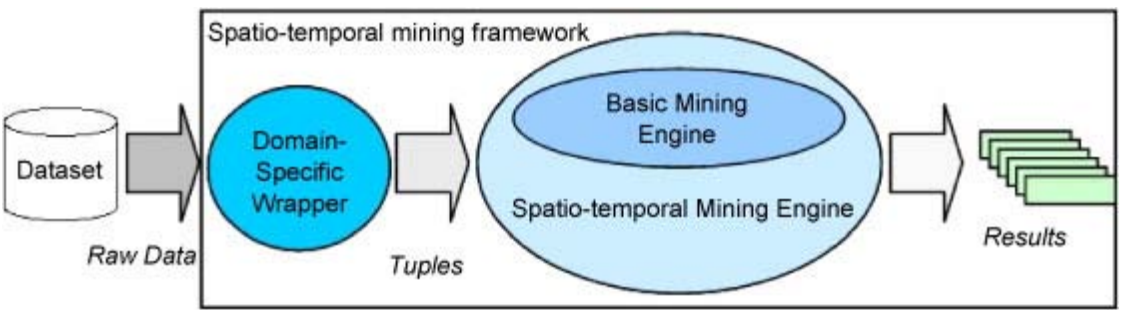
cardinality of the two added dimensions: space and time. Additionally, straight–forward application of association rule mining methods cannot always extract all the interesting knowledge in ST data. For example, consider the previous implicit ST rule example, which extracts knowledge about entities (people) with different attributes (gender, age) that interact in space and time. Such interaction will not be detected when association rule mining is applied in straight–forward manner. This creates a need to explore the special properties of ST data in relation to rule mining, which is the focus of this paper. The contributions of the paper are as follows. First, a number of real world ST data sets are described, and taxonomy for ST data is derived. Second, having the taxonomy, the described data sets, and the desirable LBSes in mind, a general methodology is devised that projects the ST rule mining task to traditional market basket analysis. The proposed method can in many cases efficiently eliminate the above mentioned explosion of the search space, and allows for the discovery of both implicit and explicit ST rules. Third, the projection method is applied to a number of different types of ST data such that traditional association rule mining methods are able to find ST rules which are useful for LBSes. Fourth, as a natural extension to the proposed method, spatio–temporally restricted mining is described, which in some cases allows for further quantitative and qualitative mining improvements. Finally, a number of issues in ST rule mining are identified, which point to possible future research directions. Despite the abundance of ST data, the number of algorithms that mine such data is small. Since the pioneering work of association rule mining methods were extended to the spatial and later to the temporal dimension. Other than, there have been no attempts to handle the combination of the two dimensions. An efficient depth–first search style algorithm is given to discover ST sequential patterns in weather data. The method does not fully explore the spatial dimension as no spatial component is present in the rules and no general spatial predicate defines the dependencies between the entities. A bottom– up, level–wise, and a faster top–down mining algorithm is presented to discover ST periodic patterns in ST trajectories. While the technique can naturally be applied to discover ST event sequences, the patterns found are only within a single event sequence. The remainder of the paper is organized as follows. Section 2 introduces a number of real world ST data sets, along with a taxonomy of ST data. In Section 3, a general methodology is introduced that projects the ST rule mining task to the traditional market basket analysis or frequent itemset mining task. The proposed problem projection method is also applied to the example data sets such that traditional association rule mining methods are able to discover ST rules for LBSes. Finally, Sections 4 and 5 identify unique issues in ST rule mining, conclude, and point to future work.

II. Spatio–Temporal Data

A spatio-temporal database system manages data whose geometry changes over time. Applications that generate such type of data include surveillance applications, transportation systems, mobile communication systems and geographical and environmental systems, and so on. When the data has relations with spatial data, the term becomes spatial data mining. In other words, spatial data mining is the application of data mining technique to spatial data. It will follow along the same functions in data mining; Spatial data mining is the process of extracting implicit knowledge, spatial relations, or other patterns that are not explicitly stored in spatial databases. Spatio-temporal data is usually modeled by extending temporal databases or spatial databases. That is, spatio-temporal data is modeled in two ways. First, we can add spatial properties and operations in temporal databases. The second way is to add temporal properties and operations in spatial databases. For clearer following figure is illustrate the architecture of the spatio-temporal data-mining.



Data is obtained by measuring some attributes of an entity/phenomena. When these attributes depend on the place and time the measurements are taken, the data is refer to as ST data. Hence such ST measurements not only include the measured attribute values about the entity or phenomena, but also two special attribute values: a location value, *where* the measurement was taken, and a time value, *when* the measurement was taken. Disregarding these attributes, the non–ST rule "Businessmen drink coffee" would

result in annoying advertisements sent to businessmen who are in the middle of an important meeting.

a) Examples of ST Data Sets

The first ST data set comes from the "Space, Time, and Man" (STM) project In the STM project activities of thousands of individuals are continuously registered through GPS–enabled mobile phones, referred to as mobile terminals. These mobile terminals, integrated with various GIS services, are used to determine close–by services such as shops. Based on this information in certain time intervals the individual is prompted to select from the set of available services, which s/he currently might be using. Upon this selection, answers to subsequent questions can provide a more detailed information about the nature of the used service. Some of the attributes collected include: location and time attributes, demographic user attributes, and attributes about the services used. This data set will be referred to as STM in the following. The second ST data set is a result of a project carried out by the Greater Copenhagen development Council (Hovedstadens Udviklings R®°ad (HUR)). The HUR project involves a number of city busses each equipped with a GPS receiver, a laptop, and infrared sensors for counting the passengers getting on and off at each bus stop. While the busses are running, their GPS positions are continuously sampled to obtain detailed location information. The next big project of HUR will be to employ chip cards as payment for the travel. Each passenger must have an individual chip card that is read when getting on and off the bus. In this way an individual payment dependent on the person and the length of the travel can be obtained. The data recorded from the chip cards can provide valuable passenger information. When analyzed, the data can reveal general travel patterns that can be used for suggesting new and better bus routes. The chip cards also reveal individual travel patterns which can be used to provide a customized LBS that suggests which bus to take, taking capacities and correct delays into account. In the following, the data sets from the first and second projects of HUR will be referred to as HUR1 and HUR2, respectively. The third ST data set is the publicly available INFATI data set, which comes from the intelligent speed adaptation (INtelligent FArtTIlpasning (INFATI)) project conducted by the Traffic Research Group at Aalborg University. This data set records cars moving around in the road network of Aalborg, Denmark over a period of several months. During this period, periodically the location and speeds of the cars are sampled and matched to corresponding speed limits. This data set is interesting, as it captures the movement of private cars on a day–to–day basis, i.e., the daily activity patterns of the drivers. This data set will be referred to as INFATI in the following.

Finally, the last example data set comes from the Danish Meteorology Institute (DMI) and records at fixed time intervals atmospheric measurements like temperature, humidity, and pressure for Denmark for 5 km grid cells. This data set is unique in that unlike the other data sets it does not capture ST characteristics of moving objects, but nonetheless is ST. This data set will be referred to as DMI in the following.

b) A Taxonomy of ST Data

Data mining in the ST domain is yet largely unexplored. There does not even exist any generally accepted taxonomy of ST data. To analyze such data it is important to establish taxonomy. Perhaps the most important criterion for this categorization is whether the measured entities are *mobile* or *immobile*. The ST data in the DMI data set is immobile in the sense that the temperature or the amount of sunshine does not move from one location to the other, but rather, as a continuous phenomenon, changes its attribute value over time at a given location. On the other hand, the observed entities in the other four data sets are rather mobile. Another important criterion for categorization is whether the attribute values of the measured entities are *static* or *dynamic*. There are many examples of static attributes values but perhaps one that all entities possess is a unique identifier. Dynamic attributes values change over time. This change can be slow and gradual, like in the case of the age of an observed entity, or swift and abrupt, like in the case of an activity performed by the observed entity, which starts at a particular time and last or a well–specified time interval only.

III. Spatio–Temporal Baskets

Following the methodology of market basket analysis, to extract ST rules for a given data set, one needs to define ST *items* and *baskets*. This task is important, since any possible knowledge that one can extract using association rule mining methods will be about the possible dependencies of the items within the baskets.

a) Mobile Entities with Static and Dynamic Attributes

Consider the STM data; it is mobile in nature and has several static and dynamic attributes. Base data contains the identity and some demographic attributes of the user, and the activity performed by user at a particular location and time. Further attributes of the locations where the activity is performed are also available. By applying association rule mining on this base data one can find possible dependencies between the activities of the users, the demographics of the users, the characteristics of the locations there the activities are performed, and the location and time of the activities. Since the location and time attributes are items in the baskets one may find {Strøget, noon,

businessman, caf´e} as a frequent itemset and from it the association rule {Strøget, noon, businessman}⇒ {caf´e}. Strøget being a famous pedestrian street district in central Copenhagen in Denmark, this rule clearly has both a spatial and temporal component and can be used to advertise special deals of a caf´e shop on Strøget to businessmen who are in the area around noon.

In the INFATI data set, a record in the base data contains a location, a time, a driver identifier, and the current speed of the car along with the maximum allowed speed at the particular location. The possible knowledge one can discover by applying association rule mining on the base data is where and when drivers or a particular driver occur(s) and/or speed(s) frequently. However, one may in a sense pivot this table of base data records such that each new row represents an ST region and records the car identifiers that happen to be in that region. Applying association rule mining on these ST baskets one may find which cars co–occur frequently in space and time. Such knowledge can be used to aid intelligent rideshare services. It can also be valuable information for constructing traffic flow models and for discovering travel patterns. While the possible knowledge discovered may be valuable for certain applications, the extracted rules are not clearly ST, i.e.: there is no *explicit* ST component in them. In fact the same set of cars may frequently co–occur at several ST regions which may be scattered in space and time. Nonetheless, it can be argued that since the "co–occurrence" between the items in the ST baskets is actually an ST predicate in itself, the extracted rules are *implicitly* ST. An alternative to this approach might be to restrict the mining of the ST baskets to larger ST regions. While this may seem useless at first, since the baskets themselves already define more fine–grained ST regions, it has several advantages. First, it allows the attachment of an explicit ST component to each extracted rule. Second, it enhances the quality of the extracted rules.

Base Data Records from INFATI

Location	Time	CarID
1	07:30	A
1	07:30	B
2	07:31	A
2	07:31	B
2	07:31	C
3	07:32	A
3	07:32	C
3	16:20	A
3	16:20	B
2	16:21	A
2	16:21	B
1	16:22	A
1	16:22	B

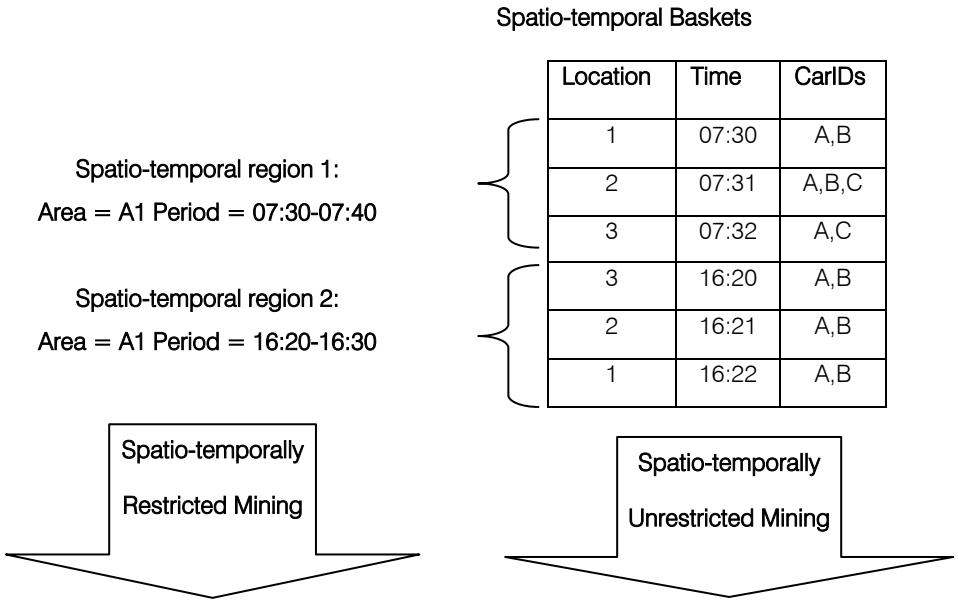
Pivoting

Spatio-temporal Baskets

Location	Time	CarID
1	07:30	A,B
2	07:31	A,B,C
3	07:32	A,C
3	16:20	A,B
2	16:21	A,B
1	16:22	A,B

Figure 1.1 : Process of Pivoting to Obtain ST Baskets from INFATI Base Data

Finally, it significantly speeds up the mining process, as no two itemsets from different regions are combined and tried as a candidate. Figure1.1 shows the process of pivoting of some example records abstracted from the INFATI data set. Figure1.2 shows the process and results of spatio–temporally restricted and unrestricted mining of the ST baskets. In this example the shown frequent itemsets are based on an absolute minimum support of 2 in both cases, however in the restricted case specifying a relative minimum support would yield more meaningful results. Naturally the adjective "relative" refers to the number of baskets in each of the ST regions. Figure 1.2 also shows the above mentioned qualitative differences in the result obtained from spatio–temporally restricted vs. unrestricted mining. While the frequent co–occurrence of cars A and B, and cars A and C are detected by unrestricted mining, the information that cars A and B are approximately equally likely to co–occur in area A1 in the morning as in the afternoon, and that cars A and C only co–occur in area A1 in the morning is missed. Similar pivoting techniques based on other attributes can also reveal interesting information. Consider the data set in HUR2 and the task of finding frequently travelled routes originating from a given ST region. In the HUR2 data set a record is generated every time a user starts and finishes using a transportation service. This record contains the identifier of the user, the transportation line used, and the location and time of the usage. For simplicity assume that a trip is defined to last at most 2 hours. As a first step of the mining, one can retrieve all the records that fall within the ST region of the origin. Following, one can retrieve all the records within 2 hours of the users that belonged to the first set. By pivoting on the user–identifiers, one can derive ST baskets that contain locations where the user generated a record by making use of a transportation service.



Area	Period	Itemset	Support
A1	07:30-07:40	{A}	3
A1	07:30-07:40	{B}	2
A1	07:30-07:40	{C}	2
A1	07:30-07:40	{A,B}	2
A1	07:30-07:40	{A,C}	2
A1	16:20-16:30	{A}	3
A1	16:20-16:30	{B}	3
A1	16:20-16:30	{A,B}	3

Itemset	Support
{A}	6
{B}	5
{C}	2
{A,B}	5
{A,C}	2

Figure 1.2 : Process and Results of Spatio–Temporally Restricted vs. Unrestricted Mining of ST Baskets

Applying association rule mining to the so–derived ST baskets one may find frequently travelled routes originating from a specific ST region. The pivoting process for obtaining such ST baskets and the results of mining such baskets is illustrated in a simple example in the light bordered box of Figure1.3. Naturally, the frequent itemset mining is only applied to the "Unique Locations" column of the ST baskets. As before the minimum support is set to 2. Considering the spatial relation between the locations one might consider altering the bus routes to better meet customer needs. For example, if locations A and C are close by on the road network, but no bus line exists with a suitable schedule between A and C, then in light of the evidence, i.e., support of A, B, C is 2, such a line can be added. Note that while the discovered frequent location sets do not encode any temporal relation between the locations, one can achieve this by simply placing ST regions into the ST baskets as items. The pivoting process and the results of mining are shown in the dark bordered box of Figure 1.3. The discovered ST itemsets can help in adjusting timetables of busses to best meet customer needs.

b) Immobile Entities with Static and Dynamic Attributes

So far the examples considered data sets that are mobile and have either static, dynamic, or both types of attribute values. Now consider an immobile ST data with mostly dynamic attribute values, as the DMI data set. The base data can be viewed as transactions in a relational table with a timestamp, a location identifier and some atmospheric measurements like temperature, humidity and pressure.

Considering the geographical locations A, B, C, and D depicted in Figure 1.4, one might be interested in trends like, when the temperature in regions A and B is

high and the pressure in regions A and C is low, then at the same time the humidity in region D is medium. By applying something similar to the pivoting techniques above, one can extract such information as follows. For each record concatenate the location identifiers with the atmospheric measurements. Then, for each distinct time interval when measurements are taken, put all concatenated values, each of which is composed of a location identifier and an atmospheric measurement, into a single, long ST basket. By performing association mining on the derived ST baskets one can obtain the desired knowledge.

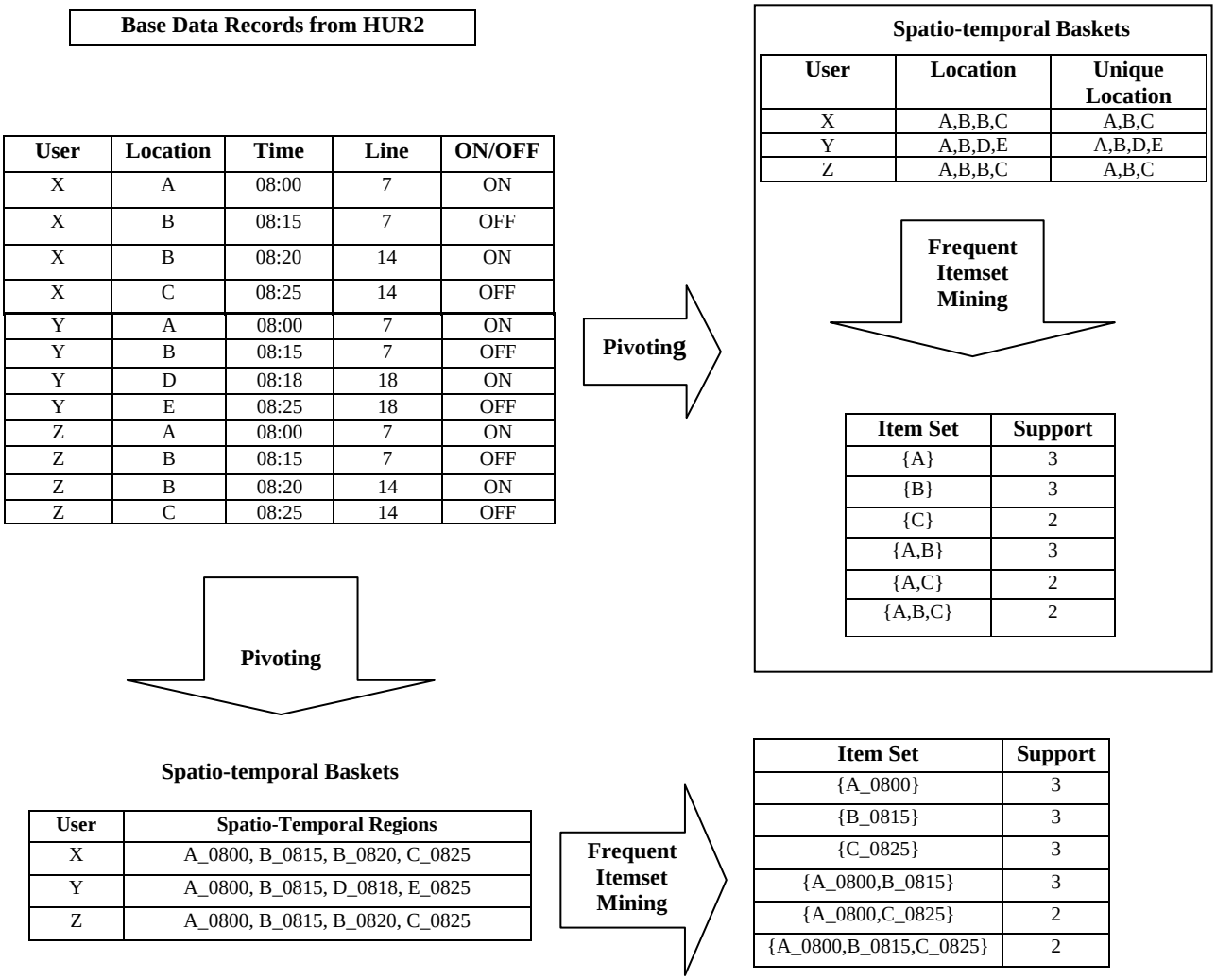


Figure 1.3 : ST Baskets and Frequent Itemset Mining for HUR2

As an illustrative example, depicted in Figure1.4, consider the four neighboring cells A, B, C, and D and the corresponding measurements of temperature (T), humidity (H), and pressure (P) at three different times. Items in the ST baskets are derived by concatenating a location identifier followed by an attribute symbol and an attribute value. Hence, the item 'ATlo' in the ST basket at time '08:00' encodes the fact that at '08:00' at location 'A' the temperature ('T') was low ('lo'). Notice that the extracted knowledge refers to specific locations. If one is interested in obtaining knowledge about the inter–dependencies of these attributes relative (in space) to one another, for each base data record at each distinct time interval when measurements are taken, an ST basket can be constructed that encodes measurements from neighboring cells only. So, for example considering the immediate 8 neighbors of a cell and assuming three different attributes the number of items in each basket is $3 + 8 \times 3 = 27$. Considering a five–by–five relative neighborhood centered around a cell the number of items in each basket is 75, and the number of possible itemsets, given three possible attribute values for each of the attributes is $3^{75} \approx 6.1 \times 10^{34}$.

Base Data Records from DMI

Location	Time	T	H	P
A	08:00	lo	hi	hi
B	08:00	lo	hi	hi
C	08:00	hi	me	me
D	08:00	me	me	me
A	09:00	me	hi	me
B	09:00	hi	lo	lo
C	09:00	lo	lo	me
D	09:00	lo	hi	hi
A	10:00	lo	hi	hi
B	10:00	hi	lo	lo
C	10:00	hi	hi	me
D	10:00	lo	hi	hi

Geographical Locations

A	B
C	D

Longest Frequent Itemset (out of 157)
{BThi,BHlo,BPlo,CPme,DTlo,DHhi,DPhi}

Pivoting

Spatio-temporal Baskets

Frequent Itemset Mining

Time	Spatial Measurements
08:00	ATlo,AHhi,APhi,BTlo,BHhi,BPhi,CThi,CHme,CPme,DTme,DHme,DPme
09:00	ATme,AThi,APme,BThi,BHlo,BPlo,CTlo,CHlo,CPme,DTlo,DHhi,DPhi
10:00	ATlo,AHhi,APhi,BThi,BHlo,BPlo,CThi,CHhi,CPme,DTlo,DHhi,DPhi

Figure 1.4 : ST Baskets and Frequent Itemset Mining of DMI

To reduce complexity, top–down and bottom–up mining can occur at different spatial and temporal granularities. While in the above examples the type of ST data that was analyzed and the type of ST knowledge that was extracted is quite different the underlying problem transformation method—referred to as *pivoting*—is the same. In general, one is given base records with two sets of attributes A and B, which are selected by a data mining expert and can contain either spatial, temporal and/or ordinary attributes. Pivoting is then performed by grouping all the base records based on the A–attribute values and assigning the B–attribute values of base records in the same group to a single basket. Bellow, attributes in A are referred to as *pivoting* attributes or *predicates*, and attributes in B are referred to as *pivoted* attributes or *items*. Depending on the type of the pivoting attributes and the type of the pivoted attributes the obtained baskets can be either *ordinary*, *spatial*, *temporal*, or *ST* baskets. Table1.1 shows the different types of baskets as a function of the different types of predicates used to construct the baskets and the different types of items placed in the baskets.

pred/item type	s–i	t–i	st–i	ordinary–i
s–predicate	s–b	**st–b**		s–b
t-predicate	**st–b**	t–b		t–b
st–predicate	**st–b**	**st–b**	**st–b**	**st–b**
other–predicate	s–b	t–b	**st–b**	ordinary–b

Table 1.1 : Types of Baskets as a Function of Predicate Type and Item Type

Basket/mining type	s-r	t-r	st-r	unr
s–basket	X			X
t–basket		X		X
st–basket	X	X	X	X
other–basket				X

Table 1.2 : Possible Mining Types of Different Types of Baskets

The symbols s, t, st, i, and b in the table are used to abbreviate the terms 'spatial', 'temporal', 'spatio–temporal', 'items', and 'baskets' respectively.

In the "co–occurrence" mining task, which was earlier illustrated on the INFATI data, the concept of restricted mining is introduced. This restriction is possible due to a side effect of the pivoting technique. When a particular basket is constructed, the basket is assigned the value of the pivoting attribute as an implicit label. When this implicit basket label contains a spatial, temporal, or ST component, restricting the mining to a particular spatial, temporal, or ST sub region becomes a natural possibility. It is clear that not all basket types can be mined using spatial, temporal, or ST restrictions. Table 1.2 shows for each basket type the type of restrictions for mining that are possible. The symbols s, t, st, r and unr in the table are used to abbreviate the terms 'spatial', 'temporal', 'spatio–temporal', 'restricted', and 'unrestricted' respectively.

IV. Issues in Spatio–Temporal Rule Mining

The proposed pivoting method naturally brings up questions about feasibility and efficiency. In cases where the pivoted attributes include spatial and/or temporal components, the number of items in the baskets is expected to be large. Thus, the number and length of frequent itemsets or rules is expected to grow. Bottom–up, level–wise algorithms are expected to suffer from excessive candidate generation, thus top–down mining methods seem more feasible. Furthermore, due to the presence of very long patterns, the extraction of all frequent patterns has limited use for analysis. In such cases closed or maximal frequent itemsets can be mined.

Useful patterns for LBSes are expected to be present only in ST sub regions, hence spatio–temporally restricted rule mining will not only make the proposed method computationally more feasible, but will also increase the quality of the result. Finding and merging patterns in close–by ST subregions is also expected to improve efficiency of the proposed method and the quality of results.

Placing concatenated location and time attribute values about individual entities as items into an ST basket allows traditional association rule mining methods to extract ST rules that represent ST event sequences. ST event sequences can have numerous applications, for example an intelligent ride–sharing application, which finds common routes for a set of commuters and suggests rideshare possibilities to them. Such an application poses a new requirement on the discovered itemsets, namely, hey primarily need to be "long" rather than frequent (only a few people will share a given ride, but preferably for a long distance). This has the following implications and consequences. First, all subsets of frequent and long itemsets are also frequent, but not necessarily long and of interest. Second, due to the low support requirement a traditional association rule mining algorithm, disregarding the length requirement, would explore an excessive number of itemsets, which are frequent but can never be part of a long and frequent itemset. Hence, simply filtering out "short" itemsets after the mining process is inefficient and infeasible. New mining methods are needed that efficiently use the length criterion during the mining process.

V. Conclusions and Future Work

Motivated by the need for ST rule mining methods, this paper established a taxonomy for ST data. A general problem transformation method was introduced, called pivoting, which when applied to ST data sets allows traditional association rule mining methods to discover ST rules. Pivoting was applied to a number of ST data sets allowing the extraction of both explicit and implicit ST rules useful for LBSes. Finally, some unique issues in ST rule mining were identified, pointing out possible research directions.

Future work will devise and empirically evaluate algorithms for both general and spatio–temporally restricted mining, and more specialized types of mining such as the ride–sharing suggestions. Especially, algorithms that take advantage of the above– mentioned "long rather than frequent" property of rideshare rules will be interesting to explore.

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Improve Relevancy of Object Oriented Class Cohesion Metrics with Inheritance

By Jaspreet Kaur & Rupinder Kaur
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Abstract - Cohesion is a very important quality attribute in software. As we know that there are number of cohesion metrics are proposed in the literature to measure the cohesion of software systems. These metrics gives undefined values for a large number of classes which comes under special cases. Because of this reason, these metrics became non-applicable for these classes as they are unable to give cohesion values for these classes. In this paper, a value assignment criterion would be used to make cohesion metrics applicable and the concept of inheritance would be included for these special cases. Study the effect of including or excluding the inherited elements i.e., methods and attributes.

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GJCST-C Classification *: D.2.3*

Strictly as per the compliance and regulations of:

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Jaspreet Kaur [α] & Rupinder Kaur [σ]

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I. Introduction

Software Engineering is the branch of computer science which is mainly concerned with developing large applications. There are number of quality attributes which are available to measure the quality of softwares i.e., maintainability, reusability, availability, reliability, cohesion, coupling, security, scalability, testability, usability etc.

a) Class Cohesion

Cohesion can be defined as the relatedness of elements in a module. There can be two types of modules in software system:

- Highly Cohesive Module
- Low Cohesive Module

Highly Cohesive Module is defined as those modules whose elements have a tight relationship among themselves. A **Low Cohesive Module** is defined as the module that has some elements that have little or no cohesion relation to others.

Class consists of following two members:

- Attributes
- Methods

Attributes can be defined as the things where the objects stores the data i.e., variables. On the other hand, **Methods** can be defined as Functions and Procedures that are attached to an Object and allowing the object to perform the different actions.

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Class Cohesion Metrics are applicable on the following two phases:

- High Level Design (HLD Phase)
- Low Level Design (LLD Phase)

Several HLD and LLD metrics have been proposed in the literature to measure cohesion. HLD metrics require the information that is available during the HLD phase, such as types of attributes and method parameters. LLD metrics requires the information that is available during LLD phase, such as attributes referenced by the methods.

As we know that, there have been proposed a number of cohesion metrics in the literature in order to measure the cohesion of various software systems. But most Class Cohesion Metrics shows the undefined values for some special cases given as follows:

- Classes consisting of fewer than two methods.
- Classes that do not contain any attributes.
- Classes in which none of the methods has parameters.

In 1998,2004,2011,2012, authors of [1], [2], [6], [7], [8], [9], [10], [11], [12], [13] and [14] excluded all classes that come under special cases mentioned above for which 12 object oriented class cohesion metrics like LCOM1, LCOM2, LCOM5, TCC, LCC, NHD, CC, SCOM, COH, DCD, DCI and CAMC gives undefined cohesion values and cohesion value can never be infinity.

II. Related Work

This guideline is used for all journals. These are the manuscript preparation guidelines used as a standard template for all journal submissions. Author must follow these instructions while preparing/modifying these guidelines. This guideline is used for all journals. This guideline is used for all journals. These are the manuscript preparation guidelines used as a standard template for all journal submissions. Author must follow these instructions while preparing/modifying these guidelines. This guideline is used for all journals. This guideline is used for all journals. These are the manuscript preparation guidelines used as a standard template for all journal submissions. Author must follow these instructions while preparing/modifying these guidelines. This guideline is used for all journals. This guideline is used for all journals. These are the manuscript preparation guidelines used as a standard

template for all journal submissions. Author must follow these instructions while preparing/modifying these guidelines. This guideline is used for all journals.

a) Review Stage

In 2011, [3] introduces criteria for assigning cohesion values to classes of special cases, such as classes having lesser than two methods, classes containing no attributes, classes having methods with no parameters. They used a value-assignment criteria to assign values to special cases. But they have not included two factors including inheritance and the accessibility levels i.e., public, protected and private). Through this value-assignment criteria, the applicability of considered metrics in paper increases to 100%.

This paper worked on same criteria as [3] mentioned i.e criteria for assigning cohesion values for special cases, such as classes having lesser than two methods, classes containing no attributes, classes having methods with no parameters and additionally, it will include a factor of inheritance i.e., the inherited attributes and methods would be included.

This paper considered four scenarios:

- both inherited methods and attributes are excluded,
- only inherited attributes are excluded,
- only inherited methods are excluded,

both inherited methods and attributes are included.

Following table shows assigned values are used for metrics to calculate cohesion for special case:

Metric	m=0 and a>0	m=1 and a=0	m=1 and a>0	m>1 and a=0
NHD	0	0	0	1
Coh	1	1	Assigned Before	0
TCC, LCC, CC, SCOM, CAMC	1	1	1	0
DCD, DCI	1	1	1	Assigned Before
LCOM1, LCOM2	0	0	0	Assigned Before
LCOM5	0	0	2*(1-α/a), where α is the summation of the number of distinct attributes accessed by each method in a class.	m/(m-1)

Table 2.1 : The assigned values for the metrics under consideration [3]

In the table 2.1 **m** refers to method, **a** refers to attribute and **assigned before** means the metric does not show undefined value for the case shown in respective column

b) Final Stage

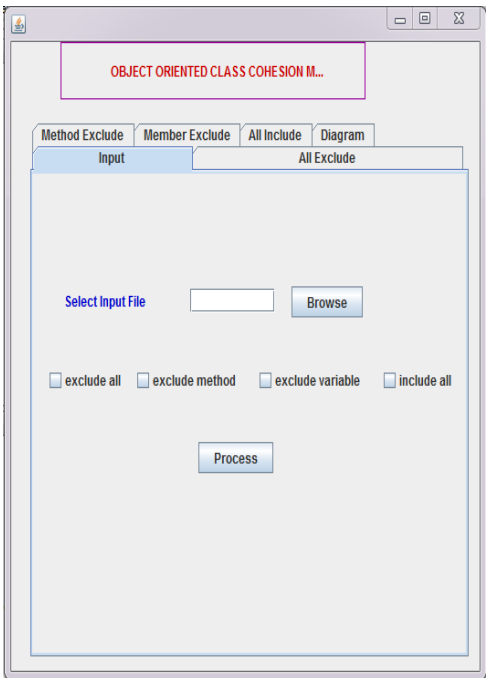
This paper proposed a tool named SoftMetric Tool to show the comparisons and results of four scenarios using Netbeans IDE 7.3. Java is a high-level programming language originally developed by Sun Microsystems and released in 1995 [4]. **Netbeans** is a Java IDE that is open source and free. Most developers recognize the NetBeans IDE as the original free Java IDE [5].

i. *SoftMetric*

SoftMetric Tool is implemented using Netbeans. This tool will calculate the cohesion values for the following 12 metrics:

- TCC (Tight Class Cohesion)
- LCC (Loose Class Cohesion)
- NHD (Normalized Hamming Distance)
- CC (Class Cohesion)
- SCOM (Class Cohesion Metric)
- LCOM1 (Lack of Cohesion 1)
- LCOM2 (Lack of Cohesion 2)
- LCOM5 (Lack of Cohesion 5)
- COH
- DCD (Degree of Cohesion - Direct)
- DCI (Degree of Cohesion - Indirect)
- CAMC (Cohesion Among Methods in a Class)

Following is shown the snapshot of the tool:



Following we take an example of class named test1.class to show the calculation of cohesion using this tool:

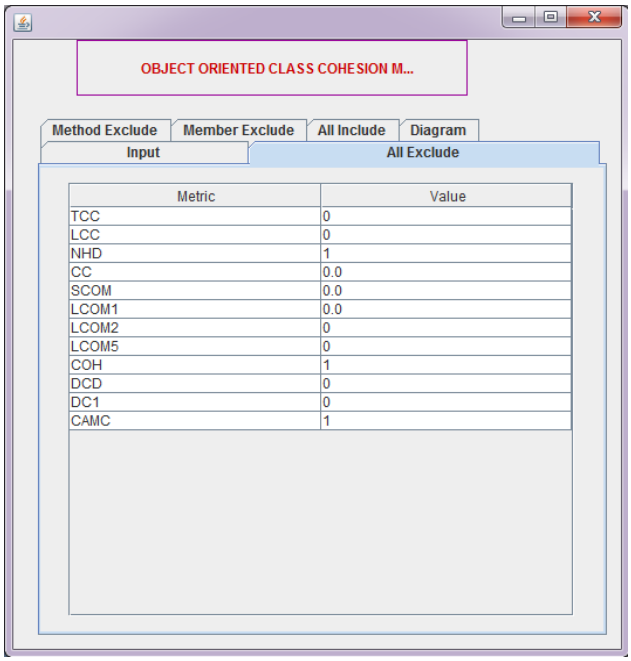
1. This following snapshot shows "**Select Input File**", this will browse and select .class file. After selecting a class file, we will select one option from four options:

- exclude all,
- exclude method,
- exclude variable
- include all.

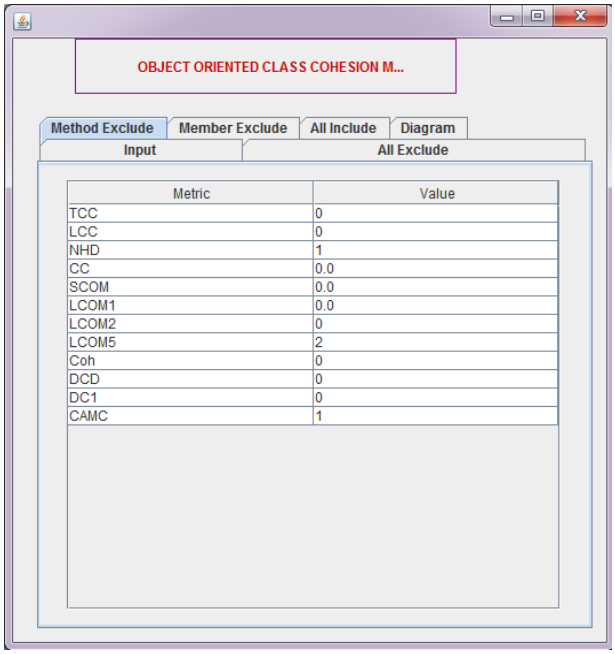
Exclude All will exclude all inherited members of a class in cohesion calculation, **Exclude Method** will exclude inherited methods in cohesion calculation, **Exclude Variable** will exclude inherited methods in cohesion calculation, and **Include All** will include all inherited members of a class in cohesion calculation. **This tool will calculate cohesion for normal classes as well as for special classes also.**

But in this paper, we have just included the result only for special classes like classes those have less than two methods, classes that do not contain attributes, classes whose methods have no parameters.

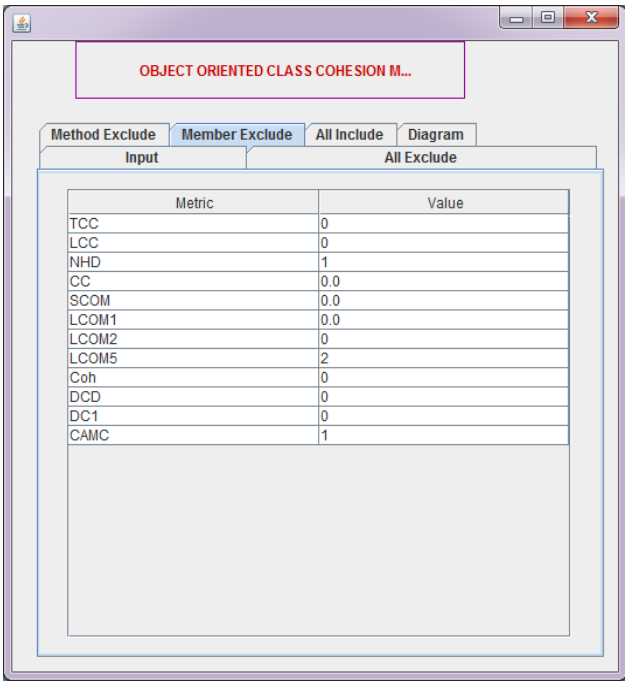
2. The following snapshot shows the cohesion values of class test1 using 12 metrics calculated for the scenario in which both inherited methods and attributes are excluded.



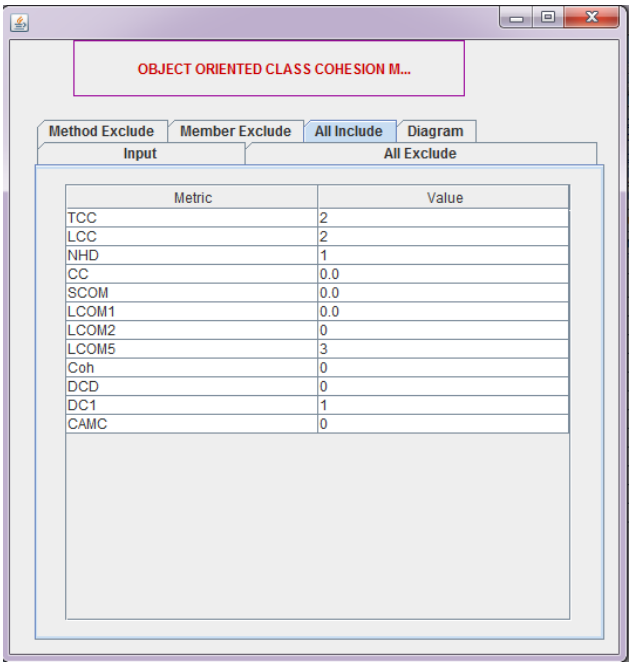
3. The following snapshot shows the cohesion values of class test1 using 12 metrics calculated for the scenario in which **inherited methods** are excluded.



4. The following snapshot shows the cohesion values of class test1 using 12 metrics calculated for the scenario in which inherited attributes are excluded.



5. The following snapshot shows the cohesion values of class test1 using 12 metrics calculated for the scenario in which both inherited methods and attributes are included.



6. The following snapshot shows comparison of four scenarios, which shows that with including inherited members increase the overall cohesion of a class i.e., with including inherited member improve the applicability of maximum metrics of the literature.

ii. *Results*

We have considered 55 classes of special cases and calculated cohesion for classes using each four scenarios for each class. Following bar-chart shows the overall conclusion for four scenarios.

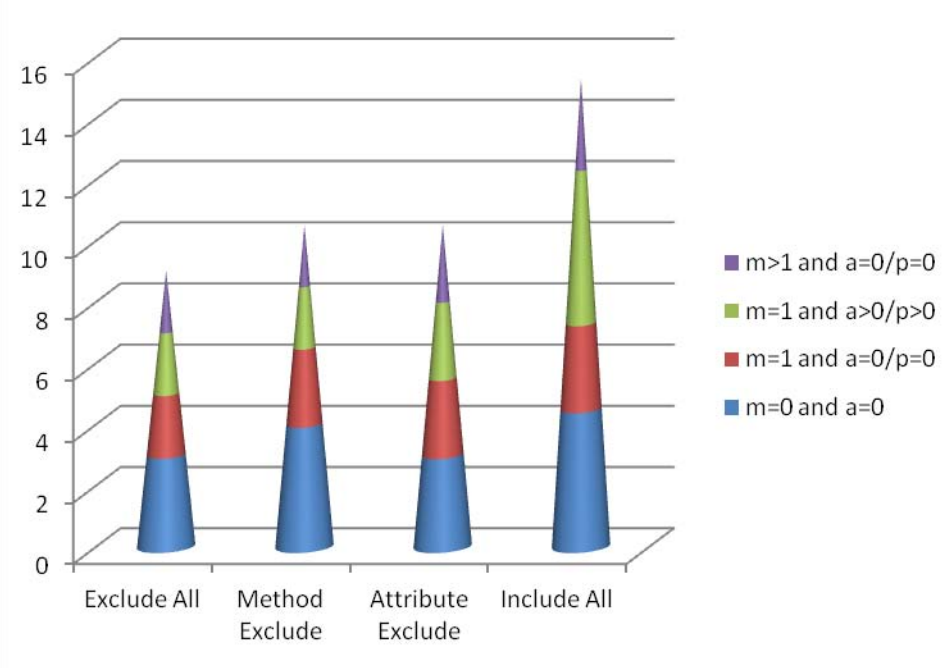


Figure 2.1 : Results of four scenarios for 55 classes

The above chart shows that with including inherited methods and attributes shows the better cohesion results. In it, ***m*** refers to methods, ***a*** refers to attributes and ***p*** refers to parameters. These results shows that including the inherited members the cohesion of a classes increases, thus it improves the applicability of cohesion metrics by using assigned values for special cases in all four scenarios increase the cohesion of maximum number of classes.

III. Conclusion

As there are number of metrics that show undefined values for classes of special cases. This paper proposed a tool for cohesion calculation and studied four scenarios (1) both inherited methods and attributes are excluded, (2) only inherited attributes are excluded, (3) only inherited methods are excluded, and (4) both inherited methods and attributes are included. After studying these scenarios we get the results that relevancy of maximum of metrics increases with including the inherited metrics.

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A New Approach for Reducing the Testing Effort

By Muhammad Shahid Khan, Naveed Khan, Muhammad Abid Khan & Muhammad Ahmed Javed

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Abstract - In-Process testing metrics has been used from some years and its usage is frequently increasing. There are different metrics for software testing i.e. to measure testing progress, Mean time between arrival of error, density of errors, fixation of errors, failure rate, test execution Productivity, cost of defects, Test efficiency and efficiency checking and so on. But all these metrics are independent and have no relation with each other. There are some attributes of testing metrics which are very much homogenous and interrelated with interdisciplinary measurement. It is quit natural to inter-relate all these metrics into a single metric which should provide overall functionality of some of existing selected metrics and also depicts some new approach of testing measurement. So the derived frame work modeled a new metric. This new metric covers the measurement of major quality attributes such as Correctness, Reliability, Efficiency, Flexibility, Inter-operability, Usability and Maintainability. The derived new metric possess higher level of reliability, early predication of testing progress, less cost of correctness in maintenance phase, effectiveness in error exploration, efficient approach of measuring testing process, Compatibility of different existing metrics, reduce the corrective maintenance effort, less cost of corrective maintenance, a new stander for measuring corrective maintenance effort, high degree of flexibility and interoperability of different Tools.

GJCST-C Classification : D.2.5

Strictly as per the compliance and regulations of:

A New Approach for Reducing the Testing Effort

Muhammad Shahid Khan [α], Naveed Khan [σ], Muhammad Abid Khan [ρ] & Muhammad Ahmed Javed [ω]

Abstract - In-Process testing metrics has been used from some years and its usage is frequently increasing. There are different metrics for software testing i.e. to measure testing progress, Mean time between arrival of error, density of errors, fixation of errors, failure rate, test execution Productivity, cost of defects, Test efficiency and efficiency checking and so on. But all these metrics are independent and have no relation with each other. There are some attributes of testing metrics which are very much homogenous and interrelated with interdisciplinary measurement. It is quit natural to inter-relate all these metrics into a single metric which should provide overall functionality of some of existing selected metrics and also depicts some new approach of testing measurement. So the derived frame work modeled a new metric. This new metric covers the measurement of major quality attributes such as Correctness, Reliability, Efficiency, Flexibility, Inter-operability, Usability and Maintainability. The derived new metric possess higher level of reliability, early predication of testing progress, less cost of correctness in maintenance phase, effectiveness in error exploration, efficient approach of measuring testing process, Compatibility of different existing metrics, reduce the corrective maintenance effort, less cost of corrective maintenance, a new stander for measuring corrective maintenance effort, high degree of flexibility and interoperability of different Tools.

I. Introduction

The metrics are used to measure the software i.e. software metric is a measure of some property of a piece of software or its specifications (Class et al.1994). The different metrics are used to measure the different phases of software in order to determine the progress of software development process.

The different testing metrics are used independently to covers different aspects of software testing process. Some of these testing metrics are as below Cost of finding a defect in testing (CFDT): Test Case Adequacy: Test Case Effectiveness: Effort Variance : Schedule Variance: Schedule Slippage: Rework Effort Ratio: Review Effort Ratio: Requirements Stability Index: Requirements Creep: Weighted Defect Density (Jaana Lindroos, 2005).

A software will remain in the market for a long time if it is developed with disciplined approach such type of software are easier to use and easily modifiable. Such software is the result of good effort. A type of software, may not modify and difficult to use. Such software should be the result of unsuccessful efforts and undisciplined approach. For the development of the software required effort is divided into two parts.

In system software errors and failures are increase the negative impact due to this the failure cost of the software is also increase (Beheshti et al., 1995).

Recent research on the quality of the software has resulted in the wide range of software metrics and analysis techniques (Prather, 1995).

Software metrics, such as the MTBF, are designed to provide objective criteria for management decisions. Precision instruments are not necessary to calculate most metrics. Simple counting or subjective estimation has been used. Most software metrics define a standard way of using attributes such as size, cost, defects, complexity, and environment to measure quality parameters such as completeness, conciseness, portability, consistency, usability, and structure.

A variety of metrics can assist in identifying risks early in the test process. Nonparametric statistical principles have been used to evaluate the effectiveness of metrics in identifying these risks, as well as other validity criteria.

These validity criteria include association, consistency, discriminative power, predictability, and tracking. The use of metrics in debugging software can more effectively reduce the scope of error when structured and modular programs are employed in software development. Metrics do not always provide useful information. Some metrics are designed for a particular purpose and may not reveal the existence of errors of which the user is unaware. The lack of an omnibus metric to detect all types of errors has spurred interest in the development of additional metrics.

(Rubin et al., 1995) have developed metrics with a mechanism termed "software process flight simulation" to allow IS professionals to explore their mental models of the software process. They emphasize choosing the right metrics for the modeling process. They evaluated the metrics: software size; software reliability; test session efficiency; test focus; and software maturity. Inputs for evaluating these metrics included: discrepancy report count, impact and subsystem charged; scheduled test time; effective test time; and test session rating. By tracking test results of these metrics, significant insight was gained on software quality, cost allocation, and test scheduling.

Effectively managing process improvement for software-quality can challenge any project manager. There are programs available to perform a quality check on programs sold by manufacturers. However, many of

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these types of programs are at least three times as long as the programs that they are designed to check. Despite efforts to detect software errors, some information specialists report at least one mistake per 5,000 lines of code (Beheshti et al., 1995).

II. Proposed Methodology

This chapter will cover proposed technique, working of the model, the derived frame work as a new metric and formulae for inter-related metrics.

a) Proposed Technique

In proposed methodology a new frame work is introduced for measuring software testing process. This framework has combined different metrics of testing projects and derived a new metric which covers different testing aspects.

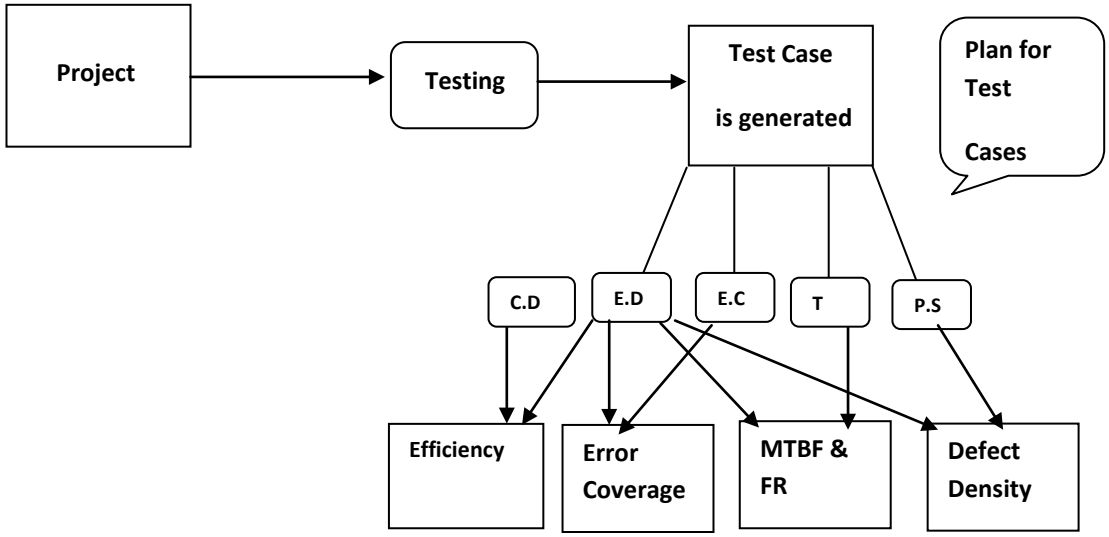


Figure 1 : Proposed Model for derived framework

b) Working of the Model

A project or system is taken to perform testing on it. At first the test cases are generated and then proper planning is done for each test case. Then the further steps will be taken to have different measures for same project such as C.D stands for Error on Customer side, E.D stands for Error Detection, E.C for Error Correction, T stands for Time taken by each test case, P.S stands for Program size tested.

c) The Derived Framework as a New Metric

Test cases Id	Time	Error	Customer side Error	Corrected	Error Cover In %	MTBF	FR	Size	Efficiency In %	DD
1	12	1	1	1	100	12	.083	85	50	1.18
2	10	3	4	2	66.67	3.34	.3	78	60	3.84
-	-	-	-	-	-	-	-	-	-	
-	-	-	-	-	-	-	-	-	-	

d) Formulae for Inter-Related Metrics

i) $$MTBF = \frac{Time}{No.\ of\ Error}$$

ii) $$Failure\ Rate = \frac{No.\ of\ Error}{Time}$$

iii) $$Error\ Coverage = \frac{No.\ of\ Corrected\ Error}{No.\ of\ Errors} * 100$$

iv) Defect Density = $\frac{\text{No. of Errors}}{\text{Program Size Tested}} * 100$

v) Efficiency = $\frac{\text{No. of Error}}{\text{(No. of Error + Customer Side Error)}} * 100$

III. Implemented Proof and Results

This chapter will give you the practical approach of the system I proposed.

The system was implemented using VB.NET and SQL. The results were generated using P-IV with 2.8 GHz processor, 1GB of memory running windows XP 2003. The experiments were performed on a selected project which was developed in VB.NET and SQL server 2003. The accuracy of the system was checked by applying different values in different attributes.

a) Experiments and Results

We have selected a project for implementation of testing metrics. And twenty four (24) test cases are generated for the selected project. Where three operations such as insertion, deletion and updation test cases are generated for each of this operation of individual form of project. Black box testing method is used to check that weather the particular operation is giving the required output from specific input. If the particular operation is not performing its functionality then white box testing is performed. In white box testing method the code is tested and errors of code are detected.

Test Case Name	Insertion	Deletion	Update
	Test Case ID	Test Case ID	Test Case ID
Item Detail	1	9	17
Item Price	2	10	18
Ware House	3	11	19
Sale Detail	4	12	20
Receipt Detail	5	13	21
Good Return	6	14	22
Good Returns from customer	7	15	23
Demand Detail	8	16	24

Table 1 : Name and ID of Test Case

In the figure-1, 8-Test Cases have its own identification number for a specific (insertion, deletion, Updation) operation.

b) S-Curve Testing Plan

Test cases are made according to S-curve each test case is planned and attempted. In this way progress of the testing process is traceable and error exploration is performed more efficiently.

Each test case is passed Through S-curve plan because every test case will be planned in detail.

i. *S-Curve Plan for Insertion Operation*

For more error exploration from the selected project, different test cases are applied on the insertion operation. In insertion operation, all of eight (8) test cases of are attempted but four (4) are successful as shown in the figure-2. And graph of the insertion operation is illustrated as shown in the figure-2.

Test Cases Name	Test Case Planed	Attemted	Successful
Systems	8	8	4
Item	2	2	1
Ware House	1	1	1
Sale	1	1	0
Receipt	1	1	1
Return Goods	2	2	1
Demand	1	1	0

Table 2 : Plan for insertion operation

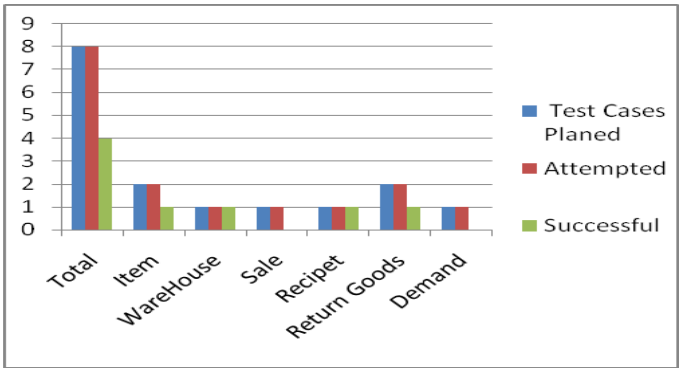


Figure 2 : Graph for insertion Operation

ii. *S-Curve Plan for Deletion Operation*

In deletion operation, all of eight (8) test cases are attempted but five (5) are successful as shown in the figure-4. And graph of deletion operation is illustrated in figure-5.

Test Cases Name	Test Case Planed	Attempted	Successful
Systems	8	8	5
Item	2	2	2
Ware House	1	1	1
Sale	1	1	0
Receipt	1	1	0
Return Goods	2	2	1
Demand	1	1	1

Table 3 : Plan for deletion operation

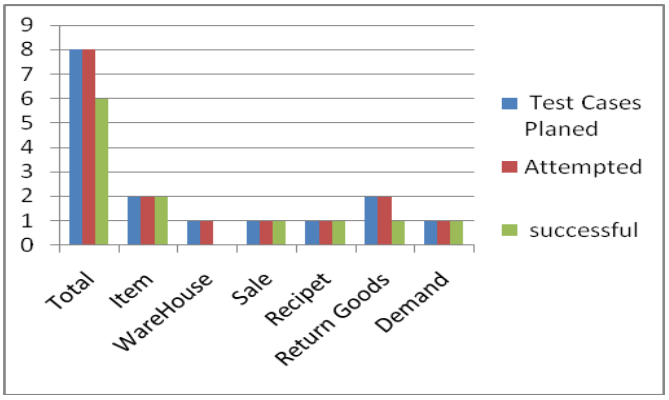


Figure 3 : Graph for Deletion Operation

iii. *S-Curve Plan for Updation Operation*

In Updation operation, all test cases are attempted eight (8) but five (5) were successful as shown in the figure-6. And graph of Updation operation is illustrated in figure-7.

Table 4 : Plan for Updation Operation

Test Cases Name	Test Case Planed	Attempted	Successful
Systems	8	8	5
Item	2	2	2
Ware House	1	1	1
Sale	1	1	0
Receipt	1	1	0
Return Goods	2	2	1
Demand	1	1	1

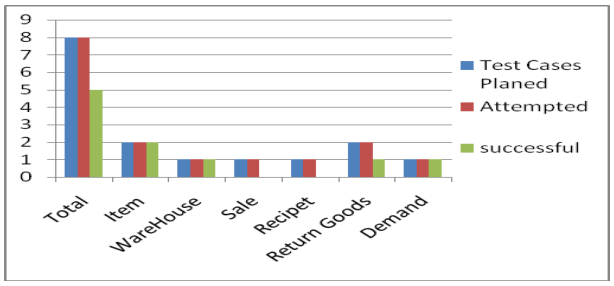
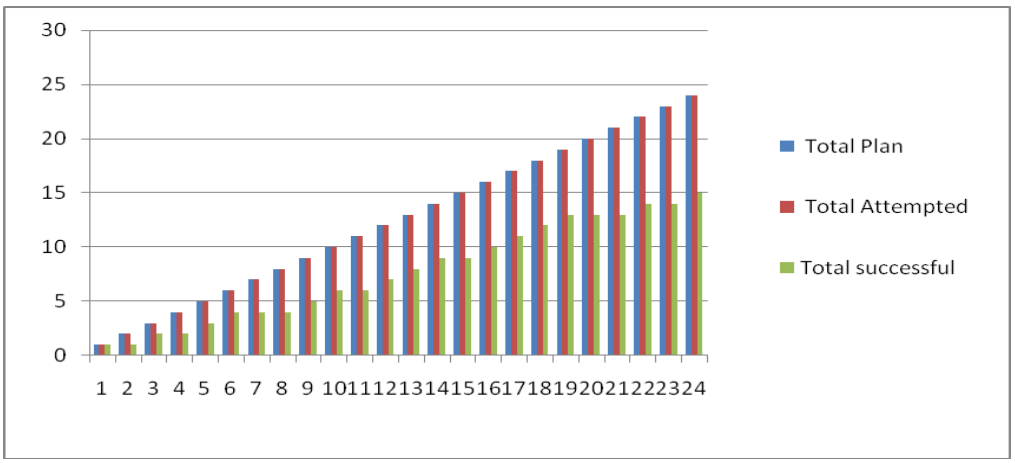


Figure 4 : Graph for Updation Operation



Over all result of test plan of all operations

IV. Comparative Study of Single Project

a) Without single framework

In selected project there are total 24-Test cases but due to lack of proper planning the system named "Goods Returns from customer" are left from testing. There are two (2) test cases of system "Goods Returns from customer" and there are three (3) operation of "Good Returns from customer" system so

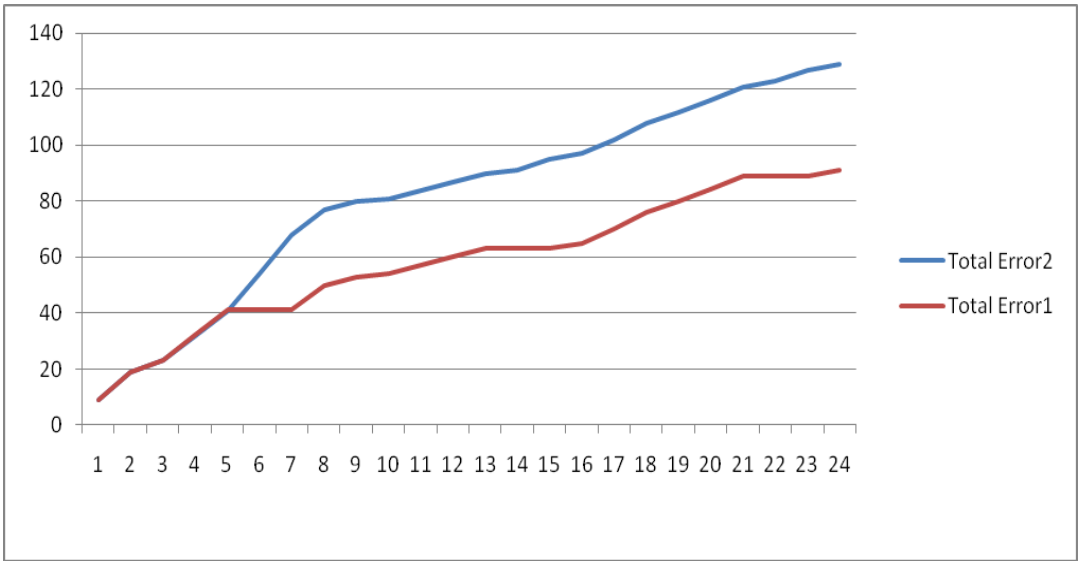
$$2*3=6$$

i.e six (6) test cases are left to be tested. So the errors of these six (6) test cases are thirty eight (38) which are left from fixing at developer side, i.e 27, 5 and 6 errors of insertion, deletion and updation respectively. The errors detected on developer side without single framework is 50,15 and 26 for insertion, deletion and updation respectively.

While using single framework there is a plan for testing via s-curve and the error are explored at big ration.

The following graph shows a clear picture of detecting errors at high ratio via using single framework. Where Error1 line shows the error detection of particular project without using single frame work and Error2 line shows the error detection of particular project with using single frame work.

Error Detection Report		
Operations	With Single Frame Work	Without Single Frame Work
Insertion	77	50
Deletion	20	15
Updation	32	26



b) Impact on Efficiency

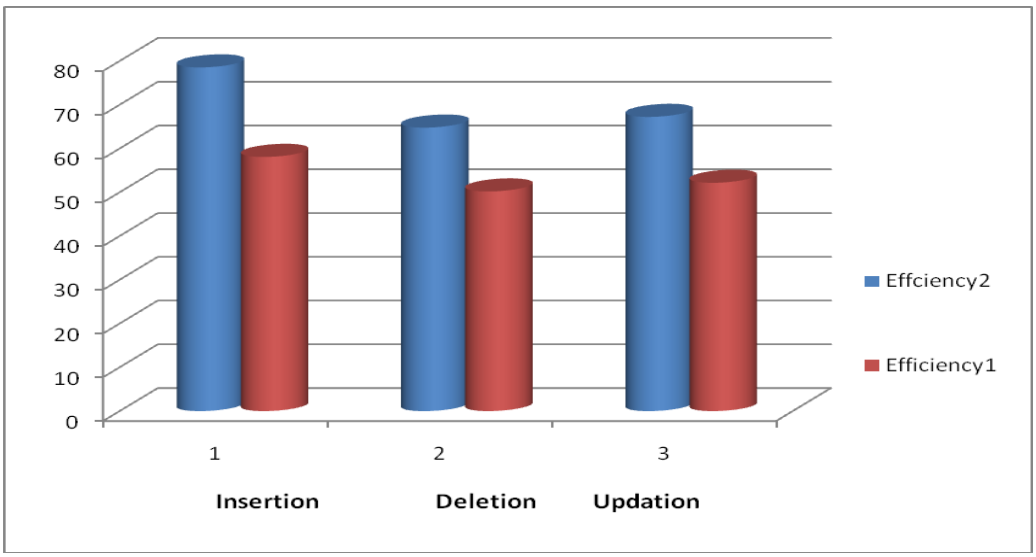
The less exploration of errors and has a direct impact on software testing efficiency. Because those all errors which are left on developer side would be appeared on customer side.

The customer side error with single frame work is 21,10,15 for insertion, deletion and updation respectively.

The customer side error without single frame work is 48,15 and 21 for insertion deletion and updation respectively as shown below:

21+**27**= 48, 10+**5**= 15, 15+**6**= 21.

Average Efficiency Report		
Operations	With Single Frame Work	Without Single Frame Work
Insertion	78.549	58.099
Deletion	64.791	50.208
Updation	67.247	52.188



Impact on corrective maintinance effort

V. Conclusion

This new frame work provides a proper way of measuring different aspects of testing process. There is a number of software testing metrics such as Failure Rate, MTTF, MTBF, Defect Density, Test Plan, Testing Efficiency, Error fixation etc. These metrics are independent and have no link with each other, but some these have homogeneous attributes with inter-disciplinary measurement. Some of these homogeneous attributes metrics has been integrated into single frame work. So from this single frame work some major measurement of testing process such that plan for testing, error detection and correction efficiency, program size tested, testing efficiency, execution time take by each test case, the reliability measurement using MTTF and FR can be performed. This derived frame provides the measurement of software testing process at different stages, from which the effect of each step taken in software testing is determined. The derived metric also provides the higher degree of flexibility where different metrics are combined in a single frame work to be used more effectively and also provides the compatibility of different metrics. The term plan testing is also included in new derived metric which is helpful in exploring more errors, and this reduces the corrective maintenance cost. From this derived metric more reliable and efficient product can be achieved with low cost of maintenance. It has a direct impact on product quality because this new metric provides the measurement of some basic attributes of quality such that Correctness, Reliability, Efficiency, Usability and Maintainability. This new metric is applied on different tools such that VB.Net and SQL and provides the interoperability of different tools.

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7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

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16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

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Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

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The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

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- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

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The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
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This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
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- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
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- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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