A Practical Application of the IDEAL Model

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Abstract. The focus of this paper is to outline the experience of a European based software organization utilizing the IDEAL model, while implementing a tailored Capability Maturity Model (CMM) software process improvement program. The goal was to achieve process improvement rather than a specific CMM maturity level. In doing this, the IDEAL model was extensively researched and employed. The benefits and limitations of the IDEAL model are presented as experienced. Further details on this research are available in [1]. Research was carried out on a number of software process improvement paradigms prior to the selection of the CMM. A key element of this approach was to see the requirements of the organization as paramount and immediate. It was deemed important to achieve process improvement in specific Key Process Areas regardless of their position in the CMM. This provided the flexibility for future investment in SPI to capitalize on the current work.

1. Introduction

Software process improvement (SPI) is a complex and expensive exercise, which should not be entered into lightly and without due preparation. Therefore the correct implementation of any improvement initiative is an important undertaking. To implement an improvement plan, companies must consider how they should go about it. This is particularly important for the small to medium sized enterprises (SME), where the company needs to have fast return on investment [2]. No company, regardless of whether they are large or small, is willing to undertake any project without being assured that the resources expended will in fact give maximum value for money. The research project presented here demonstrates an implementation of the IDEAL model in an SME, ensuring that the organization's business requirements are top priority.

2. Research Project

The action research five-phase cyclical process based approach as defined by Susman and Evered [3] and Baserville [4] was used during this research project. This approach allowed one of the authors perform the role of assessor in the process improvement program detailed in this paper. It also provided both authors with the objectivity and structure to effectively perform their work.

The project was carried out within a subsidiary of a software company employing 120 people. It was focused on two teams with a total staff of 20, running an independent process. It had its own Project Manager who reported directly to senior management and was financed as an independent profit centre. This subsidiary, given its independent mode of operation meets the criteria necessary to be defined as a SME.

The questions being researched in this project include:

- Can standard models work within SME companies?
- Do process improvement models make a meaningful contribution, or do they add unnecessary levels of bureaucracy?
- Does the IDEAL model work?
- How does the research undertaken in this project compare with the findings on the IDEAL model presented by Bill Curtis at the ICSE 2000[5]?

3. Background of the Organization

The organization, Software Future Technologies (pseudonym) is based in the Republic of Ireland and while having an Irish management team, is part of a multinational whose parent is in the United States. The parent organization established a mainframe software application development and maintenance company in Ireland in the nineteen nineties. While mainframe application development and maintenance continued to be a significant part of the organization's business, by 1999 the technological focus of the Irish operation had evolved to include the development and maintenance of applications on a number of diverse platforms, including client server, web-based and CASE tool technologies. Software Future Technologies developed and expanded its market share in Europe and the US, and while this research was being carried out, employed 120 staff.

3.1 History of the Process Improvement within the Organization

In 1998 the parent organization took the strategic decision to develop a CMM-compliant process for all its software development and maintenance activities. Plans were drawn up for a US based assessment to take place. A CMM assessment of the Irish operation was also scheduled to take place. SEI-approved CMM assessor

training was provided to key members of staff, including one of the authors. However, due to a sudden change in corporate strategy, the CMM initiative was dropped for both the US and the Irish division.

3.2 Software Future Technologies Process

On establishing Software Future Technologies a defined process had been documented for mainframe software application development and maintenance. The documented process was stored on the company's intranet. This proved very successful. Despite the introduction of projects for other platforms no new defined processes were developed. Basic Requirements Management (Key Process Area (KPA) at Level 2 of the CMM) was in place as was limited Project Planning (KPA at Level 2) and Project Tracking and Oversight (KPA at Level 2). A number of methods of Configuration Management (KPA at Level 2) were employed, but this did not extend to documentation or specifications and was not used on all projects. An extensive Training Program (KPA at Level 3) was in place and Peer Reviews (KPA at Level 3) were carried out from the establishment of Software Future Technologies in Ireland. While some basic Software Quality Assurance Key Process Area practices were in place, defect reoccurrence had been identified as a major problem area. Any process improvement initiative in Software Future Technologies would have to address this problem.

Having reviewed customer and prospective customer quality expectations, it was determined by the Marketing department that there was no demand for the organization to achieve any specific external certified quality standard, or the achievement of a specific maturity level. This allowed the assessor to review and evaluate a number of standards for application in the process improvement initiative.

4. Selection of the CMM

A number of process improvement models were reviewed prior to the selection of the CMM as the basis for this initiative, including ISO 9001 and ISO/IEC 15504 (SPICE). The goal of this review was to determine the most suitable and flexible model for the organization to implement. Each model was extensively compared and their strengths and weaknesses explored.

The CMM and ISO 9001 are the most popular frameworks for process improvement within the software industry [6]. Indeed it has been recognised there is a strong correlation between ISO 9001 and the CMM [7]. That stated, clear differences have been recognised in each approach [6], [8], [9]. Given the organization's European location, ISO 9001 was a strong contender.

Based on the organizations goals an extensive comparison was made between the CMM and ISO. This included the examination of Paulk [7] and O'Tinney [8]. The

final decision to choose the CMM was reached because ISO 9001 had specific limitations from the organization's perspective. In particular the ISO standard provided only a minimum quality baseline for software organizations [7]. ISO 9001 placed an emphasis on meeting minimum requirements rather then promoting continued process improvement.

ISO/IEC 15504 (SPICE) was also considered. This standard was in beta test at the time the initiative was undertaken. It did offer advantages; these included the separation of process and capability into two dimensions and the consistency of results between ISO/IEC 15504 and CMM [10]. The problem identified with this option was that there was only an academic knowledge of the model within the organization and the cost of further training and outside support would be high.

On the other hand the CMM offered a comprehensive approach to process improvement. There was also the advantage of the opportunity to leverage any formal CMM assessment that might take place in the medium to long term utilising ISO/IEC 15504 to generate an internationally standardised rating. The compatibility between ISO/IEC 15504 and the CMM was seen as a further advantage offered for utilising the CMM. While ISO/IEC 15504 was the up and coming standard, the CMM was the proven market leader. A commitment to continued process improvement was a key element in the initiative undertaken. It was also determined that given the location of a number of the organization's customers in the US, a US centric improvement paradigm with acceptance in Europe would be the perfect model to apply.

The process improvement initiative had to be performed under a number of constraints and within a defined scope to achieve clear goals and objectives. The scope, objectives and constraints had only been verbally discussed. It was understood there was need for clear guidance on the implementation of the process improvement initiative. That guidance appeared to be provided by the IDEAL model [11]. The initial selection of the IDEAL model as the life cycle approach to the process improvement initiative went hand in hand with the selection of the CMM [12].

5. The IDEAL Model

The IDEAL model [13] is defined as " *A life Cycle approach for process improvement*". It was developed by the Software Engineering Institute (SEI) and based on the CMM [14]. The model clearly has its roots in the Shewart/Deming cycle Plan Do Check Act approach [9]. It offers specific and practical implementation guidelines for the adoption of new software processes and methods. It addresses the essential phases, activities, and resources required for effective process improvement to take place. Given the potential offered by the IDEAL model for general application the SEI have revised it and Version 1.1 has been used in this project.

The model consists of five phases (See Fig. 1):

Initiating	Laying the groundwork
Diagnosing	Determining where you are and your future goals
Establishing	Planning how you are going to achieve your goals
Acting	Doing the work required to reach the defined goals
Learning /**L**everaging[1]	Learning from what has been done for the next iteration of the process improvement cycle

The five phases consist of a total of fourteen activities, which address the specific requirements of one complete cycle of the model. The length of time taken to complete a cycle depends on the resources and the agreed time frame defined for each iteration by the organization.

Each phase is made up of a number of activities. In the Initiating phase the business reasons for undertaking the initiative are recognized and defined. The whole effort is put in context within the organization's business goals and objectives. The benefits, which will result from the effort are defined and articulated. Senior management sponsorship is established. To manage the initiative a Management Steering Group and Software Engineering Process Group are formed.

During the Diagnosing phase the current state of the organization is determined and a baseline established. The recommendations that arise from this activity provide the basis for a draft improvement action plan.

The purpose of the Establishing phase is to develop a detailed action plan. Priorities are determined which take external and internal factors into account. Once these priorities have been set a strategy is developed and a detailed action plan is prepared. This plan includes milestone metrics, decision points, responsibilities, resources and all other elements, which are essential for the success of the initiative.

During the Acting phase all the key elements are brought together and a best guess solution is identified. The solution is then piloted and modified through a number of iterative cycles. This can take a long period of time. Once the solution is deemed satisfactory, it is implemented.

[1] The letter 'L' of IDEAL is referred to as Leveraging in [9], [11], [13] and Learning in [14]

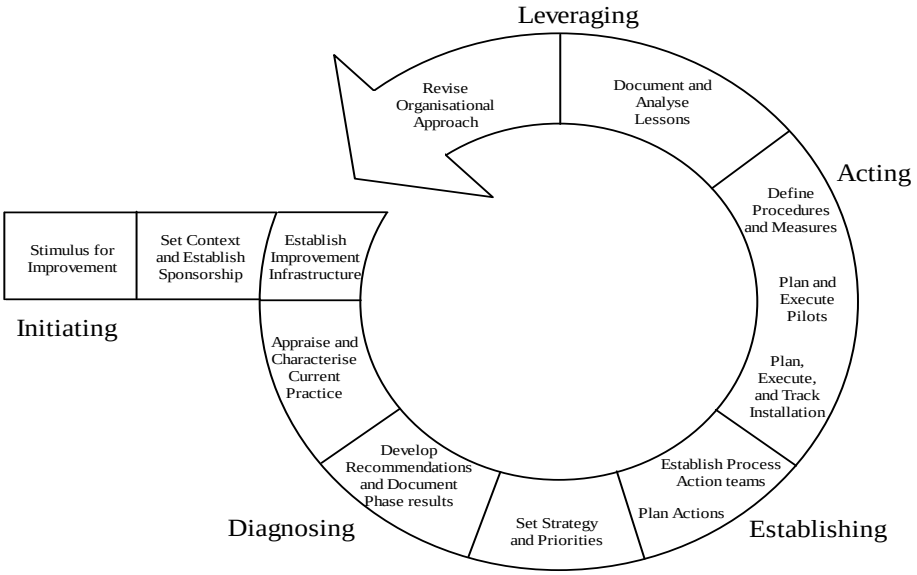

Fig. 1. The IDEAL Model [13]

The Leveraging\Learning phase focuses on learning from what has been done and determining what goals and objectives have been met. It also provides the opportunity for learning from the work undertaken and incorporating that knowledge into continued process improvement as further areas are identified and implemented during future iterations of the IDEAL cycle.

6. Using the IDEAL Model

The IDEAL model was accepted as the life cycle paradigm for the initiative at a preliminary stage, its suitability was now reviewed in detail. It was determined that in general it provided comprehensive guidelines and direction to manage the change process. It was noted that it particularly addressed initial areas of concern in the key stages of the improvement project. Management in Software Future Technologies agreed that it should be utilised in the development of the initiative's mission statement, initial project plan and as a framework for reference as the initiative developed. It was also agreed that it provided a good basis for continued improvement during future iterations of the process improvement cycle.

6.1 The Initiating Phase

Utilizing the IDEAL model as the basis for the process improvement initiative, the assessor and a senior manager held their first meeting. The first item to be addressed was to determine the stimulus for change. The business reasons for change had to be defined and articulated. The importance of this step cannot be understated. Without a clear understanding of why an improvement initiative is undertaken, it will in most circumstances be doomed to failure, given the level of commitment required by all concerned for its successful conclusion.

Two important questions were asked:

- Why are we initiating these changes?
- What are our business reasons for this undertaking?

The stimulus for change and business reasons identified included increased profitability, better levels of service to existing customers, and the development of new business. It was also realised that this initiative offered the opportunity for the development of a CMM-based development process. This would tie in with any future quality initiatives that might be undertaken by the parent organization. To address each business reason clear objectives were defined and agreed

Having determined the stimulus for change it was now time to set the SPI initiative in the context of Software Futures Technology's business strategy. It was determined that the initiative would assist with future development and expansion of business with new and existing customers by increasing customer satisfaction and enhancing the organization's reputation. It would allow the development of a repeatable, effective and efficient production process, which would underscore that expansion. It would help to ensure product delivery was on time and within budget. It would also allow management more visibility into the process at all stages of development, which was recognised as being essential for the successful maintenance and development of quality software.

Having determined what the business reasons were and how they fitted into the company's overall business strategy it was time to build sponsorship. The level of commitment required through managerial support and the availability of resources were outlined. The constraints that would have to be imposed on the effort were also defined and discussed. Management clearly understood what those constraints were and how they would impact on the level of achievable goals and objectives. This provided an excellent first step, which greatly assisted with the building of management sponsorship. A clear understanding of why the initiative was being undertaken, what goals it was going to achieve and how they fitted into the overall business strategy of the organization was invaluable in presenting and winning the required level of approval and commitment from senior management. As a result a senior manager was appointed sponsor and a long-term commitment to the initiative was made.

Sponsorship being established, it was essential to develop a mechanism to manage the implementation of the initiative. The need for the establishment of a Management Steering Group (MSG) was addressed and its role and responsibilities were defined. They included the strategic and tactical direction of the initiative. This necessitated the establishment of clear goals, setting direction, priorities and monitoring the effort.

A Software Engineering Process Group (SEPG) had been established in December 1997, but had been abandoned when the CMM initiative was cancelled. The SEPG was reconstituted and was made up of the assessor and the local outsourcing centre Project Manager. The role of the SEPG was to facilitate the definition, maintenance, and improvement of the software process. This included maintaining the motivation and the enthusiasm for process improvement within the organization.

To complete chartering the infrastructure the need for the establishment of Technical Working Groups (TWG) was identified. The role and responsibility of the TWG was defined and included dealing with specific element of process improvement as the initiative progressed. This incorporated the documenting, and assessment of current processes. It was also required to make a meaningful contribution in implementing process improvement.

It was decided after discussions with the sponsor that a mission statement would not be formulated. It was also agreed that the assessor would develop a project plan for the initiative in consultation with the MSG and the SEPG. The assessor would also be responsible for the development of a modified CMM-based appraisal method.

The project plan formally recognised the current and desired states for process improvement in the company. It set priorities for change and it formally outlined the business reasons for the initiative. It laid out a timeframe and highlighted key activities that would have to be carried out to implement the tailored process in keeping with the IDEAL model.

6.2 The Diagnosing Phase

Before meaningful process improvement can take place a company must determine its current level of maturity. "*If you don't know where you are, a map won't help*" [15]. To that end a CMM-based process assessment was undertaken [1]. As an initial step information was provided to the teams whose process was being assessed describing what the CMM was about and what was involved in a CMM assessment. There was no official rollout meeting for the initiative as the sponsor felt it was unnecessary. This was something the assessor disagreed with, as this offered an ideal opportunity to demonstrate visible management support for the effort.

A Project Manager, two team leaders and three software engineers completed the full CMM maturity questionnaire. Given the complexity of the questionnaire full support was provided to those who required clarification on any of the questionnaires content.

On completion of all questionnaires a comprehensive report was complied detailing the results. This report was analyzed and areas highlighted for further research. A document review was undertaken and some queries were answered while others were raised.

Interviews were held to clarify outstanding issues. Seven people were interviewed, a Project Manager, two team leaders and four software engineers. Four of people interviewed had completed the questionnaire. The interviews followed a structured approach and while dealing with outstanding issues also endeavored to define the existing process culture. This broadened the assessment to include areas outside the definition of the CMM, but which directly impacted on the existing process. On completion an interview report was compiled

Each CMM Key Process Area was reviewed in the light of the questionnaire, document review and interview report. A maturity audit report was prepared and a maturity level determined. The outsourcing process was rated at a CMM Maturity Level 1. It was clear that two process cultures existed side by side in the teams reviewed. These cultures were a formal disciplined approach to the process and a more ad hoc, Rapid Application Development (RAD) approach. This was due to the background of the teams involved. The maturity audit report with its specific recommendations was incorporated into the assessment report. The findings were presented to management and the teams to ensure that they were aware of what had been achieved and to prepare them for the next phase.

6.3 The Establishing Phase

Having reviewed the assessment report and analyzed pressing business requirements the Management Steering Group prioritised the establishment of a defect tracking system as an urgent requirement. The template provided by the CMM Level 5 Defect Prevention Key Process Area (KPA) provided guidance on what was required. An implementation plan was prepared which outlined the schedule, roles, milestones, and metrics, tracking and reporting procedures for the initiative.

The Software Engineering Process Group met and undertook the management of the implementation of the Defect Prevention KPA. This was purely a supportive role. The assessor prepared a non-technical translation of the KPA's key practices for presentation to the Technical Working Group (TWG). The SEPG also took responsibility for informing management and staff on a regular basis on the status of the initiative.

The next step was the selection of the TWG. It was agreed that the initial group would be made up of four members, the assessor and three software engineers. Membership of the TWG was to be on a part time position. This would ensure that the TWG members were not divorced from the rest of the organization.

The initial role of the TWG would be to examine the requirements of the KPA. When

they had established a clear understanding of them, they would tailor the KPA to meet the specific requirements of the company. When this was complete the group would take responsibility for introducing new procedures, roles, documentation, organize training and ensure the availability of essential infrastructure and resources. Feedback on the progress of the initiative would be presented to the rest of teams on a regular basis through the SEPG.

6.4 The Acting Phase

At the first meeting of the TWG the goals of the initiative were outlined and the need for the establishment of a Defect Prevention Group presented. A presentation was made on the Defect Prevention KPA (CMM Level 5) and the introduction of a Defect Tracking System. Using the Defect Prevention KPA as guide a detailed action plan was drawn up; this included the identification of resources, responsibilities, tasks, and milestones. Measurements to assess the success of the initiative were discussed and agreed, these incorporated the metrics outlined in the implementation plan.

Having a clear understanding of what was required and utilizing the CMM as a template, an effective solution was created. There was no time and more importantly no need, for the development of a best guess solution, cyclical pilot testing and refining. The CMM outlined an effective approach and the knowledge and experience of the TWG confirmed that prior to its implementation. The tailored key practices of the Key Process Area were implemented on a project-by-project basis over a three-month period.

A problem-centred approach was applied in this initiative. If all the activities outlined for the Acting phase had been carried out the time scale required would have had a serious impact on the success of the program. Curtis [16] states, "*Most successful improvement programs begin working with projects to make improvements very early*". This ensures that preliminary positive results are available to management and staff and this encourages support and enthusiasm for continued process improvement. This is particularly important in a SME with limited resources.

Using a software process improvement model like the CMM, which outlines and addresses the achievement of the goals of a mature software organization ensures that a cyclical best guess approach is not required. Tailoring of the IDEAL model to meet the needs of the organization implementing process improvement is strongly recommended [12].

6.5 The Leveraging Phase

Having successfully introduced a Defect Tracking System based on the CMM Defect Prevention KPA it was time to validate and analyze what had been done. The criteria agreed to monitor the performance of the Defect Tracking System was evaluated and reviewed. The level of success achieved in all aspects of the improvement program

was assessed. It was determined that the effort had been an overall success and had led to a quantifiable improvement in the operation of the software development process. The MSG, SEPG and TWG had all worked well together and having achieved an initial success it helped to reinforce the value of team effort and support.

While the Sponsor had been committed to the initiative, it became clear that there was a lack of overall senior management support for further process improvement in general. This was hard to understand given the success of the initiative and the minimal cost it incurred. There had been a positive effect on all aspect of the process as a result of the undertaking. The goals of the effort had been closely tied to the overall business strategy and objectives of the organization. Better software was being produced as defects were reduced and tracked back to source allowing preventive and effective action to be taken to stop reoccurrence. As a result of the re-evaluation of management sponsorship further process improvement was put on hold. To leverage from the exercise undertaken, as much material and experience gained was documented and stored. This valuable resource is available to be utilized in future process improvement activities.

7. Conclusion

The unorthodox approach to the CMM undertaken in this project is not ideal but practical. The problem with the Defect Prevention being a Level 5 Key Process Area has been used to criticise the CMM "*Why is defect prevention a Level 5 practice? Defects impact all organisations and their prevention and tracking is an important and necessary task for all organisations to be involved in regardless of their maturity level.*" Bach [17]. Taking this into consideration the implementation of the CMM presented in this project was based on the approach outlined by Bamberger [18].

The use of the IDEAL model made a substantial contribution to the success of the process improvement initiative outlined in this research. The only full time person employed on the initiative was the assessor. The Management Steering Group consisted of only two members, as did the Software Engineering Process Group. Membership of both groups was on a part time basis. The roles that both groups fulfilled provided a substantial contribution to the overall success achieved. When applying the IDEAL model in small to medium sized companies the temptation is to ignore roles like the Management Steering Group. Our research demonstrates that this group is vital and that its inclusion has direct benefits.

The Initiating phase addressed the need for a clear understanding of the initiative. Once that had been determined goals and objectives were defined and put in context with the objectives and business strategy of the organization. The clarity provided by this exercise allowed senior management to make an informed commitment to provide the necessary leadership and resources required for effective process improvement to take place. It also provided senior management with the opportunity

to decide at an early stage if the effort would be worthwhile, or if it should be abandoned. The appointment of a committed sponsor ensured that the required resources would be provided and the resistance to change that is encountered in all organizations could be addressed and successfully overcome. The commitment of senior management is key to any successful process improvement initiative and cannot be underestimated.

The Diagnosing phase allowed a baseline to be established of the existing process. It allowed a maturity level to be determined and the strengths and weaknesses of the process were highlighted. This facilitated the development of clear recommendations for current and future improvements. During the Establishing phase changes were outlined and the need for a Defect Tracking System prioritized. The Defect Prevention Key Process Area was utilized as a template for process improvement based on the business needs of the organization. An implementation plan was prepared and the Technical Working Group was established.

In the Acting phase the Technical Working Group's approach and available time scale did not allow or require the development of a best guess solution. Neither did it require the use of pilot testing and further refinement prior to implementing the improvement strategy. The CMM provided an excellent solution. The Technical Working Group did not divorce itself from the rest of the organization. Membership was a part-time role and change was introduced on a project-by-project basis. Based on the Defect Prevention KPA the Technical Working Group determined the requirements of the organization. The implementation of the Key Process Area was tailored to meet those defined requirements. If all the activities outlined in the Acting phases had been implemented it would have had a negative impact on the process improvement effort. This fact was identified at an early stage and the implementation of IDEAL model modified accordingly.

In his workshop presentation at the ICSE 2000 Curtis [5] outlined the problems encountered utilizing the IDEAL model. The problem as he defined it is what he termed "*the action teams separation from development work*". It takes too long to set priorities, develop and pilot its approach and implement process improvements. When improvements are finally implemented it is too late, both management and staff have lost faith in the improvement program. This paper concurs with those findings and has been researched independently of his work. We would not suggest that there should be a quick fix approach, but the CMM offers clear guidelines where and how improvements can be made. The CMM template should be utilized to ensure timely and effective process improvement takes place.

The Leveraging phase provides an excellent opportunity to evaluate what has been achieved and opportunity to learn from work, which has been completed. The activities of the initiative, which has been undertaken, are reviewed and analyzed. The achievement of goals and objectives are assessed. Lessons learned are recorded for future reference. The evaluation of continued sponsorship is very important. The IDEAL model quite rightly stresses the importance of continued sponsorship and support of senior management for effective process improvement to be undertaken in

further iterations of the model.

In summary the IDEAL model provided a good framework for process improvement to take place within the SME we researched. That stated, we would stress that the model should be tailored to fit the needs of the organization utilizing it [19]. The need for tailoring is clearly understood and recommended by McFeely [12] who states, when referring to the IDEAL model "*One Size Does Not Fit All!*" and "*SPI managers must tailor the guide to their particular situation*".

The layers of management, supervision and support provided by the IDEAL model encouraged effective process change and improvement. The model did not require the establishment of a bureaucratic system to be effective and offered a clear path for continuous process improvement to take place. We conclude that the modified IDEAL model worked.

The Defect Tracking System introduced as a result of this effort led to a large reduction in the number of defects produced. Defects that do arise are logged, corrected, tracked back to source and discussed. Preventive action is taken to ensure that where possible such defects do not arise again, or are identified at an earlier stage in the process. The level of rework has been reduced; milestone and deadlines have been met on a more consistent basis. Both teams are much more aware of quality as each team member spends time working as part of the Defect Tracking Team. These improvements have been achieved with the support and guidance of the IDEAL model. The CMM provided the template while the modified IDEAL model provided the framework to implement it.

In our view the tailored IDEAL model is a useful framework for software companies who wish to implement process improvement. The Initiating, Diagnosing, Establishing and Learning phases are of particular value. If the activities of the Acting phase are adapted to the needs of the organization then required results can be achieved.

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