10-003

SCRUM APPLIED TO A CONSTRUCTION SMALL ENTERPRISE: LEARNING WHILE TEACHING

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A small installations company with a well-established 25-year-old hierarchical structure wants to evaluate Agile project management methodologies. To do so, the company decides to implement SCRUM in two projects: i) Sanitary and hot water installations in a 6-unit apartment building; ii) Photovoltaic system installation for a single-unit property. The implementation and management are carried out by an engineering student on his final degree thesis. The process begins with the capacitation of the company workers on the basic concepts of SCRUM. After a few sessions, the theory is put directly into practice in both projects. To evaluate the efficiency of the implementation of SCRUM in the SME, several factors were taken into consideration: Timing, costs, and degree of satisfaction of workers, the owner of the company, and the propriety. Results show an important improvement in all those key performance indicators. The satisfaction of all involved parts (workers, director, and propriety) was higher than what they expected, while there was a reduction between 20% and 25% in the scheduled plan and between 13 and 20% in costs. Everyone got what they wanted.

Keywords: SCRUM; learning-by-doing; learning-while-teaching; construction

SCRUM APLICADO A UNA PEQUEÑA EMPRESA DE CONSTRUCCIÓN: APRENDIENDO MIENTRAS ENSEÑAS

Una pequeña empresa de instalaciones con una estructura jerárquica establecida hace 25 años se aviene a gestionar sus proyectos mediante metodologías Agiles. Para ello, decide hacer un experimento práctico con dos proyectos: i) Instalación de agua caliente y sanitaria de seis apartamentos unifamiliares; ii) Instalación de un sistema de generación de energía fotovoltaica en una propiedad. El seguimiento y la implementación de la metodología SCRUM en ambos proyectos la llevó a cabo un estudiante de ingeniería en el marco de su trabajo final de grado. El proceso empezó con la formación del personal de la empresa en los conceptos básicos de SCRUM y seguidamente se empezó a trabajar en los proyectos. Para evaluar la eficacia de la implementación, se tuvieron en cuenta los tiempos, los costes y el grado de satisfacción del personal empleado, la empresa y la propiedad. Los resultados muestran una clara mejora en todos los aspectos: la satisfacción de las tres partes implicadas (trabajadores, propiedad y dirección) en ambos proyectos ha mejorado con respecto a las expectativas iniciales.; los proyectos han presentado una mejora de los tiempos entre un 20% y un 25% y entre un 13 y *20% en costes. Todos salieron ganando.*

Palabras clave: SCRUM; aprendiendo haciendo; aprendiendo enseñando; construcción

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1. Introduction

Following the traditional project management models (mostly waterfall) in all type of projects was seriously questioned due to the high difficulties to reach milestones and initial goals on time and budget. Around 1990, agile project management methodologies appeared to help software development projects to become more agile and reach satisfactory goals in this so fast changing sector (Gonçalves, 2018). SCRUM was, and still is, one of the most studied and applied of these methodologies (Asraf & Ali, 2013) and by 2010 most software companies already applied, knew something about it or wanted to implement it (Cardozo, Araújo Neto, Barza, França, & da Silva, 2010).

Although it has been proved that SCRUM and other agile methodologies can be applied in other sectors rather than only in software development (Sutherland, 2014), its implementation asks for a different mindset and organization for which not all companies are ready. Problems might appear in relation to people, processes, project or the company organization itself (Lopez-Martinez, Juarez-Ramirez, Huertas, Jimenez, & Guerra-Garcia, 2016). In fact, applying agile methodologies incorrectly might end up in even worse results than using well known and stablished traditional methodologies (Rigby, Elk, & Berez, 2020).

For these reasons, its entrance into other sectors that historically deal with well-structured planification and specialized works, such as the construction sector, is scarce or rare, having done not much changes in decades in their way to manage projects (Walker, 2015). However, as the market gets more technologically based and competitive, results are more visible and some companies try to test this change to improve the results of teamwork and to soften the problems related to working in group (Casals Canals, Tejedor Herrán, Cremades, Amante, & Lopez-Grimau, 2022).

This is the case of a small company, Eurosolar, which has been operating similarly during the last 25 years. Eurosolar presents a quite rigid and hierarchical structure, but aims to give SCRUM a chance to see how results improve while not investing much.

With the hope of seeing positive results but fearing possible dramatic consequences in the ongoing of the company, this work presents how SCUM was tested in two small projects of 3-4 weeks long in the framework of the final degree thesis of one of the company-related members and co-author of this work. Through this process, teaching and learning SCRUM was done almost simultaneously, for which a new learning methodology based on learning-by-doing but having similar approaches to flipped classroom (Akçay & Akçay, 2018) and project based learning (Tascı, 2015) might be claimed: Learning-by-teaching

2. Methodology

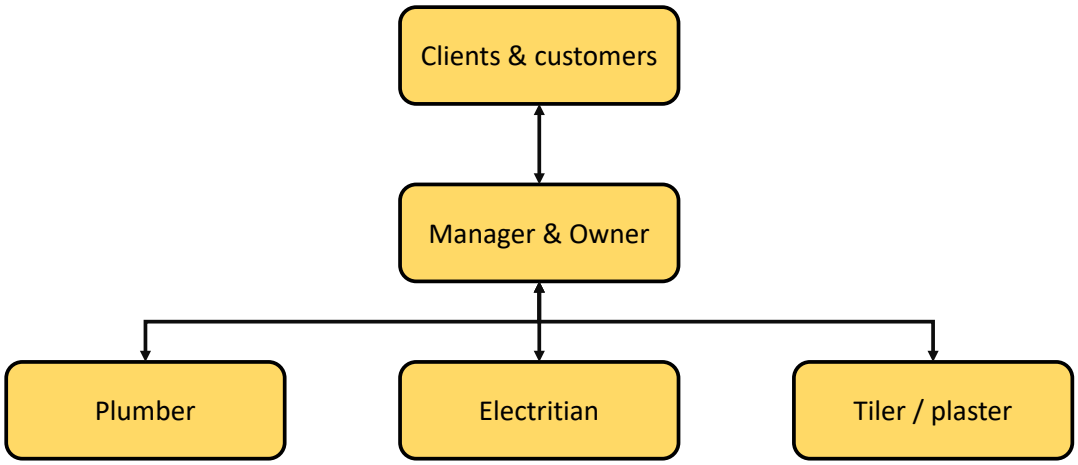
This section will first present the company, its organization structure and type of works. Then, it will present the two projects in which SCRUM was implemented and, then, how was this implementation carried out.

2.1 The company

Eurosolar is a small (SME) enterprise stablished in Mallorca specialized in the installation of photovoltaic (PV), wind turbine and heating and cooling systems together with sanitary facilities and other amenities. PV systems are the most common type of projects the company works on. The company participates in small, mid and large-scale projects indistinctly, although for the latter it focusses its work only in the aforementioned areas leaving the rest to the main constructor. The company growth since 2015 (except for 2020, the year of COVID) might have facilitated the acceptance to do this methodological test.

Eurosolar counts with only 3 workers specialized on each of the lines of work of the company (who commonly coincide in the different assigned projects) and one manager which is in charge of receiving and transferring all the communications between workers and customers (Figure 1). This is good from a control perspective, as the owner knows the exact situation of the work, but, at the same time, it might be blocking the information flow and the fast advancement due to unnecessary micromanagement. Note that, except for initial or final inspections and when explicitly asked for, the manager does not perform on-site works.

Figure 1: Structure and communications flow in the SME



Using the waterfall project management structure, the company performs projects following a linear stream (Figure 2), which, together with the communication strategy and the working placements, generates regular bottlenecks and difficult projects' overlapping and the company desires to reduce these situations so they can grow faster.

Figure 2: Current linear workflow

2.2 The test projects

The two projects in which SCRUM is implemented are a sanitary and hot water installation in a 6-apartment building (project #1) and the installation of a PV system in a single-unit property (Project #2). The main characteristics of these projects are:

- Project #1: This project is part of a larger project developed by another constructor company that subcontracted Eurosolar for this specific works. In this case, the works concern a general refurbishing of a 6-apartment building were the sanitary and water installation will affect bathrooms, kitchen and laundry or service rooms with the machinery, plumbing, and pipping and drainage needs specified in (Table 1).
- Project #2: A property wants to enlarge the PV system so increase the electricity generation to be self-sufficient as the house is not connected to the electricity grid. This upgrade of installations will add twelve 350 W_p PV panels, one 4000W_p regulator, one 8000W_p sine inverter, a galvanized steel surge protector and the corresponding safety switches but will maintain the current PVs and the 12 lead acid batteries already in use.

Table 1: Material and works previewed for project #1

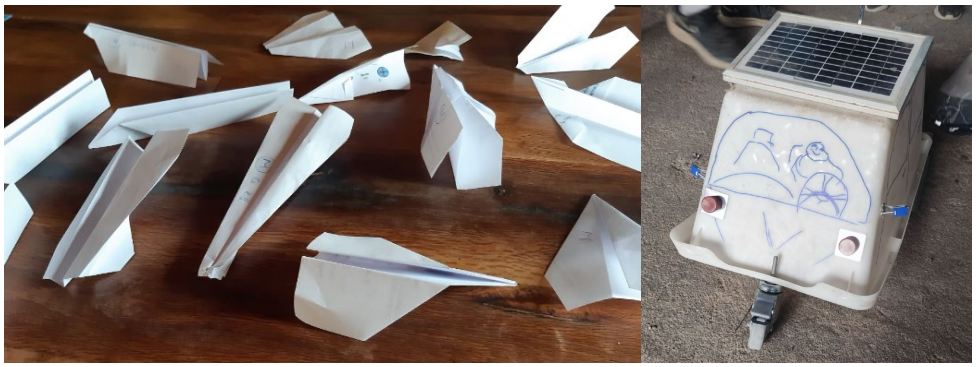
Machinery	Qty	Plumbing	Qty	Piping	Qty	Drainage pipes	Qty
thermosyphon	3	spherical valve	7	Bathroom	6	exterior connection	1
pressure booster	1	safety valve	1	Kitchen	6	80 mm drainage	7
circulation pump	6	laundry room	6	Gallery	6	110 mm drainage	6
Air conditioning	18	kitchen	6			125 mm drainage	1
		bathrooms	6			90 mm rainwater	6
		garden faucet	2			110 mm rainwater	1
						160 mm rainwater	1

2.3 Implementation of SCRUM

The first thing to do was to teach SCRUM as the team and overall environment was completely unfamiliar to it. SCRUM is characterized by the fact that the team needs to understand its beat and how relevant is the team's commitment for the project. It's worthless to impose SCRUM without a proper training and using a peer is a good strategy so the team really understands and gets the main idea (Deemer, Benefield, Larman, & Vodde, 2010). A very good way to ensure commitment is by showing results and learning this can be pretty successful through gamification (Majuri, Koivisto, & Hamari, 2018). Therefore, teaching SCRUM principles was performed through a series of games:

- The paper airplanes game (Sutherland, 2014), which consist on planning and building paper airplanes for few sprints so participants can see how fast improvement is reached through visualizing preliminary results (Figure 3) and reviewing sprints. It's also very useful to understand that failure in reaching the goals should not be seen as something bad but as opportunity to improve. This exercise shows pretty well the Plan-Do-Check-Act basic steps of agile (Deming, 2018).
- Car building game. In this game the participants should develop a vehicle of any kind capable of moving on its own using its 3 or 4 wheels. This exercise is useful to get used with the task's board (backlog, to do, doing, verification, done) typically used in agile methodologies and to discover communications channels. For this reason, this exercice has no iterations neither roles.

Figure 3: Pictures of the games' prototypes



After that, the work structure was changed for the two specific projects incorporating daily scrum meetings and sprints lengths defined in Table 2. In both projects, the student got

involved with the company as the SCRUM master. Note that, according to the manager's experience using waterfall methodologies, Projects #1 and #2 should be finished in about 5 weeks and 8 days respectively. This will be the reference for comparing the results in terms of time performance. Moreover, Project #2 was defined in just two sprints of 3 days due to the short time expected duration and because two clear increments were identified: Disassembly of the current installation and installation of the new one. Note that, the sprints in 2nd project summ 6 days and not 8 as the manager initially scheduled, this is caused by the fact that the sprint planning was done after finishing the first project and seeing that they could go faster than expected.

Note also that this implementation is focussed only in the execution phase of projects.

Table 2: Characteristics of SCURM's implementation

	Project #1	Project #2
Sprints	5	2
Sprint duration	5 days	3 days
Sprint retrospective	Friday	After dismantling
Tasks prioritization	Coloured tokens	Coloured tokens

2.4 Key Performance Indicators

This section presents the Key Performance Indicators (KPI) used to evaluate the goodness of the results after the implementation of SCRUM in both projects. This work defined two sets of KPIs depending on their origin: quantitative (based on time and economic efforts) or qualitative (resulting from surveys and perceptions of the people involved before and after both projects ended). See section 2.5 for details on the process of performing such surveys.

Quantitative KPIs are defined as:

- Construction time (CT): Ending minus beginning of works date. This time will be compared to the expected time indicated by the manager.
- Net percentage deviation in variable costs (NPC_{VC}): consisting on the labour hour costs and derived (such as fuel for transportation).

$$NPC_{VC} = ((Final_{VC}) / Budgeted_{VC}) * 100 \quad (1)$$

While qualitative KPIs are:

- Workers' satisfaction (WS): This KPI is based on the perception of the worker on 3 items: Responsibilities, communication inside the company and work organization. Each item has a set of 3 binary (agree/disagree) questions and all 3 items weight equally (1/3), so results can be easily translated to a scale of 10 (see section 4).
- Client Satisfaction (CS): Similarly, to the WS, this KPI is evaluated on a scale of 10 and counts equally on the perception of the architect and the owner of the building.
- Fulfilment (F): This KPI is evaluated only by the manager of the enterprise at the end of the project based on previous experience in these kinds of projects.

2.5 Data acquisition through surveys

To correctly evaluate the change perceived by the three workers of the company, the survey that feeds WS is done twice: One before implementing SCRUM (to see the departing

situation and to have a base to compare with) and a second one after having completed the project with the same exact questions. An intermediate survey is not foreseen to avoid any impact on the ongoing work, knowing the short duration of the projects.

The survey is be done on paper as it seems there' is no significant impact on the responses between online and paper surveys, but participants perceive that anonimity is better ensured using the paper format (Sabina B. Gesell, Drain, & Sullivan, 2007) were they can control the environment in which they fill it.

The architect and the owner, evaluate the work on the base of their expectations at the end of the project, while the enterprise manager does so knowing that his expectations might differ to those of the client.

Moreover, the student acting as SCRUM màster also answered an interview on the knowledge acquired during the exercice and, one year after the tests were done, the study analyzed to what extend the company embraced this agile project management methodology.

3. Results

Together with the product owner (Eurosolar's manager), the backlog was done indicating the criticity of the tasks. For project #1 these tasks were classified as:

- Very low difficult tasks: Seven tasks of very low difficulty (evaluated with a 1 in a scale from 1 to 10) were identified (six kitchen sinks, six circulation pump connection, garden water connection, pressure booster's installation, syphon pipin, connection of wire lines, installation of six circulation pumps).
- Medium difficult tasks: Five tasks were classified with a medium level (evaluated with a 5) of difficulty (six bath sinks and taps installation, air conditional (AC) preinstallation, water heater installation, syphon machinery installation, AC machinery installation.
- Hard work tasks: Five more tasks were classified as being very difficult (evaluated with a 10) tasks (six toilet installation, six shower plates and taps installation, mounting the water counter, kitchen and taps piping and laundry room taps and pipping)

Project #1 ended up in 4 weeks (Table 3), one week before planned. After the first sprint, the team was surprised of not having finished two of the 6 tasks planned for the sprint. In fact, one of the tasks, the toilet installation did not even began showing an initial excess of confidence in the work advancement. However, the sprint retrospective was useful to better plan next sprints and for understanding which were the bottlenecks that left workers waiting for other's work to end and how communication facilitates the cooperative work.

Table 3: Sprints overview of project #1

	Task criticity plan per sprint	Task completion	Observations
Sprint 1	36	64%	Frustration for not finishing all the tasks. Bottlenecks identified and the team decided to avoid multitasking, as it slowed the peace (origin of bottlenecks).
Sprint 2	24	100%	Satisfaction of having reached the goals
Sprint 3	18	120%	Satisfaction for seeing how fast things were going and eagerness to begin sprint #4 and finish the project
Sprint 4	18	100%	
Sprint 5	-	-	

After the second sprint, all the workers indicated that they were active almost all the time and all activities were accomplished. While running the third sprint, the team decided to add an additional task to what was initially projected. For the 4th sprint, the team decided to put all the rest of activities and try to finish one week in advance.

Project #2 began with the identification of the backlog tasks and their criticity index. As in project #1, tasks were classified in 3 levels of criticity.

- Very low difficult tasks: Four tasks identified: Uninstallation of old PV regulator, uninstallation of old inverter, installation of PV regulator and Wiring and fine tunning.
- Medium difficult tasks: Four more tasks were classified with a medium level: Dismantle old PV panels, unmount old PV supports, mounting of the inverter, and fix new supports.
- Hard work tasks: Just two tasks were classified as being very difficult: Build the fixed support for PV panels and the PV installation.

Coming from the previous project, the dynamics were already taken and the first 3-day-sprint finished according to what was expected. However, the sprint retrospective and the plan for sprint 2 was interesting to highlight the need of coordination of the 3 workers in the first day of this second sprint. It all went fine and the project ended one day before what was planned in this second sprint.

As a brieff summary of the projects' clousure meetings, several issues were identified as important for SCUM implementation:

- Avoid multitasking: It was seen that, in addition to a slower pace, multitask was the origin of several botleneks.
- Divide big tasks in smaller ones: As they might not be feasible for one sprint only and dimensioning was difficult.
- Increasing the team's efficiency takes time as it was not until finishing the 2nd sprint that the team felt itself at a correct beat.
- Monitor repetitive tasks assigned to one worker, as doing a repetitive tasks increases worker performance but, if done for too long it might end-up in burnouts (Häusser, Schulz-Hardt, Tomaschek, & Mojzisch, 2014).
- The work panels or boards were very useful and coordination was increased.

3.1 KPI

To correctly evaluate the effects of the implementation of SCRUM, an analysis of the results obtained from the KPI described in section 2.4 is done.

Concerning the less subjective KPI, both projects improved the time and the cost deviation (both KPIs are strongly related, as much of the evaluated project cost is related to the labour hour costs as shown in equation 1). Thus, a reduction of a week in the schedule for project #1 and spending 5 days instead of 8 in project #2 (Figure 4) represent a reduction of the time scheduled initially of about 20% and 37% respectively. In terms of cost deviation (NPC_{VC}), project #1 saved 14% of labour-costs while project #2 did so by a 35%.

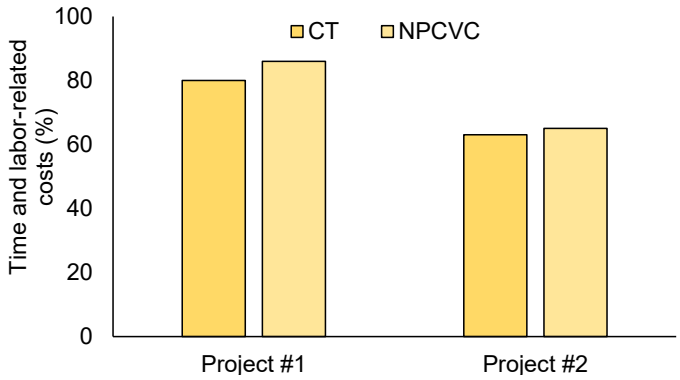
The more subjective KPIs, which are related to the employees, client and manager satisfaction, also show pretty good results.

The client satisfaction survey at the end of project #1 received an overall value of 9 over 10, which is an excellent result. This value is obtained by doing the average of an 8, which is the evaluation based on the architect's perspective, and a 10 given by the owner of the 6 buildings.

The manager evaluated the work done also with an excellent (9 over 10), as results were good and savings were reported but there were some organizational issues that should improve.

Project #2 received an evaluation of 10 over 10 by both the client and the manager, which are impressive results for such a short project.

Figure 4: CT and NPC_{VC} indices in both projects



Following the surveys on the three employees, which intended to identify if they felt more comfortable and satisfied with this agile management methodology, also seemed very pleased with the experiment in both projects.

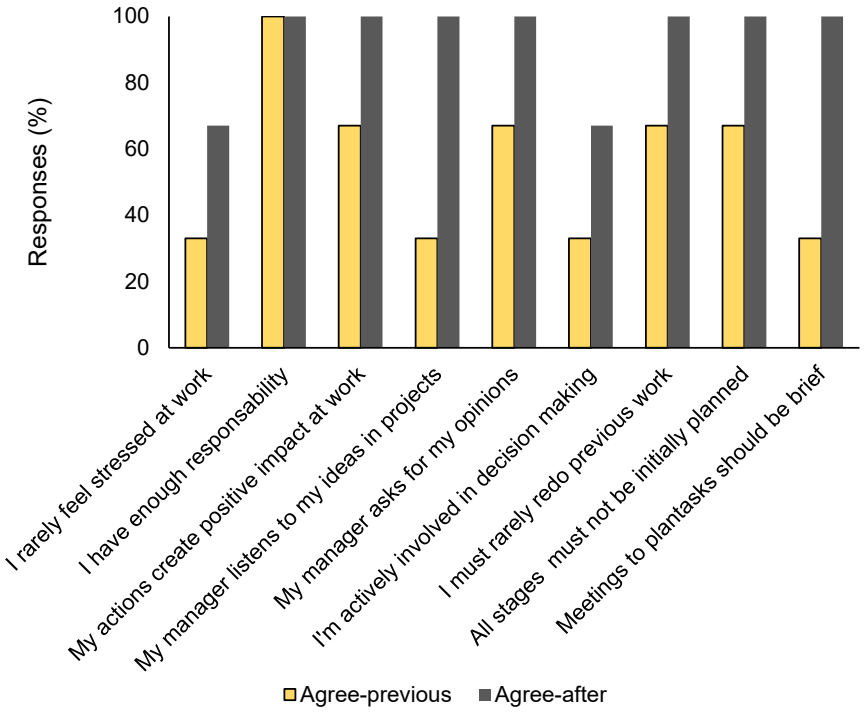
Before and after finishing the projects, they answered a small survey whose binary questions asked for their agreement in terms of responsibilities (questions 1 to 3), communication within the enterprise (questions 4 to 6), and work organization (questions 7 to 9). Responses are visible in Figure 5, showing how the employees feel less stressed, better organized and strongly committed at the end of both projects than before implementing SCRUM. See how, before the implementation of SCRUM, only one of the questions had a 100% of “agree” answers (2nd question asking if they had enough responsibility), while after both projects, the number of questions having this high ratting was 7 and the other 2 questions also improved their marks.

These responses in Figure 5 allow to calculate the indices by grouping them and doing the average for each of the 3 items analysed. Table 4 show the numbers and how they passed from a 5,55 before implementing SCRUM (which means that employees are fine but see much ways of improvement) to a final rating of 9,26 after finishing both projects. These awesome results indicate how, effectively, the commitment, and overall satisfaction of employees improved significantly thanks, basically, to the implementation of agile project management methodologies.

Table 4: Worker’s satisfaction indices

Workers satisfaction	Before	After	Increase
Responsibility	6,67	8,89	33%
Enterprise communication	4,43	8,89	101%
Work organization	5,56	10	80%
Worker satisfaction	5,55	9,26	67%

Figure 5: Responses to the 9 agree/disagree questions done before and after the projects



3.2 Legacy

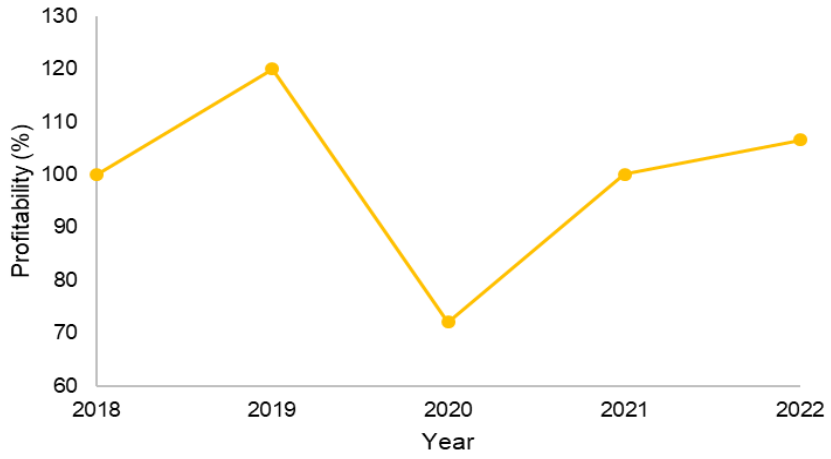
One year after the test, the analysis of the project management techniques and methodology followed by this small company shows that the basics of SCRUM are not followed anymore. That is, there are no daily SCRUM meetings neither sprints. The reasons behind this is, mainly, because the SCRUM master, who was in charge of these dynamics, stopped his relation with the company to continue studying abroad and nobody decided to take this role. As the testing projects were relatively short, and thus sprints too, the feeling after finishing them was, somehow, that taking this SCRUM master responsibility by any of the workers in the company would be exhausting and none was sufficiently motivated to continue with it.

Nonetheless, there are several aspects that are still working and were somehow adapted to the traditional way of managing the company:

- Product backlog: At the beginning of the project, the team identifies the different tasks and prepares this useful tool to deal with the project challenges.
- Elimination of micromanagement: The backlog and assigning the tasks to each worker is done by the same employees without the need of the manager to impose anything.
- Communication: Employees are visibly more open to discuss openly any issue, to accept constructive criticism, and to collaborate with each other to obtain better results from other's comments. Communication is far more horizontal than before.

This low level of implementation of agile methodologies in the structure of the organization does not allow to see any clear impact on the economics of the company, which eliminating the huge negative impact of the COVID in 2020, it recovered the numbers of 2018 in 2021 and saw an slight increase of a 6,5% of the previous year revenues by the end of 2022 (Figure 6).

Figure 6: Economic results of the company in the last 5 years



3.3 Learning by teaching

In terms of SCRUM learning, the student performing as SCRUM master during his degree thesis and while doing this work, seems to have learned much more while implementing SCRUM in these two projects than following the project management course taught at the technical school of industrial engineering in Barcelona (ETSEIB).

The student indicates that, before the course, he knew nothing on project management, after the course he felt confident to take part on some and when finishing the thesis, he felt that he knew “a lot” on project management.

The student also indicates some changes in the way he felt about project managers. Before the course he had the image that project managers should indicate everyone what to do, after the course this image tended to follow micromanagement strategies while, at the end of the thesis he clearly switched his mind to a point in which the project manager should explain the goals, apply accountability and be part of the team.

In terms related to multitasking, the student also changed his mind. Before the course he strongly believed in multitasking. After the course he understood that multitasking was not a good idea, but couldn’t think on how to do it while, at the end of the thesis, he has seen the benefits of avoiding multitasking and will try to apply it in his day-to-day tasks.

In terms of specific SCRUM knowledge, the student reported, before the beginning the thesis, that he had felt familiar with the SCRUM concepts of product owner, backlog and increments. He also indicated that he had an idea of what the sprint backlog, the sprint planning, and the daily SCRUM were, but that he heard about or had no knowledge on any other concept of scrum, such as Scrum master, sprint review, sprint retrospective, poker planning, color-coded tokens, dog's size for tasks or the idea of the Fibonacci numbers. However, by the end of the thesis, he felt familiar with most of them, although he felt that sizing the tasks’ difficulty was still something he had to figure out what exactly was.

As a consequence, this study reports that a new learning methodology has been implemented that could be called as: Learning by teaching.

Future work should be evaluated in other small but not so small companies to avoid this lost opportunity to keep on using most of the agile management in installation companies. The main characteristic should be to ensure a minimum number of employees or participants so the methodology can keep on without the need of involving more people in the company.

The other aspect to keep track on is this learning by teaching methodology which is a mixture between flipped classroom and project-based learning. Having to teach something to others forces anyone to take the study more seriously, as it puts the student in a very visible situation. However, the presented process is highly individual and it might be difficult to implement it in a course with several studies.

3. Conclusions

This study presents the implementation of agile management (SCRUM specifically) in an installation small in two projects.

Results indicate report time and economic savings while substantially increasing the satisfaction of the employees and having excellent feedback from the owners of the projects and the manager of the company.

However, even though these results were very good, the total implementation of this methodology in the company was not finished and finished with these two projects. This is attributed to the fact that there were not enough people to build a numerous team and, mainly, to the fact that no-one felt himself with sufficient knowledge/attitude to be the SCRUM master. Nonetheless, some agile tools and concepts were incorporated to the day-to-day organization, such as the product backlog, the elimination of micromanagement (and the incrementation of self-organization by the workers as a consequence), and an increase in the communication flows and the eagerness to learn from errors.

This study also proposes a new learning methodology that could be called learning by teaching: a student took the role of the SCRUM master during the implementation of SCRUM to perform his final degree thesis and he clearly increased his project management knowledge while he was teaching how SCRUM works.

References

Akçay, G., & Akçay, M. (2018). The flipped classroom : A review of its advantages and challenges. *Computers & Education*, *126*(January), 334–345. doi:10.1016/j.compedu.2018.07.021

Asraf, M., & Ali, N. (2013). Impact Agile Project Management: Identification And Analysis Of Problems In Scrum Implementation. *VAWKUM Transactions on Computer Sciences*, *1*(1). doi:10.21015/VTCS.V2I2.99

Cardozo, E. S. F., Araújo Neto, J. B. F., Barza, A., França, A. C. C., & da Silva, F. Q. B. (2010). SCRUM and Productivity in Software Projects: A Systematic Literature Review. In *14th International Conference on Evaluation and Assessment in Software Engineering (EASE)* (pp. 1–4). doi:10.14236/ewic/ease2010.16

Casals Canals, L., Tejedor Herrán, B., Cremades, L. V., Amante, B., & Lopez-Grimau, V. (2022). Tools to correctly evaluate the individual contributions in a teamwork. In *26th International Congress on Project Management and Engineering* (pp. 1844–1856). Retrieved from http://dspace.aeipro.com/xmlui/handle/123456789/3301

Deemer, P., Benefield, G., Larman, C., & Vodde, B. (2010). *The SCRUM primer*. doi:1285931497-15

Deming, W. E. (2018). *Out of the Crisis*. MIT press.

Gonçalves, L. (2018). Scrum: The methodology to become more agile. *Controlling & Management Review*, *62*, 40–42. doi:10.1007/S12176-018-0020-3

Häusser, J. A., Schulz-Hardt, S., Tomaschek, A., & Mojzisch, A. (2014). Experimental

evidence for the effects of task repetitiveness on mental strain and objective work performance. *Journal of Organizational Behavior*, *35*(5), 705–721. doi:10.1002/job.1920

Lopez-Martinez, J., Juarez-Ramirez, R., Huertas, C., Jimenez, S., & Guerra-Garcia, C. (2016). Problems in the adoption of agile-scrum methodologies: A systematic literature review. In *Proceedings - 2016 4th International Conference in Software Engineering Research and Innovation, CONISOFT 2016* (pp. 141–148). doi:10.1109/CONISOFT.2016.30

Majuri, J., Koivisto, J., & Hamari, J. (2018). Gamification of education and learning: A review of empirical literature. *CEUR Workshop Proceedings*, *2186*(GamiFIN), 11–19.

Rigby, D., Elk, S., & Berez, S. (2020). *Doing Agile Right: Transformation Without Caos*. Bain & Company inc.

Sabina B. Gesell, Drain, M., & Sullivan, M. P. (2007). Test of a Web and Paper Employee Satisfaction Survey:Comparison of Respondents and Non-Respondents. *International Journal of Internet Science*, *2*(1), 45–58. Retrieved from https://www.ijis.net/ijis2_1/ijis2_1_gesell.pdf

Sutherland, J. (2014). *Scrum: The Art of Doing Twice the Work in Half the Time*. Crown Business.

Tascı, B. G. (2015). Project Based Learning from Elementary School to College, Tool: Architecture. *Procedia - Social and Behavioral Sciences*, *186*, 770–775. doi:10.1016/j.sbspro.2015.04.130

Walker, A. (2015). Systems Thinking and Construction Project Organisation. *Project Management in Construction*, 72–105. Retrieved from https://www.wiley.com/en-us/Project+Management+in+Construction%2C+6th+Edition-p-9781118500408

Communication aligned with the Sustainable Development Objectives