DESIGN AND TESTING OF A METHODOLOGY FOR THESIS ADVISORY AS AN APPROACH FROM PROJECT MANAGEMENT

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Abstract

After applying several project management and quality methodologies to industry, consulting and academic projects of different complexity levels for several years, a methodology for thesis advisory was designed and implemented using an approach from projects management, for increasing the quantity and quality of terminal efficiency when facing the fact of having many students requesting thesis advisors and few professors as advisors at superior education institutions. This methodology also looks reduction of risk of academic abortion pushing a cultural change directed by the advisor using social media and digital resources. Methodology, maturity stages and test results applied to bachelor students when developing thesis advisory based on learning based projects is discussed. This methodology was applied to a small under graduated students group for a two-years project, those students got their grades successfully after the project. Now this methodology is being applied to groups of under graduated and graduated students. Methodology looks for a win to win game for students, advisors, but also research groups increasing productivity and quality reducing invested time.

Keywords: learning based projects, projects management, methodology for thesis advisory, project based learning.

1 INTRODUCTION

For many people in different disciplines, a project could be anything, but “project” is a concept in evolution considering the maturity of the person or group using the concept. In the academic world, project has a different meaning for students in elementary school than for students at high school; it is different for under graduated students than for graduated students in post grade. In the industry world, project has a different meaning for young practitioners than for senior practitioners or a very experimented practitioner one, but also in the consulting world, projects with different complexity level require different profiles and experience from consultants in project management and skills. It doesn’t matter if you work for industry academy or as a consultant, you always learn based on projects. On the industry and consulting side the PMBook from PMI (Project Management Institute) is the guide used by project managers around the world for a wide range of projects; but as always in standards and frameworks, all of them indicate the “what” but not the “how”, so something else is required to apply then to specific projects, here is where experience in real projects is very valuable. In general frameworks and best practices are recommended for different kinds of projects. Since 2013 PMBook was redefined with 47 processes to be more aligned to the well-known DIKW (Data, Information, Knowledge, and Wisdom) model used in the field of knowledge management [1].

On the academic side, just at the beginning of this century an excellent review about project-based learning reference, discusses almost 90 references of research on this topic at different education levels [2]. In general, when people have a wrong knowledge, misconception, or perception about projects, they release at the end of the day, perception is not matching with reality, having projects out of time and budget, conducting to frustration and stress, among other feelings. Commonly students have non, or very few experience in real projects, methodologies, tools for planning, estimations, risk management, monitoring, controls, and other processes, resulting in projects which are delivered out of time, budget, and quality. After when students get out superior studies and get into work world, they get experience and develop abilities doing projects, but study, knowledge management and working in groups, using guides, standards and frameworks, students and professionals can increase the quality and quantity of handled projects. In real world when people works on a project, they can feel time, skills and information is not enough, this is because in this century we have facing day by day much more complex projects with a lot of data and information as inputs and a lot of information and
knowledge as outputs. Digitally speaking we face the “Zetta bytes Age”, we are in the “Big Data Age”, where information has 3 characteristics moves at a very high speed, volume, and variability, so we need to develop more and new abilities, to read, understand and think faster than yesterday due to the complexity. In 2013 Gartner’s hype curve shown big data had exploded to the highest expectation around the world, with huge volume, velocity, and variety as characteristics for information [3]. As an example of complexity in the project management and its interactions is shown in Fig. 1.

**EXAMPLE 2017 – PROJECTS AND SUBPROJECTS**

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![Diagram Example 2017 - Projects and Subprojects](image)

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**Figure 1. Example of complexity in project management faced by a professor per year.**

It is a very well-known fact that in Latin America for many different causes, there is a very high percentage of students aborting under graduated studies in superior education, many analysis and reports have been done analysing causes of this phenomena in elementary, and high school but very few in superior education at universities for under graduated and graduated studies [4-5]. In 2015 in México only 16% of adults (25-64 years) got superior education, this percentage is superior to Brazil (14%) and China (10%), but inferior to the OECD (Organization for Economic Cooperation and Development) average of 36%. In the same year, Mexico had more than 3.5 million students in superior education and is expected 21% will be graduated, from that quantity is estimated that 23% of graduates are in engineering and manufacturing areas so a high quantity of students and a few number of professors for advising thesis in engineering areas is a reality [6-8]. It is estimated, Mexico forms around 24,000 engineers per year.

For this work, we are interested in those who become passant and need to complete a thesis to graduate. Consider the realization of thesis is not necessary for all students in all universities, with time many universities have included many different graduation options for students to get a grade. We are interested in passant students interested in developing thesis at under graduated and graduated level. So, our interest is to increase productivity, quality and quantity when advising thesis, so technical and non-technical skills must be developed by students and advisors, but also identified risks must be reduced to get successful projects. In this work, we show a methodology specifically to be applied to thesis advisory, so it could be applied as framework for thesis, where advisors, under graduated and graduated students can get several benefits, letting increase quality and quantity spending less time when developing projects, also advisor can expect at the end of the process future graduated students be part of the research or development group having a win to win process for all members of the team.

The methodology proposed will not be directed to face socio-economical, sociological, individual, or institutional factors, just the academic ones when developing a thesis trying to motivate developing soft skills and cultural change while conducting students in a process looking for successful projects.
2 RELATED WORK

S. Bell considers PBL (Project Based Learning) was an innovator teaching approach, due to students direct their own learning by research and collaborative work, creating projects reflecting their knowledge [9]. In some cases, students don’t attend to classes, learning activities for industrial projects solving complex problems of the real world are organized [10-11]. In these cases, a project becomes the real force for the learning process [12], so there is where students acquire new tech abilities, they become expert communicators and complex problem solvers [9].

Particularly engineering students improve their writing and oral communication skills successfully [13]. PBL is designed to involve students into research and real problem solving, promoting learning to learn [14], promoting also the self-directed learning and professional development [16]. PBL has been applied to engineering students [9-12], [15], and an improvement in motivation and thinking was identified [12], [14].

On the other hand, PBL can be difficult in terms of project management processes and require a lot of invested time from professor and students [11]. PBL application has a positive impact when professional competences are measured [10], students show less dispersion and better notes [12]. Results demonstrates this experience is very positive due to student learning is potentiated [11], even it has been fundamental for ABET accreditation for engineering careers [10][16]. Authors show a study case where the proposed learning model based on projects.

3 METHODOLOGY

After hundreds of projects and subprojects when working for industry or as consultant or as academics for more than 20 years having a certain maturity level, a methodology for thesis advisory was designed, developed, and tested. Due to the ambiguity of what a project is, the first step was to use metrics or indicators to define a projecting, so we consider a project must have the following arbitrary characteristics: (A) two or more sub projects must form a project; (B) each sub project requires more than 100 effective work hours per team member; (C) each subproject must produce a specific product as result as minimum, (D) then subprojects are coupled into a project through an integration process. The methodology designed to apply to thesis advisory, where the objective is to receive a candidate, to form a student with abilities in project and to get at the end of this process, a new member of a group for future projects. The complete process has three stages as shown in Fig. 2, where an UML activity diagram indicates the general process to be followed by advisor and students.

3.1 Stage 1: Pre-thesis student

In general, advisors don’t know in deep how candidates work, it could be an advantage if candidates and students know each other in courses or developing small projects, but also consider that in our universities, candidates requesting thesis advisory can come from different campuses, or different universities. At first, it is supposed an advisor knows how to take a student from a starting point to an ending point through a process so a successful thesis is expected. But in real life we must attend two different approaches one for the advisor and one for the candidate student, so a number of questions arise, such as: is the candidate prepared in a holistic way to be a thesis student and being at the end of all the process, part of the advisor´s team group? Is the student at the starting point or will student require a previous training to get to the starting point?

On the other hand, is it what the candidate student is looking for? How to make interests of both part to converge. This stage is designed to obtain answers to those questions and introducing students to the advisor`s methodology work if student wish to be a candidate.

This stage begins with the interview of a potential candidate to be advised, having the proposal to validate student’s real knowledge, abilities, soft skills, attitude, and motivation, letting the advisor to design and applying activities focused on identified deficiencies or opportunity areas which can be found to be developed by the candidate. Those activities must be completed in a maximum of three months, where student and advisor work as a team. Also, a cultural change process is applied to students preferably in a group. This stage lets candidates to taste the process where they will be if they move to the next stage, so they need to know if this methodology, work and environment is for her or him. In the best of the cases, students learn theory about project management, quality tools or how to work as team, but that knowledge has not been in practice, so abilities have not been developed. In this stage, the general idea about what is developed in a specific lab, processes, activities, and model is explained to candidates, also they can see how thesis students group work
when candidates are invited to attend academic workshops were thesis students offer their advances. Some tools which advisor train candidates are: Gantt diagram, Kanban, Kanban modified, Ishikawa diagram, Kaizen, Six Sigma and simulators or emulators and laboratory equipment for technical proposals.

Figure 2. UML activity diagram for the three-state general process.

At the end of this stage an interview is done to know if students and advisor wish to continue with a thesis project, in this stage we have the equivalent as the pre-sale in consultancy projects; in this stage, an advisor or student can leave a relationship, with no problems for both parts. All this process is very useful to the student, because he or she can identify if the advisor’s methodology and work style and other characteristics are good for him or her, to get a high probability that the project could be completed successfully.

But, why is this stage so important for the advisor? After many years of observation in different universities in many cities, an important number of students abort the thesis theme or leave the advisor. Maybe a deep analysis could be required and even an interesting Ishikawa cause effect diagram could be obtained; although that topic is out of scope, avoiding or reducing the probability of aborting a project once initiated, it is one of the main objectives of this pre-thesis student stage. Managing adequately the risk will also help to reduce academic desertion when developing thesis at any level of superior education [5]. At the end of this stage advisor considers a student dedicates a minimum of 4 hours a day to assigned activities including weekends, so, if candidate and advisor agree to continue then a student can be considered a thesis student after a pool of themes are presented to the student and both advisor and student agree the election.

3.2 Stage 2: Thesis student

This model requires a minimum of two students in a similar research area, in order they can feedback and work as a team when preparing advisory sessions, when having seminars and attending to visits to industry in order they can provide feedback each other having discussions about the different reviewed topics. Thesis students must visit the advisor one per week as a minimum, providing to the
advisor a Gantt graph where a planning is outlined, advances, or finished works or simulations, which
must be discussed with the advisor, but also, he or she must follow the paths or routes having a visual
eyewitness using a modified Kanban tool proposed for the first time in this work.

The proposed modified Kanban tool named Kanban-Castillo is shown in Fig. 3. The idea behind the
Kanban modified is to have a better control of activities at the in-process phase of every project or
subproject, where numbers indicate the revisions of each activity, also in labels are indicated not only
the name of the activity but the days and hours invested in that specific activity. For instance, on the
case of the revision of a specific chapter of the written thesis, the numbers or versions reviewed can
be monitored having also the number of days and respective number of hours invested to that writing
activity, it helps both members in the process, on one hand lest the advisor to understand better how
student is advancing. It also helps student to monitor the advance of this activity, reducing the
perception of overwork, offering a trace of how student is getting better in the ability of writing abilities,
additionally it helps student to make better estimations in future.

![Kanban modified (Kanban Castillo) tool for eyewitness of thesis process.](image)

3.2.1 Cultural change: permanent communication using WhatsApp

Nowadays, our students are day by day more connected with social networks and digital media, so the
idea is using a digital tool in order to have constant communication with students pushing them to
think different and maintaining cohesion inside the group, so advisor could suggest movies, books,
documental, exercises, museum recommendations, and news related no only to technology and topics
related to their thesis, but also using topics related to social and economic implications of technology,
combining information from sources in Spanish and English languages. It’s important to get feedback
from students about how this activity is adding value to them formation.

Research in social sciences revealed that social networks exhibit complex patterns showing a deep
influence on the individual people’s behaviour which in many cases produce vicious circles spread in
different groups and the spread of influence through these social networks is named contagion;
producing a cluster effect, effects explained partially by the mirror neurons, which are important for
imitation of behaviours among other functions.

So, in this case our objective is to produce virtuous circles using the emerging properties of internet,
such as internet memes, remembering Richard Dawkins introduced the meme concept in 1989 as
something that conveys the idea of a unit of cultural transmission, so common memes are melodies,
draws, gestures and symbols. So, the idea is producing for future a kind of “hive mind” which
describes complexity in a group of individuals describing unconscious influence of the collective on the
individuals composing networks, in this case our human networks forming virtuous circles in our
research, development, and student groups [17].
3.2.2 \textit{Industry contact}

Students are invited to two industry events per year as minimum, that could include visits to installations or conferences exclusively indicated for practitioners in industry using scholarships or even other kind of events. It’s important to get feedback from students about how each activity is adding value to them.

3.2.3 \textit{Academic seminars}

Meanwhile students advance in thesis writing, each student must present a series of seminars where a student will show verbal skills in preparation for the oral grade exam. The number of seminars is in function of student’s ability which is being developed during the project. At the end of each seminar each student receives feedback from the advisor and group members about the activity to find opportunity areas letting student improve for the next one. Commonly institutions in Latin America, for example, don’t require presentation of oral examination in English language, the last seminar questions made by advisor are in English, preparing student the grade final exam.

3.3 \textbf{Stage 3: Follow up of graduates}

After graduation, engineers are invited to continue being in touch to the group. At this stage, maybe a publication in conference or journal is in progress, so advisor suggests to young engineer to get ready their passport. Advisor must consider maintaining at minimum two physical meetings if possible per year with all the group members to maintain contact and feedback about engineers work with real projects. Maintaining a group of engineers with new thesis students is important in order engineers could do comments that could add value to thesis students, maintaining coherency and activity inside the group. Information from engineers are very valuable to improve the application of the proposed methodology, letting also trace their professional path and making a better professional network.

4 \textbf{RESULTS}

Just for running the model and methodology, a first group of the ADVNETLAB was used as baseline running tests to the methodology proposed. In this case, the baseline group was formed by three under graduated students with the following results.

4.1 \textbf{Results for stage 1: Pre-thesis student}

In the case of group 1 or testing group, all three members began this stage process in February 2013, one of the members came from other campus of UACM. It was detected three students required regularization activities and this process took less than four months but more than three months, at the end, a closure project interview with each candidate was applied and reported. For the first group, all elements became thesis students and this process was considered successful, then process change to be more formal and interaction time between them time increased gradually but not slowly.

4.2 \textbf{Results for stage 2: Thesis student}

After thesis themes were defined and thesis titles were registered officially at university in Augusts of 2013, students were considered thesis student formally. Methodology conducted to the end of the activities for having a successful project, so some results are discussed:

4.2.1 \textit{Project management skills}

Meanwhile students were developing their thesis they were using different tools for controlling quality of the process so tools as Gantt, Kanban modified, Ishikawa diagram, Strength, Weakness Opportunities and Threatens (SWOT) analysis among others were used letting advisor and student a better control of the project and letting to develop specific activities to reduce risk when it appeared. Fig. 4 shows the Kanban modified named Kanban Castillo as eyewitness of the process.
This tool let students registering advances in activities visually, indicating the beginning and end of an activity, but also registering elapsed times for each activity, using man-hours as metric indicating begin and end date for each activity, reducing misperceptions about time invested in each version and phase of the project; with time the number of cycles in activities were reduced.

After implementing quality tools, it was clear for advisor that thesis students gained experience and improved their abilities when estimating month by month future activities. At the closure meeting, advisor and students agree about skills gained by students in project management. Students invested an average of 2,000 hours in their thesis project, advisor spent around 200 hours advising each thesis student considering the whole process.

4.2.2 Publication products

At the end of 2013, two products were published as proceeding papers. After thesis documents were concluded in December of 2014, exam grades offered and grade obtained by thesis students in February, March, and April of 2015. At the end of 2015 one paper was submitted but published in earlier 2016. Other work was presented in 2016 as proceedings. Publications as result of working with thesis students are shown in Fig. 5.

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<th>G-1</th>
<th>2013-2015 &amp; Publications</th>
<th>Type</th>
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<td></td>
<td>Jose-Ignacio Castillo-Velazquez and Noel Galicia-Gutierrez. Routing algorithms applied to an advanced academic network known as CUIC. IEEE Latin America Transactions, 2016.</td>
<td>IEEE, ISI / JCR.</td>
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In Mexico, in some institutions, publishing in a peer reviewing such as ISI / JCR journal or high strict peer review conference proceedings is requested for obtaining a master or doctoral grade besides the thesis document and exam. In this case although under graduated students don’t have this request, so, this is a plus for their curriculums.
4.2.3 Industry contact

For students contact with industry events far from academy offered a different point of view, it was a complement it their integral and holistic formation. Students attended data center industry events, one per year, but also to IT events, also they had the chance to visit industry installations. Now they got a different view about how industry perceives academy they never thought before, having a different perception about real world and reducing misconceptions.

4.2.4 Cultural change: permanent communication using WhatsApp.

Students referred many benefits, two benefits are related to social networks, they spend around 50% less time in social networks than when they began the project, also they are around 50% more focused when using social networks or when they look for information at the web or internet. Advisor observed an improvement in some critical thinking behaviours such as synthesizing, producing, and evaluating and partially an improvement in some social participation behaviours such as working together, initiating, managing. Also, students indicated activities related to social and economic implications of technology changed their perception of society.

4.2.5 Academic seminars

As an average, students participated in 8 seminars, two of them were participations outside their home university. In the last seminar and grade exam questions were asked in English from advisor, not a common activity but it was a good challenge students faced successfully thanks to working hard during training.

4.3 Stage 3: Follow up of graduates

After graduation in February, March, and April of 2015, engineers were invited to continue being in touch to the group. At this stage, publication in conference or journal were in progress and two students got their passports. Advisor is being offering two physical meetings per year with all the group members including the new ones. Since 2015 till 2017 the three students have been in touch with the group, one of them maintain a limited contact but that better than nothing, he was the most introverted of the group, so maybe more work must be done for developing social behaviours, so it is a characteristic to consider with future groups. Every 6 months some feedback is received from them, tracing their professional path let advisor know the three engineers work for telecommunications companies, they work in areas related to their thesis projects and their earnings are superior to the average for professionals in Mexico. Nowadays, the three engineers continue studying English and for enterprise certifications, they work hard and preparing themselves for the next step in their careers.

5 CONCLUSIONS

This work looks for helping students in general in project management, in order transfer knowledge for learning based on projects but also to accelerate the acquisition of soft skills. We also look for adding value to students in all levels helping them to gain experience managing their projects and using quality tools in order they can do more and better projects but also helping others to develop capabilities when working as a group in one or more teams. In terms of cultural change was excellent but metrics must be used in future work. In terms of work insertion, graduated engineers obtained good jobs, in some occasions thesis students get a job before graduation, which represents a risk for finishing a project or subproject, for that reason cultural change is very important. This successful methodology is advisor’s time demanding but with sweet fruits. Now it’s being applied to a 2nd four under graduated students group at UACM, other three under graduated students group at UAM and graduated students group at UDG.

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REFERENCES


