Standardized software development model for SME software houses in Pakistan

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Abstract — **There are many software development models that exist for software development like Extreme Programming, Waterfall, Spiral, Agile, RAD, SCRUM etc. These models are very useful for development but its usefulness varies from company to company in nature of product and services of companies. When we talk about software development in Pakistan then there are no specific or standard model followed by most of the software Development Companies due to which they are facing many problems regarding development and deployment of software and at the end did not succeed to maturity level, as a whole there are lacking in standardization of software model in Pakistan. Subsequently, the customer also suffers and reluctant to avail long-term business. This study focus and cover software development procedure that are followed by small and middle level software houses like how to overcome risk management factor in software development, how to improve software development process. My target is to counter those software houses that work on limited scope software but as all software are important for the industry and for the growth of that software house, they must follow some standards and best practices that are built on their ethics and culture so that they can be known as the software houses that fulfil the maturity level. Since every country has its own ethics and goals so here the study will cover the software houses in Pakistan and proposed a SDLC model that lead them to achieve successful maturity level. Since the study assume the company size to be 30-40 employees as it is suggested to be SME. The major reason of selecting the ratio of 30 – 40 is that the companies from where I have conducted the research are small SME's and average company size of SME's are 30 to 40 employees.**

Keywords—SME, Pakistan Software Houses, SDLC, Model.

I. INTRODUCTION

There are many software development models exist in software development industry. They help a lot to develop software and useful to use and cater to all business requirements which are given by the clients. Subsequently it helps in the successful growth of a software house. There are many changes occur according to the need for improvement and better performance to develop software.

When we talk about the changes in software development life cycle it highly depends on the environment of the country or region and there is not a single company worked on standardization as to how make software development models. Many customized software development models or rather practices are being designed by normal industry persons. Their need to change in software development model is focused

primarily on the easiness of their software development process. All software development model cover almost same phases of software development but the difference between these models are in there processes. Still these models vary according to the working environment of the region or country.

When we talk about Pakistan software industry, there are many different environments and practices to develop software project. In Pakistan there are many small and medium software houses which do not adopt standard software development model in there company instead to use standard model they build their own model which is helpful to complete project in their software houses environment. They made some changes in existing process of SDLC like change working flow, increase or decrease iteration of process etc. Since there are many reasons of failure of the above discussed scenario but the most important one is that the traditional models are still in practice as they became out-dated because of change in nature of software.[7]

That's why these successful models are not much practical in Pakistan software development industry because in Pakistan there are many small or medium software houses exists instead of large software development companies so they do not follow the proper model to development software they use their own designed model. The focus of this research is to analyze the issues related to Pakistan software development working environment like why standard models are not feasible to use in these software houses. Research on different type of models which are used locally and analyse these models from standardize perspective. [9]

A. Problem statement

Majority of Pakistani software companies don't go for CMM levels as it is not feasible for their existing business model, especially small to medium software houses. Customers are unable to gage these software companies' capabilities and are reluctant to avail their services. If there is any standard which can blend with Pakistani environment, these software houses can adopt it and thus can gain local customer trust. Local industry will not only survive but will grow.

B. Importance of issue

- There is still no standard software development model followed by majority of the software houses to

develop software in Pakistan so my purpose of study is to identify those models which are followed by regular practice in software industry. After identify I will make one standard model which is useful for Pakistan's software industry.[8]

- Through this research I can identify the software development process which are practically useful and viable in Pakistan and conclude result by comparative analysis of different standard models and customized models made by software houses by themselves.

- Through this study the reason of software house failure is also identified so as to highlight them for industry is very important and is a huge problem in software industry[3].

The above figure shows the importance of the standard development model for the increasing growth of software companies in Pakistan. [7].

IT companies registered with PSEB	1082
Substantial IT companies region-wise:	
Karachi	611
Islamabad/Rawalpindi	479
Lahore	544
Other regions	105
Foreign IT and telecommunication companies	60
Number of CMMI-assessed companies:	
CMM Level 5	1
CMMI Level 5	2
CMMI Level 3	3
CMMI Level 2	16
Total industry size	US$ 2.8 billion
IT and IT-enabled services exports	US$ 1.4 billion
Percentage growth in exports (2009-2010)	19%
IT graduates produced per year	Approx. 20,000
Export targets for fiscal year 2010-2011	US$ 350 million
Number of institutes offering IT/CS programs	110
IT professionals in export-oriented activities	More than 15,000
IT professionals employed in Pakistan	110,000
Space utilized in IT & Software Technology parks	11 parks covering 750,000 sq ft

Fig. 1. Global Information Technology Report 2011 [6]

C. Rationale of the study

My aims are very high and I want my research to be useful and there is not a specific list but I will try to achieve at least one or two objectives because of the time limitation and other constraints. Objectives are:

- Research on existing software development models.

- Comparative analysis among existing models.

- Gather and analyze practically used models in Pakistan local software industry and provide one standard model on the basis of my analysis outcome.[6]

D. Basic Components for Every SDLC

If we see the picture from bird's eye view then there are mainly two practices followed in SDLC. The first one is sequential and the other one is evolutionary [5]. Sequential model are those in which one component is depended on another or we can say that output from one component will served as input for second component. Evolutionary model are those in which there is no strong dependency among components. Waterfall is an example of sequential mode of SDLC and increment/iterative mode is an example of evolutionary mode.[12]

- Requirement Gathering
- Software Design and Architecture
- Implementation and Testing
- Software Integration
- Software Verification and Validation
- Maintenance
- Replacement

E. Standard Software Development Methodology

There are many software development models or SDLC models are developed and these models are very helpful to make software in a proper profession way. Here I discuss about the usability of the models according to the environment of Pakistan[10]. So I highlight their positive things which are really usable in Pakistan and highlights issues like why SME software houses are unable to adopt them in their development environment.

- Understanding the problem
- Designing and preparation for a solution
- Coding the designed solution
- Testing the real program

1. Waterfall Model

Waterfall model is not suitable of our Pakistan software industry like in small software house because they don't have clear specification about their project at the start so the requirements are not well known at early stage in my point of view their have no software house exist in Pakistan which follows waterfall model there have no proper management to manage software project so it is impossible to follow this.[4] Waterfall methodology is appropriate for large scale project so it means that it is not suitable for Pakistan's SME software houses. Also the implementation cost is very high for this methodology. When SME software houses adopt waterfall they need high cost to implement it. [2].

2. Spiral Model

This model is usually considered as rapid application development model, in this model as things comes, we implement it, there is no particular sequence to follow. This is the model that is follow in majority of SME software house in Pakistan, because they just need to develop it rather than conducting the development in efficient manner. [9] Here is the lacking that why they are not achieving. My interview counters these types of questions that why they use this type of model.

3. Prototype Model

All the users/ clients are not technical and they don't know that what they want, to give them a picture of software that how it will be , we give them a prototype , through this we can engaged our clients to the software. In Pakistan we face a lot of clients that are not literate, so we use this model. The large companies work well on this but small software houses are not

taking it as it is supposed to be, like they show the client different prototype and use different in actual development because of minor changes in prototype.

4. Iterative and Incremental Model

This is the model where smaller amount of functionality is been delivered to client. This is the model where we deploy the chunks to clients, the issue here in Pakistan SME doesn't exactly follow the model and release version according to the functionality is not well defined. They just developed the release and patch is deployed to client.[2]

5. V-Shaped Model

This is the model where parallel activities take place like requirement and system verification works on the same time. Development and testing works on the same time, this is followed in some of the companies in Pakistan but still they are fail to achieve the target because synchronization between parallel activities are not managed properly and at the end it leads to confusion.[1]

6. SCRUM Model

This is the model which is only used in large enterprises software companies of Pakistan, as this could be used for large scope software, now the thing is that SME didn't want to use it as they don't have such need to follow it, but as per the CMM model, levels achieve when these types of software model follow or combination of such of them so my model will rectify the issue mentioned above. [8]

F. Software Development Approaches

There are mainly two approaches follow in software development. Custom development is an approach in which the software company developed generic solution and follow the process accordingly, here the maintenance phase after deployment is very important and critical and the second approach is customer oriented in which the software is developed specific to the client requirements, here the requirement understanding phase is critical as it is based on the client specific solution. [13].

- Reason of Failure of Software Development
- Extracting Requirements
- Lack of User Involvement
- Team Size
- Time Dimension
- Fixed Controller
- Testing
- Poor Quality management

G. Pakistan Local Software Development Methodology

a. Company A Model

Here I present the SDLC model of company A which is the mixture or combination of three standard SDLC model which is Waterfall, Iterative, and Agile. The company A modified those models according to need and environment of the software development life cycle. I got this model after conduct interview from Company A. I asked some sort of question about their process. This is the SME level software house which generate acceptable revenue in the market.[11] When I

conduct interview I found some issues like why SME software houses are not adopt standard software model. The one of the valid reason in software houses they do not afford the highly paid employee which are specialist in their filed so the developer and company owner do multiple work in the organization like they develop the software and also do some sort of the analyst work as a part time analyst.

Model Description

The model contains phase like waterfall the company follow same model phase just like a waterfall but company do not follow the cycle of the waterfall because there have not flexibility to move backward from middle phases. So for the iteration of the cycle they follow iterative models according their modification like there have many iteration occur between requirement gathering phase and analysis phase because when we talking about SME software houses their clients are not technical mostly so they face some difficulties to communicate with their clients and collect requirement as they are needed so they increase iteration between these two phases after confirmation about the requirements they proceed further move towards the design phase they also called wireframe in this phase they developed prototyping as per user requirement and also take client feedback for confirmation. After that they use their architecture which are generic for also types of software which is developed by this company so they do not need to make new architecture for the software and that is one of the reason they increase their iteration in analysis face because they save their time in architecture phase that's why they spent their 70% of time in requirement gathering and analysis phase. Implementation and testing phase are parallel activities in this company. After testing they deploy their software on client end. They deploy their software at once after the completion of all task.
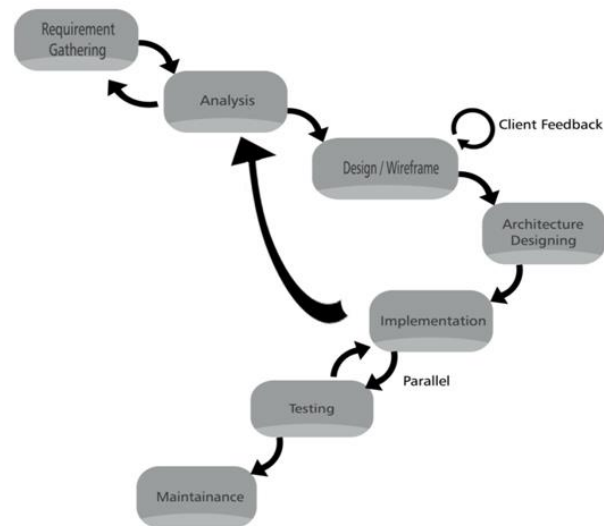

Fig. 2. Company A Model

b. Company B Model

I visited company 2, they are following the below mentioned model. The company developed the generic solution and client oriented solution as well. They follow different models on different software as they also use the combination of different models. The below model is a combination of SCRUM, Agile and Waterfall methodologies.

Model Description

The model is mainly divided into three phases, the first one is related to development the second one is related to management and the third one is the flow of steps that are followed. The first activity is to gather the requirement but according to the small releases keeping in mind the big picture of software as well from this step the flow is reversible to client interaction as well. Now after the requirement are gathered properly then the development is starts, meanwhile the management of the project is working continuously as to align the resources and manage the product on a global scale, here they need SCRUM to do such activities like SCRUM meeting, product backlog etc. but complete SCRUM model is not follow here as the meeting part and other relevant activities use here. Now if we comes on development phase then a cycle of agile methodology is produced in a sense that development is being done on the requirement given by management and additionally the client is involve during development, the flow is development to client, client to management and management to development. Here they need agile methodology to do so because programming is the main focus in this phase. Now after the cycle the developed release is send to testing, but if testing is fail then it will send to development phase again and cycle goes on. After successful testing the release is deployed on UAT environment, here all the test cases are being executed and after this the flow is towards the deployment release on live environment. At the end the other release will be developed as per the above discussion and finally these all are maintain by the maintenance component of the model. Here the third part is from waterfall as all the components are sequential like after requirement gathering development starts and after development the testing starts, though these individual components use the iterative model in their individual phase like development.
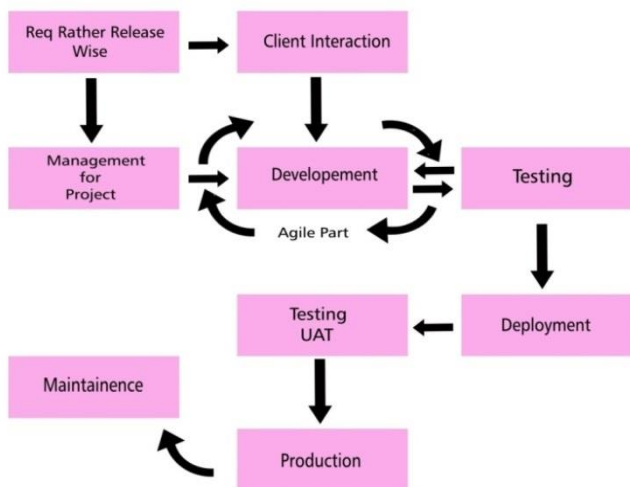

Fig. 3. Company B Model

c. Company C Model

The company C is the SME software house which developed software according to the business domain solution like financial solution. This is the product based software company that's why they have permanent clients so they make financial product and deploy it in different companies after do some modification.

Model Description

When conduct interview with the authenticate person he said that the primary focus of the company is the customer satisfaction so this purpose the modify the standard model which is the combination of three models like V-Model, Iterative Model and Waterfall Model. The below figure shows that the first three components like requirement gathering, analysis, and design are placed in the loop through this loop they check the verification of the requirement gather analysis through the detail coordination with the client in this part of the model they use V-Model. After verification of the all requirements they proceed further towards the implementation and testing phase these two phases are worked parallel. In testing phase the cover both type of testing like UAT and functional testing. After completion of implementation and testing phase the move towards the deployment phase. After detail discussion during interview I placed the decision symbol in this model. The purpose of the decision symbol is when they deploy the software at client end if no problem occur then they should live this software if in any case the deployment is failed so the developer must resolve this problem at the client end during the deployment phase they do not stop the deployment phase.
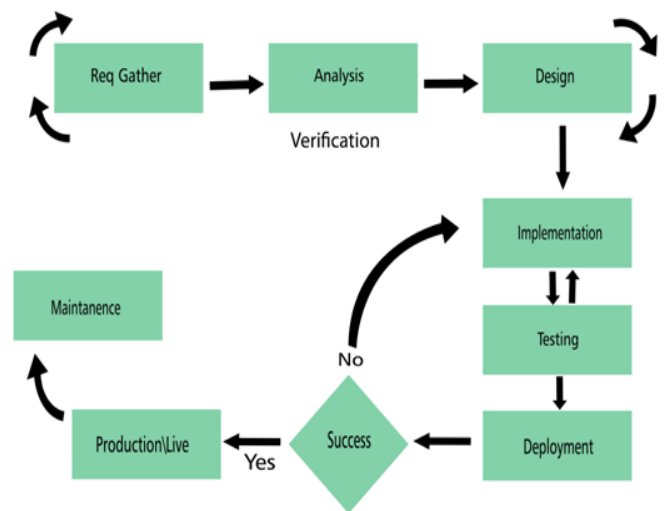

Fig. 4. Company C Model

II. RESEARCH METHODOLOGY

The study is a qualitative & quantitative research. I started this as a qualitative research but ended it as an survey research

A. *Instrument*

Different models and framework are the instruments through which I got the data to be analyzed and do comparison between them. Conduct interviews from different companies.

B. Procedures

1. First decide the scope of the research which is necessary for the good research.

2. The research is related to the SDLC models which are follows in Pakistan.

3. During the research I analysis there are no standard models are followed by SME software houses majority they modified standard models according their need.

4. So I started the research to understand the existing standard software development model because which is really helpful for me when I conduct interviews.

5. After complete my literature survey I started interview with different companies.

6. I am facing some problem when I am trying to communicate with different software houses they do not shows there interest to allow me in their software house after long struggle only three companies are agree to share their SDLC model for analysis.

7. After analysis these model I put it down all information in the form of matrix which is help out to make standard software model according to the Pakistan environment or culture.

III. INTERVIEW

- Pakistan Software Development Environmental Issues

When we talking about Pakistan software industry there have many problems are facing by software development. These problems are listed below.

1. Requirement Gathering problem is one of the major issue in Pakistan's SME software houses because these software houses work with those client which do not know about the technically so they do not define clearly their requirements so when we talking about standard software model it is the major phase which is cater in the model.

2. Cost and time management is the another problem when we deal with low budget client so if any software houses adopt or follow standard software development model which is not suitable for their organization because they are expensive to implement that why they do some modifications so the propose model definitely improve or manage them.

3. As discussion during the interviews there are some other highlighted issues should be mentioned which are really important the first one is delay software deployment, the second one is over budget, and the third one is lacking of standard.

IV. RESULT

A. Standard Software Development Model Matrix Comparison

Table 1: Standard Model Comparison Matrix

S No.	Features	Water Fall Model	Spiral Model	Prototype Model	Iterative and Incremental Model	V-Shaped Model	SCRUM Model
1.	Requirement Gathering in the Beginning	Yes	Not All Requirements Gather initially, Frequently Changed and periodicall y gathers.	Not All Requirements Gather initially, Frequently Changed and periodically gathers.	Not All Requirem ents Gather initially, Frequently Changed and periodicall y gathers.	Yes	Not All Requirem ents Gather initially, Frequently Changed and periodicall y gathers.
2.	Project Cost Estimation	Almost As Estimated Cost	Very Costly.	Above Estimated Cost	Above Estimated Cost.	Almost As Estimated Cost	Almost As Estimated Cost
3.	Model Implementati on Cost	High	Medium	Low	Low	High	Medium
3.	SDLC Phases Overlapping	No	No	Yes	Yes	No	Yes
4.	Development Process	Heavy Weight Process	Heavy Weight Process	Light Weight Process	Light Weight Process	Heavy Weight Process	Light Weight Process
5.	Customer Participation	Low, Only at Beginning.	Low, After Each Iteration Complete d.	High, After Each Prototype	High, After Each Iteration Complete d.	Low, Only at Beginning.	High
6.	Appropriate Project Size	Large Scale	Large Scale and Complex.	Low to Medium Scale	Low to Medium Scale	Large Scale	Large Scale
7.	Essential Basic Business Knowledge	Required	Required, Not much	Sensible Business Knowledge	Sensible Business Knowledg e	Required	Required, Very Much
8.	Simplicity	Simple	Complex	Moderate	Moderate	Moderate	Simple
9.	Flexibility	Rigid	Much Flexible	Much Flexible	Much Flexible	Least Flexible	Flexible
10.	Maintenance	Least Maintaina ble	Yes, Maintaina ble	Yes, Maintainable	Yes, Maintaina ble	Little Maintaina ble	Maintaina ble
11.	Risk Concern	High	Low	Low	Low	Medium	Medium
	QA Phase	High	High and Iterative	Low and Iterative	High and Iterative	High	Medium and Iterative
12.	Reusability	Least Possible	To Some Amount	To Some Amount	To Some Amount	Least Possible	Yes, Possible
13.	Development Team Size	Large Team Size Required.	Large Team Size Required.	Small Team Size Required.	Small Team Size Required.	Small Team Size	Large Team Size
14.	Overall Goal	High Quality Product	High Quality Product	Rapid Development	Rapid Developm ent	High Quality Product	Rapid Developm ent
	Primary requirement gathering Goal	High Assuranc e	Moderate Assurance	Low	Low	High Assuranc e	Moderate Assurance
15.	Time Frame	Very Long	Long	Medium	Long	Long	Medium
16.	Availability of Working Software/Proj ect	At the End of the Software Life Cycle.	At the End of Every Iteration.	At the End of Every Prototype to be Functional/Iter ation	At the End of Every Iteration	At the End of the Software Life Cycle	At the End of Every Iteration
17.	Changes Integration	Difficult	Easy	Easy	Easy	Difficult	Easy
18.	Framework Type	Linear	Combinati on of Linear and Iterative.	Iterative	Combinati on of Linear and Iterative	Non Linear	Iterative and Increment al
19.	Rework/Modi fication Cost	High	Medium	Low	Almost High	High	Medium
20.	Assurance of Success	Low	Moderate to High	Moderate	High	Moderate	Moderate to High
21.	Implementati on	Easy, But Take Long Time.	Complex	Easy	Easy.	Easy	Moderate
22.	Documentatio n and Training	High, Necessary	Yes, But Moderate	Yes, But Not Necessary	Yes, But Not Necessary	Necessary	Required, But Limited
23.	Software Testing	After Coding Phase Complete d.	At The End of Iteration Complete d	After Every Prototype to be Functional/Iter ation	After Every Iteration	After Completi on of Each Phase	After Coding Phase Completio n
24.	Software Release Cycle	Big Band, All	Big Band, All	In Phases/After Every Iteration	In Phases/Aft er Every Iteration	Big Band, All	In Phases/Aft er Every Iteration
		Functiona lity release at once.	Functional ity release at once.			Functiona lity release at once	
25.	Risk Analysis	Only at the Beginning	No Risk Analysis	No Risk Analysis	Yes	Yes	Yes, But Medium

B. Companies Comparison matrix

Table 2: Companies Model Comparison Matrix

S No.	Features	Company A Model	Company B Model	Company C Model
1.	Requirement Gathering in the Beginning	Not All Requirements Gather initially, Frequently Changed and periodically gathers.	Not All Requirements Gather initially, Frequently Changed and periodically gathers.	Almost all requirements gather initially
2.	Project Cost Estimation	Above Estimated Cost	Almost as Estimated	Above Estimated Cost
3.	Model Implementation Cost	Low	Medium	Medium
4.	SDLC Phases Overlapping	Yes	Yes	Yes
5.	Development Process	Light Weight Process	Light Weight Process	Light Weight Process
6.	Customer Participation	High, After Each Prototype	High, After Each Release	Medium
7.	Appropriate Project Size	Medium to Large Scale	Medium to Large Scale	Medium to Large Scale
8.	Essential Basic Business Knowledge	Not Necessary	Yes, But not Necessary	Yes, it is necessary
9.	Simplicity	Simple	Complex	Simple
10.	Flexibility	Flexible	Flexible	Least Flexible
11.	Maintenance	Least Maintainable	Maintainable	Maintainable
12.	Risk Concern	Medium	Low	Medium
13	QA Phase	High	Medium to High	Medium to High
14.	Reusability	Possible	Possible	Possible
15.	Development Team Size	Medium Team Size Required.	Medium Team Size Required	Medium Team Size Required
16.	Overall Goal	Rapid Development	High quality but Rapid Development	High quality but Rapid Development
17.	Primary requirement gathering Goal	High Assurance	Moderate Assurance	High Assurance
18.	Time Frame	Long	Long	Medium to Long
19.	Availability of Working Software/Project	At the End of the Software Life Cycle.	After the completion of software Release	At the End of the Software Life Cycle.
20.	Changes Integration	Easy	Easy	Medium
21.	Framework Type	Iterative	Iterative	Iterative
22.	Rework/Modification Cost	Medium	Medium	Medium
23.	Assurance of Success	Low	Medium	Medium
24.	Implementation	Moderate	Complex	Moderate
25.	Documentation and Training	Yes, But Not Necessary	Yes, But Not Necessary	Yes
26.	Software Testing	After Completed a milestone (Parallel Activity).	After Completed a milestone (Parallel Activity)	After completed a milestone (Parallel Activity)
27.	Software Release Cycle	Big Band, All Functionality release at once.	In phases After completion of every phase	Big Band, All Functionality release at once.
28.	Risk Analysis	Every Phase	Every Phase	At the start of the implementation

V. PROPOSED SOLUTION

Below is a proposed model in which all the issues discussed above are resolved and it is validated through company 1 as per they assumes the practical implementation of the model. The model consists of eight phases, every phase is own importance and it can be used by SME software house in Pakistan because the model is applicable to the limited scope product and it could be the standardization for middle level companies to get their maturity levels.

The first phase is to gather the requirement from client an analysis it, after this immediately discussed the stated requirements with client by developing a prototype. Since the product is all about the client satisfaction so to clarify or visualize the end product is necessary. After the prototype is developed then it is verified by client and if he agree then the process will move forward otherwise requirement analysis will redone with involvement of client. Once the verified prototype is final then the development is starts and the developed product is functionally test here and after this it is deployed in client testing environment to test it further once a go signal is get by client then the product is finally deployed. Below are

some points that can prove the proposed model to counter the issues discovered in this research.

- Since client is involved throughout the practice then no conflict of requirement will be occur here.
- The prototype is developed and verified by client so development team is free to develop the product and change management will not be done.
- Since the prototype is developed and process is faster as compare to waterfall then the deliverable product will be in hand earlier.
- The time management is the key factor here as when client is doing UAT then resources are free to work on other specification and release upgrading process is faster as compare to other model.
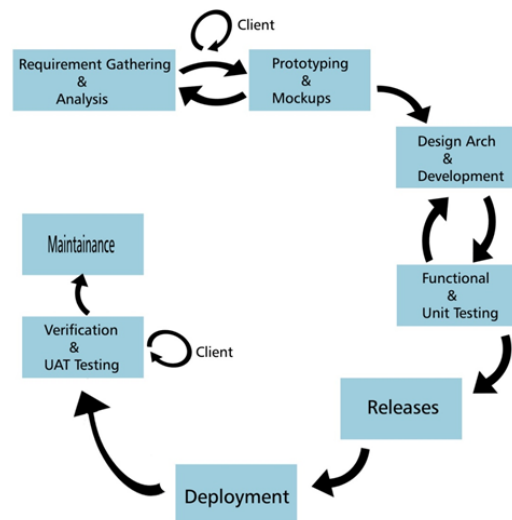

Fig. 4. Proposed Model

FUTURE WORK

This study covers the reasons that are why small software houses are not able to survive in the CMM Level 5. I covered the country Pakistan. Future work might conduct study to look the raised concern in global manner and look that this is the matter of small software house only in Pakistan or same issue could be found in other companies as well. I have validated the model through company experts but the actual worth needs to be found by implementing it on multiple software development.

CONCLUSION

Since the study assume the company size to be 30-40 employees as it is suggested to be SME. This could be changed according to the research as it is not fixed but interview conducting companies were based on around 30 employees. Software industry is mandatory for Pakistan economy. For this it needs to be improved on a global level. Generally people think about the large software houses but here small software houses should be focused as they are not getting the level of maturity. The proposed model can became the standard for Pakistan SME software so as they can achieve the level of maturity as per CMM Level.

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