

Outsourcing Agile Software Development Model Using Grounded Theory

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ABSTRACT

Co-located teams are a hallmark of agile software development that supports face-to-face communication, collaboration and control of team members. On contrary Outsource teams, integrate agile methods regardless of space, time and culture of team members. A lot is known in literature regarding outsource agile but some of its challenges like architectural and managerial management need to be addressed efficiently. This study explores practitioners opinion regarding critical deficiencies of outsource agile software development. In doing so, Grounded Theory research has been applied that involved 25 respondents from different locations all over the world. The main concern was to investigate the key concerns of outsource agile software development process. This study illustrates maturation from theory to model saturation for proving “theory of architectural and managerial management”. Thus, mentions, how outsource agile software development process caters to key concerns. For theory evaluation eleven null hypothesis were generated and proved statistically. And for model saturation, outsource agile software development tool was developed and mapped to published case study. This study will also provide researchers and practitioners with evolving guidelines, new techniques and strategies for making outsource agile software development successful.

KEYWORDS: *Outsourcing Agile Software Development, Agile Product Line Outsourcing, Lean Outsourcing.*

I. INTRODUCTION

Globalization expands the prism for business leaders by providing new options and opportunities for business processes thus it has taken over every industry including software development. Global software development has become emergent area due to its fruitful output and efficient development of software projects. Processes keep on emerging with the passage of time. Existing functions, approaches and processes are also adapted, merged, reevaluated and strategically improved [25][26]. In order to keep pace with market trends best practices are promptly reinvented. Similarly the quest for identifying new approaches and methods for growing revenue and increased return of investment has become the motivation for business leaders. Global software development is defined as “team are situated across boundaries of a region” [1]. Outsourcing has experienced great rise in global markets [2]. According to [3] 84% of shift of trend has been estimated within 2014 and only 16% have moved back to home country. Common reason are offshore supplier performance, customer perception etc. Common success factors for high turnover for outsourcing includes; high level of performance, utilizing skilled human resources, use of latest technology, gaining 24-hour development cycle, access to new markets, low costs, high quality, increased productivity, quality customer services. Software development in information systems has also shifted towards outsourcing [4]. Outsourcing is a contracting out business process. It is defined as “contracting out business processes that were performed internally by client organization to vendor organizations”. As a result of which vendors provide good quality services regarding remuneration [5].

Although outsourcing has an edge of cuttings costs and providing increased quality and productivity but it does comes with price of many challenges like hidden costs, client-vendor relationship, cultural difference, data privacy, contract management and inexperienced staffing. Most importantly internal and external management, client-vendor relationships and hidden costs that arise due to scope creep need to be addressed properly. One study showed that despite the prospective benefits, often cost estimates are not achieved, thus back-sourcing takes place [5]. Several challenges that occur in outsourcing lifecycle are; selection of vendors and strategy building. As it is distributed environment so tackling requirements becomes most crucial concern for outsourcing, communication, coordination and control, risk, architectural management. Another common yet major and concern of outsourcing is portability and interoperability [6][8]. In order to handle above mentioned concerns agile practices are regularly incorporated within outsourcing but some of the major issues regarding communication and architecture somehow still exist [9]. Agile methodology doesn't answer architectural questions completely such as extreme programming answer architectural questions very late while others provide an architectural runaway [10].

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The aim of this research is to propose a hybrid agile model formulated on the basis of grounded theory. The proposed model tends to compliment architectural issues and also result in efficient development of projects within cost and budget. For this proposition Qualitative Grounded Theory research method was implored for data collection and analysis. The results were gathered from statistical analysis and tool development.

II. RELATED WORK

Considerable research has been conducted within the field of outsourcing and different approaches and practices have been implemented in outsourcing [11-13]. Agile practices have also been merged with outsourcing. Several approaches exist in literature regarding their merger. This section explores different literature regarding Outsourcing, outsource agile software development, lean and product line. It also explains past related work regarding agile outsource software development, their gaps and motivation drawn for our work. Similarly relevancy of meta-model to our work has also been explained in this section.

In [14] authors conducted a literature review regarding implementation of Outsource agile software development. According to their research and analysis distributed environment demands tailoring of different agile practices on basis of situation and context. Agile comes with some challenges [19-22]. However to get this combination to work, considerable effort is needed. Likewise traditional software development tend to divide task competencies into independent and implicit modules in order to reduce communication between sites but when it comes to agile software projects development in outsourcing require clear modular structure and minimized communication might result in less efficient and misinterpreted product. But demonstrations of each working functionality could be organized at the end of every sprint using videoconferencing. But their results were only limited to peer-reviewed journals within time period of 1999 to 2009. From their results and conclusion we draw motivation for our research regarding outsource agile software development as their peer reviewed results serve as a base for our literature review.

Similarly, another study regarding agile and lean merger proved the merger at any specific level is possible[15][17]. Lean and agile could be combined at principle level as well as practice level. But we drew our motivation in regard of combination of agile and lean. Their results showed that merger of lean and agile was possible on every level of software development and lean proves to be substitute for time boxed agile. Another research [10] discussed the gaps which agile methodology couldn't fulfil like; extreme programming answers architectural questions very late, and while others such as scrum provides an architectural runaway. They also discussed approach to complement architectural issues for lean and agile development. The approach resulted in efficient development of projects within cost and budget but their approach could not cater budget steering applications. As their results showed architectural refactoring and design implementations which formed as our motivation. As all models made use of tailoring of method chunks so situational method engineering was another related concept for our work. Situational Method Engineering (SME) is defined as tailoring of different methods, methodologies and processes according to situations. It could be done for creating a new method or modifying existing methods. Modification requires tailoring of "off-the-shelf" method. Base methods comprise of instances of classes thus in the form of Meta-model. "One size does not fit all". Every organization has a separate culture and environment, so there is a need for SME [16]. For best practices of agile methodologies, [18] identified 27 situational factors which were used for the construction and development of agile service oriented methodology. They further divided those factors into five categories. Business units, customers, markets, products and stakeholder involvement.

III. RESEARCH METHODOLOGY

The methodology incorporated for this research was Grounded theory. Data was collected from two sources one was published literature, case studies and empirical studies were also reviewed. Direct interviews were also conducted with practitioners in order to make our grounded theory strong. On the basis of data gathered, several key points were identified, that helped in formulating hybrid solution. Hybrid solution was given in the form of process quality model that incorporated quality and change management parts. The formulated solution was then verified and evaluated with the help of tool and published case studies.

A. Data Collection

As an initial step, extensive literature was reviewed. Different studies were searched through extensive online databases. Selection of literature was done on the basis of three criteria's. Firstly selected studies covered area of distributed software development, secondly, the studies have been peer reviewed by experts and thirdly they have been evaluated through case studies. The third criteria helped us in getting empirical data from industry. Mostly data gathered showed that India is highly ranked in location wise distribution of outsourcing. Domain experts were contacted through LinkedIn social network. When those domain experts 'practitioners' found the concept regarding our research, we exchanged emails regular correspondence. Those who participated

in interviews were asked to fill a consent form, that personnel information and data will not be disclosed due to our ethical considerations.

B. Data Analysis

The data gathered and identified critical barriers were analysed using multiple regression models. As this research corresponds to exploratory research therefore it was necessary to find the multiple regression impact. That was done for all identified critical barriers and their impact on agile methodologies being used in outsourcing. Many new concepts began to emerge which were analysed using “constant comparison method”.

It was thought appropriate to perform multiple regression analysis, where relationship between independent variables (critical barriers) and dependent variables (agile outsource success) is established [17].

General regression model equation:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \epsilon$$

Where; y =dependent variable

β = regression coefficient

X_1, \dots, X_n = independent variables

ϵ =random error component

β determines the influence by X . As we also have considered contextual factors i.e. context=<situation, decision>[18], so new improved equation for our independent and dependent variables became as follows;

$$y(C) = \beta_0 + \beta_1 S X_1 + \beta_2 S X_2 + \dots + \beta_n S X_n + \epsilon$$

Where; C = contextual factors and S = situation

Contextual factors found from our research were categorized into three dimension.

C. Open Coding

[19] Describes “open coding as an initial step in performing theoretical analysis for discovery of initial categories, concepts and their properties”. Open coding is breaking down the gathered data and comparing with existing concepts in order to get codes and categories. Key point technique is used for open coding as it saves time and removes ambiguities. An example of analysis is shown below:

INTERVIEW QUOTATION: “Although we can solve but we can't due to lack of understanding of new creeping requirements because of minimum communication”.

KP1: New creeping requirements because of minimum communication

Code: Linguistic and cultural differences

Similarly codes were extracted for each statement from the interview. To analyse the codes, they were compared to each other in order to check the relevance. Related codes with and related concepts grouped to produce generalized category, thus, presenting higher level of abstraction.

D. Hybrid Agile Model

On the basis of identified critical barriers, hybrid solution was formulated, that catered outsource agile software development challenges in an efficient manner [24]. Different agile, lean and product line practices were implemented at every phase of outsourcing. Fig 1 shows the complete hybrid agile model that was proposed as a solution to critical challenges. This section summarizes the brief description of our model. The model is formulated by using best practices of agile, lean and product line engineering. The merger had been possible with the help of situational method engineering and tailoring activities. From [15], we were able to apply lean best practices on every level of outsource agile software development process. Some new lean concepts had been combined with product-line e.g. continuous coordination, push & pull, network analyser, value specification, Just-in-time, value stream, reduction of set activities and delivery-in-time. On the basis of improved model proposed by [23] we were able to expand outsourcing phases as well as change management was incorporated. The model comprised of two managerial levels; Project management and operations management. In project management level, three phases of outsourcing are catered. Decision and planning for outsourcing was done followed by selection of suitable vendors, sourcing vendors and defining work. Roles and responsibilities were defined simultaneously. After strategy and selection of vendors negotiation is done. Then comes the operation management that involved implementation through Continuous coordination and production levelling. Project is launched and requirements are stored in agile product line backlog, which is a prioritized requirement repository. Sprint meetings are arranged on daily as well as weekly basis for continuous communication of up gradations and approved changes. Team members are involved and their feedback is also supported. After implementation, management is most important phase in which different quality management tools are used for contract negotiation, vendor management and requirement management. Changes are also checked for ripple effects and defects are also tested in this phase. After all these phases, model entered the completion phase, in which contract is closed and process is delivered and integrated at the destination.

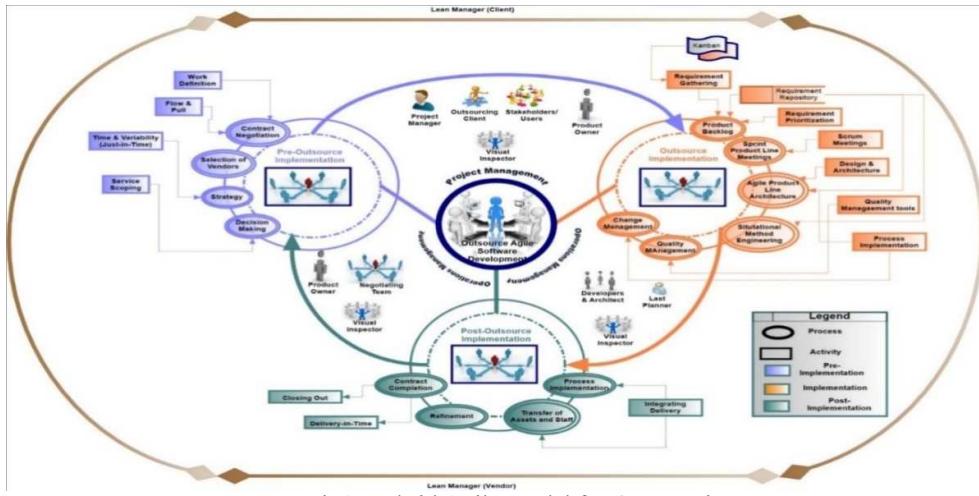


Fig1: Hybrid Agile Model for Outsourcing

IV. EVALUATION

A. Statistical Analysis

For evaluating our proposed model eleven null hypothesis were generated. The answers collected from the questionnaire and interviews regarding proposed model have been refined and proved for the generated null hypothesis. Main purpose of refining data was to remove threats to validity and intrinsic fuzziness of ordinal and informal answers. The questions apply for outsource agile projects as well as the specific methodology used by organizations for completing projects. We have used structured term for the specific methodology. Questionnaire was sent to 48 organizations out of which 30 responses came back. 25 were of outsource agile while remaining 5 were from structured organizations. The bulk of our results show that outsource agile is more effective than structured approaches. For evaluating proposed theory eleven null hypothesis are mentioned as follows which refer to outsource agile development projects;

H_0^A : There is no difference in ease of use of outsource agile methodologies vs structured methodologies.

H_0^B : There is no difference in overall success of use of outsource agile methodologies vs structured methodologies.

H_0^C : There is certain level of motivation of teams using outsource agile methodologies vs structured methodologies.

H_0^D : There is certain level of difference in management using outsource agile methodologies vs structured methodologies.

H_0^E : There is difference in real-time communication in outsource agile methodologies vs structured methodologies.

H_0^F : There is certain level of difference of asynchronous communication using outsource agile methodologies vs structured methodologies.

H_0^G : Requirements and architecture vary in using outsource agile methodologies vs structured methodologies.

H_0^H : There is difference in client-vendor communication in outsource agile methodologies vs structured methodologies.

H_0^I : There is difference in culture in outsource agile methodologies vs structured methodologies.

H_0^J : There is certain level of difference in client-vendor knowledge transfer in outsource agile methodologies vs structured methodologies.

H_0^K : There is difference in work definitions and work competencies in outsource agile methodologies vs structured methodologies.

Each hypothesis was enclosed in separate question and added to questionnaire. The answers were collected in two phases. Questionnaire was sent to domain experts from different organization all over the world, mostly from USA, India, and Norway and interview was conducted with 3 organizations of Pakistan who are outsourcing vendors and apply traditional as well as agile methodologies. Both interviews and questionnaire targeted at finding answers for each mentioned hypothesis, as we have mentioned context of grounded theory in which we have given participants detail regarding outsource agile organizations. We sent questionnaires to 48 organizations located all over the world, only 30 responses came back in which 25 projects developed by companies in Norway (6), USA (11), and India (8) were related to outsource agile while 5 were of structured projects developed by companies in the India (1), USA (2) and Pakistan (2). As Pakistani companies were feasible therefore 3 case studies were also conducted in 3 software houses who dealt in outsourcing and were outsourcing vendors. The responses were gathered by experienced staff; agile coach (5), Developers (6), Scrum

master (4), Business analyst (6), Integration team lead (4) and Project managers (2). The responses gathered were quantitatively analysed for each hypothesis and ranking was provided to each rating. Mann-Witney U test was applied in order to prove null hypothesis and probability was also estimated. Each rating was provided by each participant was analysed for mean, median, mean ranking, standard deviations and Mann-Whitney U test value for calculated for each sample and then combined sample U value was provided p represents the probability. As one-tail hypothesis was calculated therefore a significance value β was also defined, for the analysis we defined $\beta=0.05$. Value of p was compared to β , if $\beta < p$ then null hypothesis was accepted otherwise alternate hypothesis was accepted. Table 1 shows the complete quantitative analysis of responses for hypothesis $H_0^A - H_0^K$. In the table Pr represents the parameters derived for each hypothesis, T defines the type of organization, whether it is outsource agile or structured organization. Mean, Min/Max, Med (median), M.rank (Mean rank), Std.dev (standard deviation), U (Mann-Whitney U test) and p (probability) represent the qualitative analysis in order to accept or reject the hypothesis, as we have applied Mann-Whitney U test therefore mean rank was required. First ratings are sorted and then assigned a value on the ranking scale, this helps to calculate U-value. While probability is compared to the significance value in order to accept or reject the proposed null hypothesis.

Normality test was performed for considering the underlying distribution, but none proved to be having normal distribution therefore, Mann-Whitney U test was performed. When data is non-normally distributed and non-parametric then Mann-Whitney test should be performed for statistical hypothesis test. Each hypothesis was checked for the probability and compared to its significance value. The statistical analysis showed that null hypothesis were distributed above significance level hence null hypothesis were accepted. The distribution of null hypothesis is shown in fig 2 and fig 3. Further in order to prove our null hypothesis correlation, Spearman's Rho correlation test was performed. As the data gathered was ordinal and non-parametric therefore Spearman's Rho test was best suited to find the statistical significance. Table 2 shows the Spearman's Rho coefficient value and probability p . therefore, it proves our hypothesis by showing, difference between random variables is not significant

Table 1 Quantitative analysis of responses for hypothesis $H_0^A - H_0^K$.

Pr.	T	#	Mean	Min/Max	Med	M.rank	Std.dev	U	p
H_0^A : Easeability	OA S	25 5	7.6 7.8	5/10 5/10	7.5 8	6.8 7.3	1.68 1.92	18.5	0.88
H_0^B : Success	OA S	25 5	8.5 7.8	5/10 7/9	9 8	8.2 5.1	1.60 0.83	10.5	0.19
H_0^C : Motivation	OA S	25 5	8.6 8.2	6/10 7/9	9 8	7.6 5.8	1.30 0.83	14	0.42
H_0^D : Management	OA S	25 5	3.4 3.2	2/5 2/4	3.5 3	7.4 6.4	1.06 0.83	17	0.71
H_0^E : Real-time communication	OA S	25 5	3.8 3.4	2/6 2/5	3.5 3	7.2 6.7	1.75 1.14	18.5	0.88
H_0^F : asynchronous communication	OA S	25 5	2.3 1.6	1/3 1/3	2 1	8.1 5.2	0.70 0.89	11	0.19
H_0^G : Requirement & architecture	OA S	25 5	2.4 2.4	1/4 2/3	2.5 2	7 7	1.06 0.55	20	0.94
H_0^H : Distance	OA S	25 5	2.1 2	1/3 1/3	2 2	7.2 6.7	0.83 1	18.5	0.88
H_0^I : Culture	OA S	25 5	2.9 3	1/4 1/4	3 3	6.8 7.3	1.13 1.22	18.5	0.88
H_0^J : Knowledge transfer	OA S	25 5	2.4 2	1/4 1/4	2 2	7.5 6.2	1.19 1.22	16	0.60
H_0^K : Work competencies	OA S	25 5	2.1 2	1/3 1/3	2 2	7.2 6.7	0.83 1	18.5	0.88

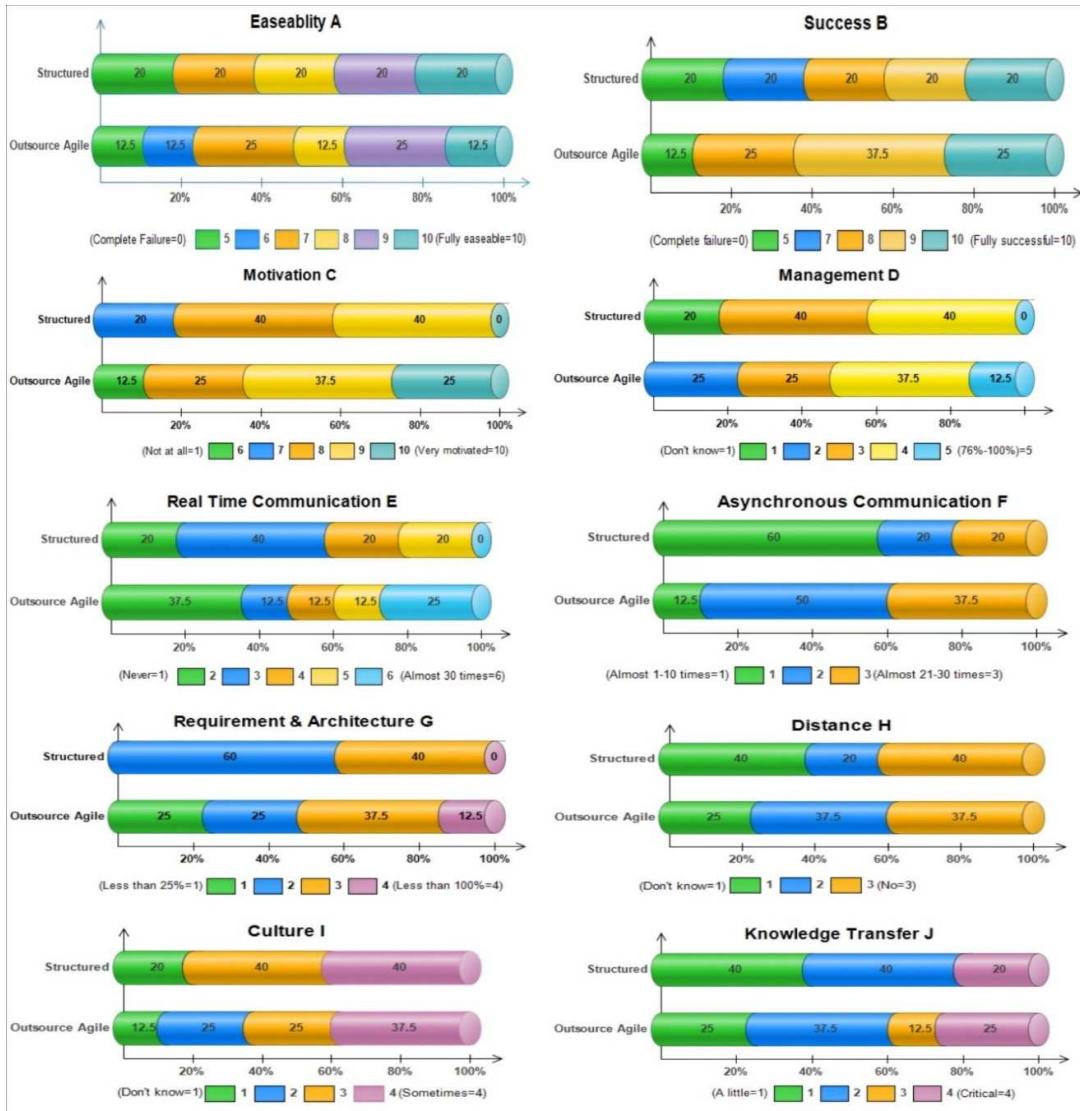
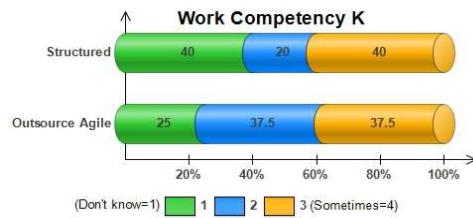
Fig2: Charts representing the distribution against each hypothesis from $H_0^A - H_0^J$ Fig 3 Chart representing the distribution against hypothesis H_0^K

Table 2 Spearman's Rho coefficient for random variables

Pair of variables	Spearman's Rho Coefficient <i>r</i>	Probability <i>p</i>
Success C/ Motivation C	0.205	0.626
Management D/ Real-time communication E	-0.044	0.916
Management D/ Requirement & architecture G	-0.356	0.385

B.

C. Tool Development

Before developing the Outsource Agile Software Development Tool (OASD), architecture was developed in order to map our model with the tool as shown in fig 4. Tool was developed with the goal of supporting the solution of outsource agile software development drawbacks using Scrum, XP, Lean and product line best practices. The tool also provides support for contract management, vendor selection and approval, contract closing. Published case represented library management system that was outsourced in order to achieve better and efficient library management system. Reasons for the selection of published case was, its relevancy and published results. Lacking's in present case were contract management, vendor selection and architectural management. Our tool will provide automated Library Management System, contract is handled efficiently and vendors are selected on the basis of their expertise level. As compared to traditional approach of outsourcing, our tool automated the outsourcing of Library Management System. In traditional approach contract was difficult to handle, and vendor selection was an issue but our tool catered to the contract as soon as possible as it was being done through the tool. Fig 5 shows the product backlog of library management system. In order to validate our tool and its management of published outsourcing case, we took our tool to the library of a renowned university. Limited time and space was given to them in order to provide feedback regarding outsource Library Management System (LMS). In order to get their responses, a multiple choice questionnaire was designed according to the Likert scale, with one to five rating scale (the end result for each question was obtained by the sum of the positive grades, ignoring the neutral grade). Results obtained from the tool were compared with the results obtained from the published case study. Fig 6 shows the result comparison of LMS outsourced functionalities, while fig7 shows the comparison of results regarding the contextual factors.

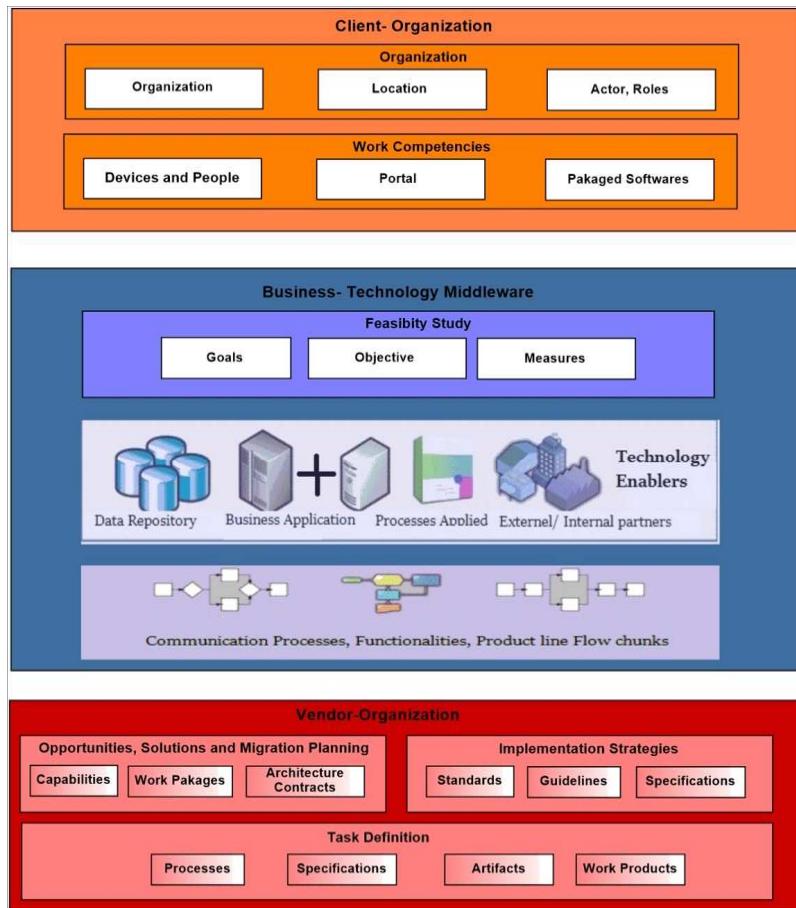


Fig 4 Architectural view

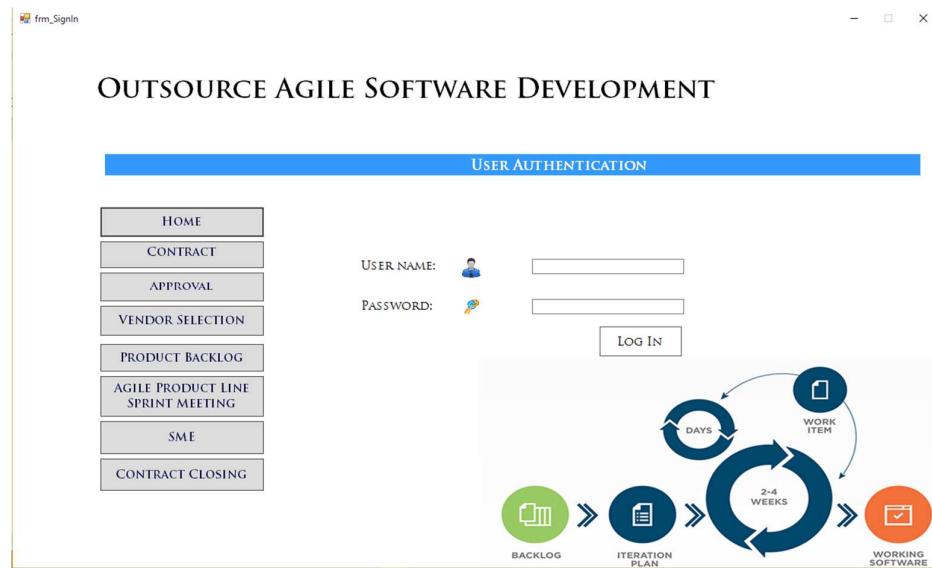


Fig 5 Product Backlog

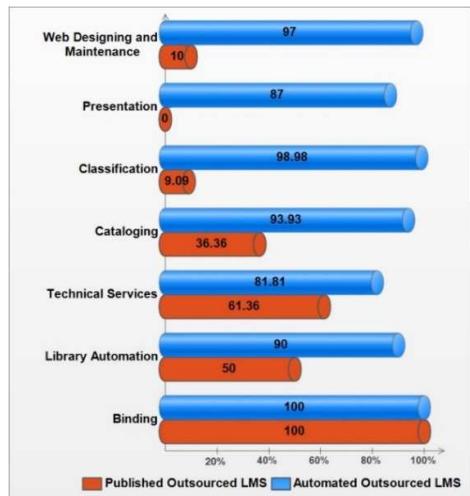


Fig 6 Comparison of Results of LMS Outsourced Functionalities

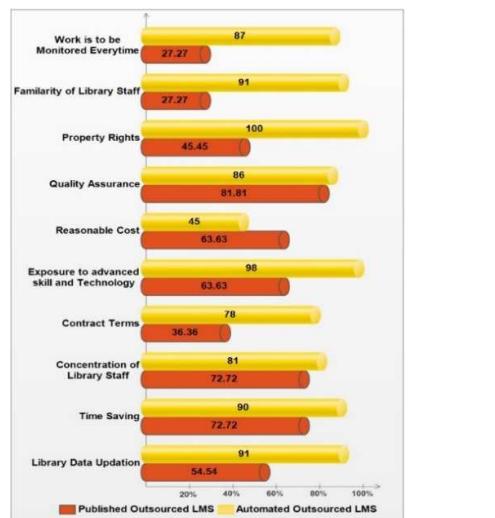


Fig 7 Comparison of Results of LMS Contextual Factors

V. CONCLUSION AND FUTURE WORK

Outsourcing contributes almost three quarters of the revenue of IT industry and is being used in global industry due to its high productivity and better quality within estimated time and limited budget. One solution to overcome critical barriers of outsourcing is using agile practices as they provide better project management. Agile along with its perks, comes with some challenges. Mostly scrum and XP are being applied for outsourcing but no hybrid agile solution has been proposed that uses lean with agile and outsourcing. Therefore, our research aimed at proposing a hybrid agile solution based on the Agile, Lean and Product line trilogy. Thus, providing efficient project management, requirement gather and solves the architectural issues occurred during outsourcing. Hybrid agile solution was shifted into a formal theory (model) using qualitative grounded theory.

Outsource agile software development tool was development on the basis of proposed theory. In order to evaluate the developed tool, data set of a published outsource library management system case study was mapped on the tool. Comparison between results showed that automated outsource library management proved to be more efficient.

We have also presented statistical analysis of eleven proposed hypothesis and correlation between success, motivation, ease-ability, management, real time communication and requirement and architecture has been evaluated statistically. The obtained results showed that the correlations between traditional and proposed approach are not negligible and without statistical significance: choosing outsource agile software development approach rather than traditional approach appears to be a crucial decision for outsourced projects. As future work, we plan to investigate various traditional and outsource agile software development projects in detail, also determine which practices of both the approaches are followed in practice, and to identify common practices across different projects.

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