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SOFT SYSTEMS AND AGILE METHODOLOGIES IN THE SUCCESSFUL DEFINITION OF ACTIVITIES FOR DESIGN ACADEMIC PROJECTS IN TECNOLOGICO DE MONTERREY ABSTRACT

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ABSTRACT
Soft systems methodologies are an excellent method for defining activities in traditional project management, such as story design and tasks in agile methodologies. Through a survey applied to former students of industrial engineering, who are working in the industry or on their own business, it is inferred that the main cause of projects is that not finishing in time and exceeding the budget, is an incomplete definition of the project activities. Wilson's Maltese Cross, Checkland's soft systems, as well as other methodologies, allow to define the problem and understand clearly who the project stakeholders are, as well as the definition of the project team, with which the detailed definition of all activities increases the probability of finishing on time. The present work shows the research to reduce the project time and increase the success probability of project management through a dynamic methodology that allows successful management of both, traditional and agile projects.
In the Tec21 educational model, students must solve challenges in a period of 5 weeks, which is the central part of the mentioned model. It has been observed that emphasising managing their projects with a systemic perspective, has reduced preparation times as well as stress, resulting in an increase in the stability of the students as well as the quality of their projects.

Keywords: Soft systems methodology, project management, innovative education, agile methodologies

1 INTRODUCTION
One of the most common questions asked by professionals who manage projects is why do projects fail? The answer has been analysed in various studies by universities, institutes, and professionals in the area. First, failure must be defined as a deviation between what was planned versus what was executed, and these can be categorised in four dimensions: time, budget, quality. and the objective. In a survey applied to former students, students, and professionals involved in project management between August 2021 and January 2022, 57.1% of respondents indicate how time changes in project management, 28.6% objectives, and 14.3% quality. pointing out that the main cause is mainly due to the presence of "blank spaces" which causes delays and cost overruns in projects, according to Dr Márquez (2020) [1] blank spaces are vital activities that are not considered in the planning part, and they have poor communication between team members. In universities, it is common for teachers to ask students for projects in almost all subjects, most of the time in teams.
In the TEC21 educational model, the element is the challenge, and it is resolved with the development of disciplinary and transversal competencies. The challenge is resolved with an academic project that is elaborated within a training unit, lasting 5 weeks, (Institute for the Future of Education 2020) [2], the challenge has three pillars, students, teachers and training partner, which in project management language can be considered as the stakeholders, the international finance corporation (2019) [3] document this model in a case study where the challenge (project) is the centre part of the learning process. Establishing a methodology, whether traditional or agile, to plan, control, manage and document the project is not practical in an educational model, due to the diversity of the type of challenges as well as the training partners, which is the main motivation for proposing the design of an academic project management methodology adapting simple systems methodologies, traditional and agile project management models.

2 DEVELOPMENTS

Currently, the results are often not as expected, because the project does not solve the challenge or problem posed or the approach is not correct, students tend to confuse symptoms with problems, for which they acquire what they in the academy of industrial engineering we call it the hamster syndrome, that is to say, that students enter a continuous cycle of trial and error without being able to advance by specifying results, which has repercussions on the emotional health of the students, appreciating a high level of stress due to finishing projects on time, as well as frustration at not achieving the expected results. At this point, other soft problems can be seen, such as the stability of the workgroup, which does not meet the expectations of being a high-performance team.

Soft systems methodologies have been promoted since 1976 by Checkland (1989) [4], in the applied survey 57.1% know it and of them only 42.9% would use it, although they state they know that they are tools focused on problems that are not (soft systems) and provides various works that allow, in the first place, to describe the problematic situation through the CATWOE of Joham and Metcalfe (2009) [5]. In the CATWOE we identify the client (C), the actors (A), the transformation (T), how the world is seen (W), the owner of the project (O), and finally the environment (E). Following each phase of CATWOE reduces the risk of defining the problem incorrectly. Already with this essential definition, the next step is to elaborate a first level Rich Picture (Rich Picture First Level) in which it is reflected, just as our ancestors did in cave paintings and artists of different times in murals, already whether in buildings or church the situation that is experienced at that moment, the Rich picture is very useful because it's descriptive power, allowing exploring the observer explain the problematic situation (Jardino et al.,2020) [6]. From the RPFL, participatory intervention techniques must be introduced, among them, the technique of nominal groups, which are the basis for identifying and defining the problem. Figure 1. Because the pillar of the training unit is the challenge and this entails establishing a relationship with training partners (Stakeholders), the participation model between students and training partner must be designed, a TWCA (Two Way Commitment Agreement) where the communication system and the periodicity of the work meetings, visits to the company as well as the confidentiality and treatment of the information. This allows the problematic situation to be drafted and this can be used to define the problem together with the training partner.

One of the most common mistakes of teachers is that we emphasise disciplinary strategies and methodologies for the success of the projects, but we leave aside the transversal competencies. In this phase zero of the project, it is necessary to transform work groups into high-performance teams, providing students with learning activities based on the concept of the value of the team that professor and captain Roberto Sylvester has taught in classes [7] and the introduction of 4 types of thoughts that guide students from the zero phases to the closure of the project and they are:

- Concurrent - Seek to carry out simultaneous activities and reduce linear activities as much as possible.
- Prospective - Define an activity as a process and think about who, how, and what the output will be.
- Systemic - All activities are related to achieving the project.
- Resilient - Maintain cohesion as a team in the face of adversity, delays, and changes.

The next step is to develop the system, which in its essential definition is a set of interrelated elements to achieve a common goal, at this point we propose some innovations and adaptations to the system models, including identifying the departments by colours, as well same as the channels of information flow between each element of the system are represented by arrows that connect them. This part of the system has as the main characteristic that it is internal, where the owner has control of the elements, this is represented by delimiting with dotted lines. On the other hand, the external part is those elements in which there is no control, but they affect the system and are outside the internal part but delimited by a box (frame) that represents norms, laws, and any type of restriction to the system.

A project is created to solve a problem, the methodologies for its solution begin mostly with "Define", but there is a little-explored previous step, the description of the problematic situation, where the abstraction of reality is defined, to later define the problem. The definition begins from a process of searching for the root cause, and different methodologies can be used. In our research, it is proposed to use the model of Kepner and Tragoe (1981) [8] based on answering four key questions: What? When? Where? Extension?

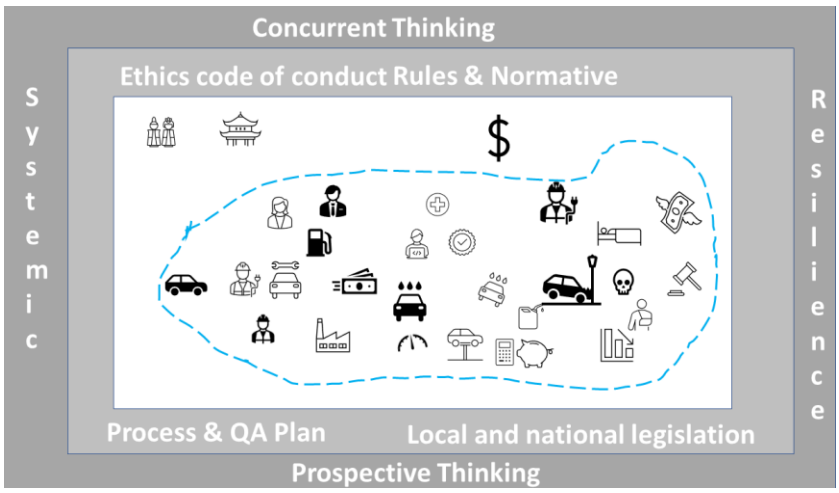

Figure 1. Rich Picture First Level

When the problem is defined, an ideation process begins, in which we use, among others, the methodology designed by González, Saavedra, Lule, Barbosa, Zubieta & Caballero (2021) [9] which merges Design Thinking (DT) with the Design of Experiments (DOE) as well as Engineering Thought (IT) by González & Feijoo [10] to find solutions that can range from simple to innovative and disruptive. If we consider the solution proposal as the project that solves the challenge. The next step is to identify the activities to implement a said solution, it is necessary to conceptualise the system as a model of information flow, for which the use of the Maltese Cross methodology designed by Dr Bryan Wison (1980) [11] is proposed, Espejo and Reyes (2011) [12] explain that this Maltese Cross can be used in a variety of engineering tools to align implementation, organisational and information processes in an organisation, as a continuous process.

In the second phase of the proposal, the systemic map is made, interconnecting the most important elements of the project that can be inferred from the Rich Picture, in this part an ideation exercise based on brainstorming is proposed to generate all the activities that entail the project, this ideation must be structured under the theory of nominal groups to ensure that all the actors or representatives of departments or organisations are present in the design.

When the required activities are finished, they are analysed through the ISM (interpretive structural modelling) methodology to first vote and stay with the most important ones to have the precedence figure. The result of this exercise is usually the milestones.

The definition of project activities is a logical consequence of the definition of the product and the processes that must be carried out for the construction of the studies that make up the project. It is in this part where systems engineering, prospective thinking, and concurrent engineering work to build the project management activities. One of the big mistakes is to generate very general activities, without a clear objective and that does not have to define the person in charge of it or the characteristics and specifications that the activity that precedes it requires; In the same way, the practicality of having activities defined in a general way causes critical activities to be exposed to ambiguity and control over them is lost.

To avoid this ambiguity, systemic maps are used to represent all the activities, their predecessors, as well as those responsible for carrying them out following a systemic thinking approach, that is, never losing the connectivity or the multidisciplinary approach between them. The next step will be to define the specifications of each activity and the document or process that performs them, using the information systems methodology of Wilson (1980) [11] and the systems thinking of Checkland (1993) [13] adapting a representation of the activities, Wilson proposes to map the information through the Maltese Cross, which on the west side (O) or negative x receives the information, on the positive y side (N) represents the activities, the negative y-axis (S) represents the method, document or process in which the information is found, so the information inputs intersect with the activities and their environment, when there is a transformation, new information represented on the axis is released x positive (E) which in turn is delivered to its predecessor through a document, process or file, thus generating a very precise control of the project.

It is important to note that more than one entry of information can affect activity, so it must be defined, we can also call these deliverables of the previous activities, which must be defined according to the characteristics and design elaborated by the owner of the activity that requires them for its process. The importance of the negative or south "Y" axis is notable since it defines the procedure for processing the information and under what format it will be sent to the activity that is requiring it.

The next step is to make a systemic map, identifying the internal system that are the studies that make up the project and that can be controlled by those responsible, and the external systems that are not controllable but that affect our project due to the interaction of vital activities. that due to their dependency can cause failure at a certain moment by not having it identified or proposing the mechanisms to be able to interact successfully with them. In the construction of the systemic map, it is suggested to differentiate the departments or entities with colours to map their activities and be easily identifiable, in this way we can correlate the precedence of information between the different work teams, the internal system is delimited through a line dotted and external systems are outside of it. A vision is proposed to design the system based on project management (Figure 3), the systemic approach, the standards for product development, and eco-design. This model is the foundation for the construction of the Gantt chart, a tool that will allow, through project management, to manage that the activities are completed on time, with the quality and specifications required concurrently and prospectively.

Phase 2 is the administration of the project, through the Maltese Cross we define the activities at the first level, with the systemic map we ensure that they are all interconnected, now it is very easy to identify the resources and predecessors for each activity, the Time calculation is done through PERT, to develop probabilistic models that allow us to reduce the probability of exceeding the planned time and budget.

In traditional methodologies, the guidelines dictated by the PMBok for project management should be followed, but it is at this point that we can merge the agile methodologies proposed by Dr Rocha (2021) [14] who mentions that the success of a project with complex problems, maybe due to the establishment of a continuous cycle of delivery of value to the client, prioritising the needs and interaction with the client, to create high-value products. A work dynamic must be established with constant interaction with the client to achieve a complete understanding of the situation and define the objectives, activities, deliverables, and scope of the project. Obtaining customer and student satisfaction.

Agile methodologies in the project management model make great sense in phase 0, which is the definition of the project. In a survey applied to 350 students, we found that 87% of them mention that it is not easy to understand the theoretical concepts of the projects. soft systems, according to Kumar, Hale & Hale [15], agile methodologies cause the application of the theory to be fast and disruptive by encouraging students to innovate in the phases of ideation and collaborative work, which in our methodology is reflected using online tools to reflect and contextualise the problematic situation and finally in simplified matrices to be able to define the problem. With the agile approach, the Maltese Cross is the most useful tool, but while students consider it more time-consuming and complicated, it becomes easy to implement to define project activities with all predecessors and resources correctly identified.

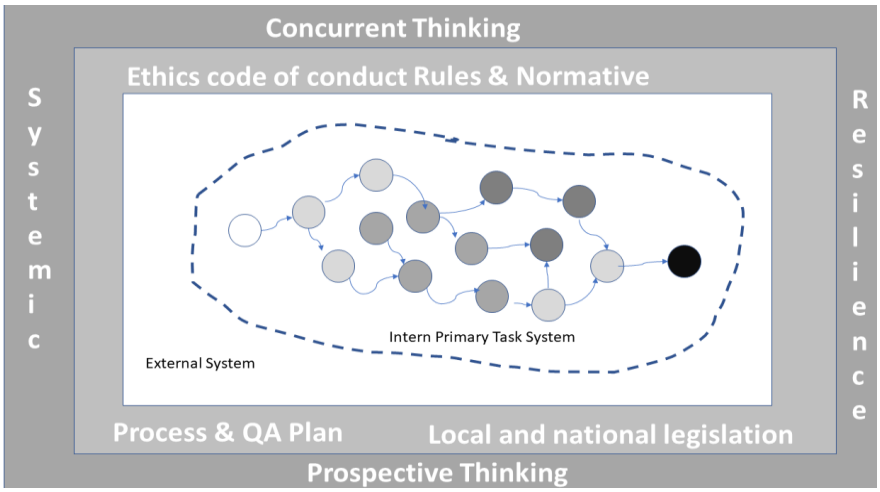

Figure 2. Systemic Map. Own source

3 RESULTS

A research protocol was designed based on the comparison of two training blocks, the IN2004 in which the students elaborated their challenge "freely" against the IN2006 block in which the students followed the methodology presented in this paper. For both training units, the null hypothesis was defined that the grades were statistically similar, so the methodology in student learning was not significant, and the alternative that was significant. If the difference was positive, we could conclude that the methodology is significant in learning. The variable of learning interest was analysed by comparing the grades obtained in the challenges. In both blocks there were the same students and the same teachers, but the method to develop the project changed. 16 teams were evaluated for the population corresponding to IN2004, the average was 84/100 points, while for IN2006 it was of 90.31. Making a comparison of two means with Student's T, we found that the acceptance zone was from -0.9054 to 0.9054, and the result of to was -1.38, with which the method proposed to elaborate the project that solves the challenge is significant.

For the variable of interest, ease of use by the student and reduction of stress (emotional stability) in the student, a survey was applied to the 62 students who took both courses with the following results, for the question. Do you consider that the methodologies of systems help define a problem effectively? 93.75 answered yes. Do you consider that thanks to the use of soft systems methodologies you were able to identify the problem to be solved in less time? 90.62 responded affirmatively, and finally for the question, Did the use of soft methodologies help you define, deliver the challenge/project on time and with quality during UF2006B? 84.36% answered yes. Therefore, our hypothesis of placing more emphasis on the definition of the problem through soft system methodologies to develop projects efficiently has been verified.

4 CONCLUSIONS

Soft systems methodologies are applied to undefined problems, including them in the project definition stage which allows reducing gaps in both time and budget. The activity definition part had already been implemented in school projects lasting one week with excellent results. Designing a project definition methodology that will help students deliver quality work in short periods has been a challenge, but now getting them to use it leads us to propose future work, such as an online platform or application; in order to allow students to make this essential part of the project more attractive, helped with the introduction of agile methodologies.

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